JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

COURSE STRUCTURE AND SYLLABUS

For UG – R20

B. TECH - FOOD ENGINEERING

(Applicable for batches admitted from 2020-2021)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

I YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Mathematics-M1	3	0	0	3
2		Fundamental Chemistry	3	0	0	3
3		Programming for Problem Solving using C	3	0	0	3
4		Communicative English	3	0	0	3
5		Engineering Drawing	1	0	4	3
6		Fundamental Chemistry Lab	0	0	3	1.5
7		Programming for Problem Solving using C Lab	0	0	3	1.5
8		English Communication Skills Laboratory	0	0	3	1.5
9		Environmental Science	3	0	0	0
Total Credits						**19.5**

I YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Mathematics-M2	3	0	0	3
2		Engineering Physics	3	0	0	3
3		Engineering Mechanics	3	0	0	3
4		Basic Electrical & Electronics Engineering	3	0	0	3
5		Computer Aided Engineering Drawing	2	0	2	3
6		Workshop Practice Laboratory	0	0	3	1.5
7		Engineering Physics Laboratory	0	0	3	1.5
8		Basic Electrical& Electronics Engineering Laboratory	0	0	3	1.5
9		Constitution of India	2	0	0	0
Total Credits						**19.5**

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II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Probability and Statistics	3	0	0	3
2		Principles of Food Engineering -I	3	0	0	3
3		Mechanical Operations in Food Processing	3	0	0	3
4		Fluid Mechanics in Food Processing	3	0	0	3
5		Food Microbiology	3	0	0	3
6		Mechanical Operations in Food Processing Lab	0	0	3	1.5
7		Fluid Mechanics in Food Processing Lab	0	0	3	1.5
8		Food Microbiology Lab	0	0	3	1.5
9		Food Handling & Storage Engineering	2	0	0	2
10		Professional Ethics &Human Values	2	0	0	0
Total Credits						**21.5**

II YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Python Programming	3	0	0	3
2		Principles of Food Engineering - II	3	0	0	3
3		Food Chemistry	3	0	0	3
4		Processing of Cereals, Pulses and Oilseeds	3	0	0	3
5		Managerial Economics & Financial Analysis	3	0	0	3
6		Python Programming Lab	0	0	3	1.5
7		Food Chemistry Lab	0	0	3	1.5
8		Processing of Cereals, Pulses and Oilseeds Lab	0	0	3	1.5
9		Instrumentation & Process Control	1	0	2	2
Total Credits						**21.5**

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I Year - I Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-M1 (Common to all Branch's for I Year B. Tech)					

Course Objectives:

- To familiarize a variety of well-known sequences and series, with a developing intuition about the behavior of newones.
- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and theirapplications.

Course Outcomes: At the end of the course, the student will be ableto

- utilize mean value theorems to real life problems(L3)
- solve the differential equations related to various engineering fields(L3)
- familiarize with functions of several variables which is useful in optimization(L3)
- Apply double integration techniques in evaluating areas bounded by region(L3)
- Students will also learn important tools of calculus in higher dimensions. Students will become familiar with 2- dimensional and 3-dimensional coordinate systems(L5)

UNIT I: Sequences, Series and Meanvaluetheorems: (10 hrs)

Sequences and Series: Convergences and divergence – Ratio test – Comparison tests – Integral test – Cauchy's root test – Alternate series – Leibnitz'srule.

Mean Value Theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders, problems and application on the above theorem.

UNIT II: Differential equations of first order andfirstdegree: (10 hrs)

Linear differential equations – Bernoulli's equations – Exact equations and equations reducible to exactform.

Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories – Electrical circuits.

UNIT III: Linear differential equations ofhigherorder: (10 hrs)

Homogenous and Non-homogeneous differential equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, $e^{ax}V(x)$ and $x^nV(x)$ – Method of Variation of parameters, Cauchy and Legendre's linear equations.

Applications: LCR circuit, Simple Harmonic motion.

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UNIT IV:Partialdifferentiation: (10 hrs)

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method.

UNIT V:Multipleintegrals: (8 hrs)

Double and Triple integrals – Change of order of integration – Change of variablesto polar, cylindrical and spherical coordinates.

Applications: Finding Areas and Volumes.

Textbooks:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd Edition, KhannaPublishers.
2. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition,Wiley-India.
2. **Joel Hass, Christopher Heil and Maurice D. Weir,** Thomas calculus, 14th Edition,Pearson.
3. **Lawrence Turyn,** Advanced Engineering Mathematics, CRC Press,2013.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford UniversityPress.

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I Year - I Semester		L	T	P	C
		3	0	0	3
FUNDAMENTAL CHEMISTRY					

Knowledge of basic concepts of Chemistry for Engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

Course Objectives:

- To familiarize chemistry and itsapplications
- To train the students on the principles and applications of electrochemistry, polymers and surfacechemistry
- To impart the concept of soft and hard waters, softening methods of hardwater

UNIT I: STRUCTURE ANDBONDINGMODELS (10 hrs)

Planck's quantum theory, dual nature of matter, significance of Ψ and Ψ^2, Schrodinger wave equation, Atomic and molecular orbitals, Linear combination of atomic orbitals (LCAO), bonding in homo- and heteronuclear diatomic molecules (level diagrams of O_2 and CO molecules), Salient features of crystal field splitting (CFT) of transition metal ion d- orbitals in tetrahedral, octahedral, and square planar geometries. Band theory of solids – band diagrams for conductors, semiconductors and insulators, Effect of doping on bandstructures.

Course Outcomes: ***At the end of this unit, the students will be able to***

- ***Apply*** Schrodinger wave equation to hydrogen and particle in abox.
- ***Illustrate***the molecular orbital energy level diagram of different molecularspecies.
- ***Explain*** the band theory of solids for conductors, semiconductors, andinsulators.
- ***Discuss***the magnetic behavior and color ofcomplexes.

UNIT II:POLYMERTECHNOLOGY (8 hrs)

Polymerisation:-Introduction, methods of polymerization (emulsion and suspension), mechanicalproperties.

Plastics: Compounding, fabrication (compression, injection, blown film and extrusion), preparation, properties, and applications (PVC, polycarbonates and Bakelite), mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste (waste to wealth).

Elastomers: **-** Introduction, preparation, properties and applications (Buna S, thiokol and polyurethanes).

Composite materials: Fiber reinforced plastics, conducting polymers, biodegradablepolymers, biopolymers, biomedicalpolymers.

Course Outcomes: ***At the end of this unit, the students will be able to***

- ***Analyze*** the different types of composite plastic materials and ***interpret***the mechanism of conduction in conductingpolymers.

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UNIT III: ELECTROCHEMICAL CELLSANDCORROSION (10 hrs)

Single electrode potential, electrochemical series and uses of series, standard hydrogen electrode, calomel electrode, construction of glass electrode, batteries (Dry cell, Li ion battery and zinc air cells), fuel cells (H_2-O_2, CH_3OH-O_2, phosphoric acid and molten carbonate).

Corrosion: -Definition, theories of corrosion (chemical and electrochemical), galvanic corrosion, differential aeration corrosion, stress corrosion, galvanic series, factors influencing rate of corrosion, corrosion control (proper designing and cathodic protection), Protective coatings (surface preparation, cathodic coatings, anodic coatings, electroplating and electroless plating [nickel]).

Course Outcomes: ***At the end of this unit, the students will be able to***

- ***Utilize*** the theory of construction of electrodes, batteries and fuel cells in redesigning new engineering products and c***ategorize*** the reasons for corrosion and study methods to controlcorrosion.

UNIT IV:SURFACECHEMISTRY (10 hrs)

Introduction to surface chemistry, colloids, nanometals and nanometal oxides, micelle formation, synthesis of colloids (any two methods with examples), preparation of nanometals (chemical reduction method) and metal oxides (sol-gel method), characterization of surface by physicochemical methods (SEM, TEM, X-ray diffraction), BET equation (no derivation), calculation of specific surface area of solids, applications of colloids and nanomaterials.

Thermal analysis techniques: Instrumentation and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA).

Course Outcomes: ***At the end of this unit, the students will be able to***

- ***Summarize*** the applications of SEM, TEM and X-ray diffraction in surfacecharacterization.
- ***Explain***the synthesis of colloids with examples.
- ***Outline***the preparation of nanomaterials and metal oxides.
- ***Identify*** the application of colloids and nanomaterials in medicine, sensors andcatalysis

UNIT V:WATERTECHNOLOGY (8 hrs)

Hardness of water, determination of hardness by complexometric method, boiler troubles (priming and foaming, scale formation, boiler corrosion, caustic embrittlement), internal treatments, softening of hard water (zeolite process and related sums, ion exchange process), treatment of industrial waste water, potable water and its specifications, steps involved in purification of water, chlorination, break point chlorination-desalination (reverse osmosis and electro dialysis).

Course Outcomes: ***At the end of this unit, the students will be able to***

- ***Analyze*** the suitable methods for purification and treatment of hard water andbrackish water.

Standard Books:

1. P.C. Jain and M. Jain "**Engineering Chemistry**", 15/e, Dhanpat Rai & Sons, Delhi, (Latestedition).
2. Shikha Agarwal, "**Engineering Chemistry**", Cambridge University Press, NewDelhi, (2019).

3. S.S. Dara, "**A Textbook of Engineering Chemistry**", S.Chand& Co,(2010).
4. Shashi Chawla, "Engineering Chemistry", Dhanpat Rai Publicating Co. (Latestedition).

References:

1. K. SeshaMaheshwaramma and MridulaChugh, "**Engineering Chemistry**", Pearson India Edn.
2. O.G. Palana, "**Engineering Chemistry**", Tata McGraw Hill Education PrivateLimited, (2009).
3. CNR Rao and JM Honig (Eds) "**Preparation and characterization of materials**" Academic press, New York (latestedition)
4. B. S. Murthy, P. Shankar and others, "**Textbook of Nanoscience and Nanotechnology**", University press (latestedition)

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I Year - I Semester		L	T	P	C
		3	0	0	3
PROGRAMMING FOR PROBLEM SOLVING USING C					

COURSE OBJECTIVES:

The objectives of Programming for Problem Solving Using C are

1) To learn about the computer systems, computing environments, developing of a computer program and Structure of a CProgram
2) To gain knowledge of the operators, selection, control statements and repetition inC
3) To learn about the design concepts of arrays, strings, enumerated structure, and union types. To learn about theirusage.
4) To assimilate about pointers, dynamic memory allocation and know the significance of Pre-processor.
5) To assimilate about File, I/O and significance offunctions

UNIT I

Introduction to Computers: Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers

Introduction to the C Language: Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers.

Structure of a C Program: Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.

UNIT II

Bitwise Operators: Exact Size Integer Types, Logical Bitwise Operators, Shift Operators.

Selection & Making Decisions: Logical Data and Operators, Two Way Selection, Multiway Selection, More Standard Functions

Repetition: Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples

UNIT III

Arrays: Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages

Strings: String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code

Enumerated, Structure, and Union: The Type Definition (Type def), Enumerated Types, Structure, Unions, and Programming Application

UNIT IV

Pointers: Introduction, Pointers to pointers, Compatibility, L value and R value

Pointer Applications: Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application

Processor Commands: Processor Commands

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UNIT V

Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion

Text Input / Output: Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions

Binary Input / Output: Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

TEXTBOOKS:

1. Programming for Problem Solving, Behrouz A. Forouzan, Richard F.Gilberg,CENGAGE
2. The C Programming Language, Brian W.Kernighan, Dennis M. Ritchie, 2e,Pearson

REFERENCES:

1. Computer Fundamentals and Programming, Sumithabha Das, Mc GrawHill
2. Programming in C, Ashok N. Kamthane, Amit Kamthane,Pearson
3. Computer Fundamentals and Programming in C, PradipDey, ManasGhosh,OXFORD

COURSE OUTCOMES:

Upon the completion of the course the student will learn

1) To write algorithms and to draw flowcharts for solvingproblems
2) To convert flowcharts/algorithms to C Programs, compile and debugprograms
3) To use different operators, data types and write programs that use two-way/ multi-way selection
4) To select the best loop construct for a given problem
5) To design and implement programs to analyze the different pointerapplications
6) To decompose a problem into functions and to develop modular reusablecode
7) To apply File I/Ooperations

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I Year - I Semester		L	T	P	C
		3	0	0	3
COMMUNICATIVE ENGLISH					

Introduction

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

Course Objectives

- Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Learning Outcomes

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

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Unit I

Lesson-1: A Drawer full of happiness from "**Infotech English**", Maruthi Publications

Lesson-2: Deliverance by Premchandfrom "**The Individual Society",**Pearson Publications. (Non-detailed)

Listening: Listening to short audio texts and identifying the topic. Listening to prose, prose and conversation.
Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests. Self introductions and introducing others.
Reading: Skimming text to get the main idea. Scanning to look for specific pieces of information.
Reading for Writing: Paragraph writing (specific topics) using suitable cohesive devices; linkers, sign posts and transition signals; mechanics of writing - punctuation, capital letters.
Vocabulary: Technical vocabulary from across technical branches (20) GRE Vocabulary (20) (Antonyms and Synonyms, Word applications) Verbal reasoning and sequencing of words.
Grammar: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural basic sentence structures; simple question form - wh-questions; word order in sentences.
Pronunciation: Vowels, Consonants, Plural markers and their realizations

Unit II

Lesson-1: Nehru's letter to his daughter Indira on her birthday from "**Infotech English**", Maruthi Publications

Lesson-2: Bosom Friend by Hira Bansodefrom "**The Individual Society",** Pearson Publications.(Non-detailed)

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts, both in speaking and writing.

Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings.**Reading**: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary Analogies (20 words) (Antonyms and Synonyms, Word applications)

Grammar: Use of articles and zero article; prepositions.

Pronunciation: Past tense markers, word stress-di-syllabic words

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Unit III

Lesson-1: Stephen Hawking-Positivity 'Benchmark' from "**Infotech English**", Maruthi Publications

Lesson-2: Shakespeare's Sister by Virginia Woolf from "**The Individual Society",** Pearson Publications. (Non-detailed**)**

Listening: Listening for global comprehension and summarizing what is listened to, both in speaking and writing.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed.FunctionalEnglish:Complaining and Apologizing.
Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension.Critical reading.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. Letter writing-types, format and principles of letter writing.E-mail etiquette, Writing CV's.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Association, sequencing of words

Grammar: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

Pronunciation: word stress-poly-syllabic words.
Unit IV

Lesson-1: Liking a Tree, Unbowed: Wangari Maathai-biography from "**Infotech English**", Maruthi Publications

Lesson-2: Telephone Conversation-Wole Soyinka from "**The Individual Society",** Pearson Publications**.**(Non-detailed)

Listening: Making predictions while listening to conversations/ transactional dialogues without video (only audio); listening to audio-visual texts.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.Functional English: Permissions, Requesting, Inviting.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicative process or display complicated data.
Reading for Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables.Writing SOP, writing for media.
Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Cloze Encounters.

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Grammar: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

Pronunciation: Contrastive Stress

Unit V

Lesson-1: Stay Hungry-Stay foolish from "**Infotech English**", Maruthi Publications

Lesson-2: Still I Rise by Maya Angelou from "**The Individual Society",** Pearson Publications.(Non-detailed)

Listening: Identifying key terms, understanding concepts and interpreting the concepts both in speaking and writing.

Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides.Functional English: Suggesting/Opinion giving.
Reading: Reading for comprehension. RAP StrategyIntensive reading and Extensive reading techniques.
Reading for Writing: Writing academic proposals- writing research articles: format and style.
Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Coherence, matching emotions.

Grammar: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Pronunciation: Stress in compound words
Prescribed text books for theory for Semester-I:

1. "**Infotech English**", Maruthi Publications. (Detailed)

2."**The Individual Society",** Pearson Publications.(Non-detailed)

Prescribed text book for Laboratory for Semesters-I & II:

1. "**Infotech English**", Maruthi Publications. (with Compact Disc)

Reference Books:

- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking.* Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.

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I Year - I Semester		L	T	P	C
		1	0	4	3

ENGINEERING DRAWING

Course Objective: Engineering drawing being the principal method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

Unit I

Objective: To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.

Polygons: Constructing regular polygons by general methods, inscribing and describing polygons oncircles.

Curves: Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents &normals for the curves.

Scales: Plain scales, diagonal scales and Vernier scales

Unit II

Objective: To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.

Orthographic Projections: Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to otherplane.

Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces.

Unit III

Objective: The objective is to make the students draw the projections of the plane inclined to both the planes.

Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

Unit IV

Objective: The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.

Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

UnitV

Objective: The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.

Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

Computer Aided Design, Drawing practice using Auto CAD, Creating 2D&3D drawings of objects using Auto CAD

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Note: In the End Examination there will be no question from CAD.

TEXTBOOKS:

1. Engineering Drawing by N.D. Butt, ChariotPublications
2. Engineering Drawing by Agarwal & Agarwal, Tata McGraw HillPublishers

REFERENCE BOOKS:

1. Engineering Drawing by K.L.Narayana& P. Kannaiah, ScitechPublishers
2. Engineering Graphics for Degree by K.C. John, PHIPublishers
3. Engineering Graphics by PI Varghese, McGrawHillPublishers
4. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, NewAge

Course Outcome: The student will learn how to visualize 2D & 3D objects.

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I Year - I Semester		L	T	P	C
		0	0	3	1.5

FUNDAMENTAL CHEMISTRY LAB

Introduction to Chemistry laboratory – Molarity, normality, primary, secondary standard solutions, volumetric titrations, quantitative analysis

1. Determination of HCl using standard Na2CO3solution.
2. Determination of alkalinity of a sample containing Na2CO3 andNaOH.
3. Determination of Mn (II) using standard oxalic acidsolution.
4. Determination of ferrous iron using standard K2Cr2O7solution.
5. Determination of copper (II) using standard hyposolution.
6. Determination of temporary and permanent hardness of water using standardEDTA solution.
7. Determination of iron (III) by a colorimetricmethod.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metry method).
9. Determination of iso-electric point of amino acids using pH-metry method/conductometricmethod.
10. Determination of the concentration of strong acid vs strong base (byconductometric method).
11. Determination of strong acid vs strong base (by potentiometricmethod).
12. Determination of Mg+2 present in an antacid.
13. Determination of CaCO3 present in an eggshell.
14. Estimation of VitaminC.
15. Determination of phosphoric content in softdrinks.
16. Adsorption of acetic acid bycharcoal.
17. Preparation of nylon-6, 6 and Bakelite (demonstrationonly).

Of the above experiments at-least 10 assessment experiments should be completed in a semester.

Outcomes: The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis; redox titrations with different indicators; EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They thus acquire some experimental skills.

Reference Books

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

I Year - I Semester		L	T	P	C
		0	0	3	1.5
PROGRAMMING FOR PROBLEM SOLVING USING C LABORATORY					

Course Objectives:

1) Apply the principles of C language in problemsolving.
2) To design flowcharts, algorithms and knowing how to debugprograms.
3) To design & develop of C programs using arrays, strings pointers &functions.
4) To review the file operations, preprocessorcommands.

Exercise 1:

1. Write a C program to print a block F using hash (#), where the F has a height of sixcharacters and width of five and fourcharacters.
2. Write a C program to compute the perimeter and area of a rectangle with a height of 7inches and width of 5inches.
3. Write a C program to display multiplevariables.

Exercise 2:

1. Write a C program to calculate the distance between the twopoints.
2. Write a C program that accepts 4 integers' p, q, r, s from the user where r and s are positive and p is even. If q is greater than r and s is greater than p and if the sum of r and s is greaterthan the sum of p and q print "Correct values", otherwise print "Wrongvalues".

Exercise 3:

1. Write a C program to convert a string to a longinteger.
2. Write a program in C which is a Menu-Driven Program to compute the area of thevariousgeometricalshape.
3. Write a C program to calculate the factorial of a givennumber.

Exercise 4:

1. Write a program in C to display the n terms of even natural number and theirsum.
2. Write a program in C to display the n terms of harmonic series and their sum. 1 + 1/2 + 1/3 + 1/4 + 1/5 ... 1/nterms.
3. Write a C program to check whether a given number is an Armstrong number ornot.

Exercise 5:

1. Write a program in C to print all unique elements in anarray.
2. Write a program in C to separate odd and even integers in separatearrays.
3. Write a program in C to sort elements of array in ascendingorder.

Exercise 6:

1. Write a program in C for multiplication of two squareMatrices.
2. Write a program in C to find transpose of a givenmatrix.

Exercise 7:

1. Write a program in C to search an element in a row wise and column wise sortedmatrix.
2. Write a program in C to print individual characters of string in reverseorder.

Exercise 8:

1. Write a program in C to compare two strings without using string libraryfunctions.

2. Write a program in C to copy one string to anotherstring.

Exercise 9:

1. Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
2. Write a program in C to demonstrate how to handle the pointers in theprogram.

Exercise 10:

1. Write a program in C to demonstrate the use of & (address of) and *(value at address) operator.
2. Write a program in C to add two numbers usingpointers.

Exercise 11:

1. Write a program in C to add numbers using call byreference.
2. Write a program in C to find the largest element using Dynamic MemoryAllocation.

Exercise 12:

1. Write a program in C to swap elements using call byreference.
2. Write a program in C to count the number of vowels and consonants in a string usinga pointer.

Exercise 13:

1. Write a program in C to show how a function returningpointer.
2. Write a C program to find sum of n elements entered by user. To perform thisprogram, allocate memory dynamically using malloc( )function.

Exercise 14:

1. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc( ) function. Understand the difference betweenthe above twoprograms
2. Write a program in C to convert decimal number to binary number using thefunction.

Exercise 15:

1. Write a program in C to check whether a number is a prime number or not using thefunction.
2. Write a program in C to get the largest element of an array using thefunction.

Exercise 16:

1. Write a program in C to append multiple lines at the end of a textfile.
2. Write a program in C to copy a file in anothername.
3. Write a program in C to remove a file from thedisk.

Course Outcomes:

By the end of the Lab, the student

1) Gains Knowledge on various concepts of a Clanguage.
2) Able to draw flowcharts and writealgorithms.
3) Able design and development of C problem solvingskills.
4) Able to design and develop modular programmingskills.
5) Able to trace and debug aprogram

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
ENGLISH COMMUNICATION SKILLS LABORATORY					

TOPICS

UNIT I:

Vowels, Consonants, Pronunciation, Phonetic Transcription, Common Errors in Pronunciation,

UNIT II:

Word stress-di-syllabic words, poly-syllabic words, weak and strong forms, contrastive stress (Homographs)

UNIT III:

Stress in compound words, rhythm, intonation, accentneutralization.

UNIT IV:

Listening to short audio texts and identifying the context and specific pieces of information to answer a series of questions in speaking.

UNIT V:

Newspapers reading; Understanding and identifying key terms and structures useful for writing reports.

Prescribed textbook: "**Infotech English**", Maruthi Publications.

References:

1. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
2. English Pronunciation in use- Mark Hancock, Cambridge University Press.
3. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
4. English Pronunciation in use- Mark Hewings, Cambridge University Press.
5. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
6. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.

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I Year - I Semester		L	T	P	C
		3	0	0	0
ENVIRONMENTAL SCIENCE					

Learning Objectives:

The objectives of the course are to impart:

- Overall understanding of the naturalresources.
- Basic understanding of the ecosystem and itsdiversity.
- Acquaintance on various environmental challenges induced due tounplannedanthropogenicactivities.
- An understanding of the environmental impact of developmentalactivities.
- Awareness on the social issues, environmental legislation and globaltreaties.

UNIT-I:

Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance – Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects;. Role of information technology in environment and human health.

Ecosystems: Concept of an ecosystem. - Structure and function of an ecosystem; Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

UNIT-II:

Natural Resources: Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; equitable use of resources for sustainable lifestyles.

UNIT-III:

Biodiversity and its conservation: Definition: genetic, species and ecosystem diversity-classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-sports of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation ofbiodiversity.

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UNIT – IV Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and hiswellbeing.

Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

UNIT – V Social Issues and the Environment: Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act -Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Public awareness.

Environmental Management: Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

Textbooks:

1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers,Vijayawada
2. Environmental Studies, R. Rajagopalan, 2nd Edition, 2011, Oxford UniversityPress.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. ManjulaRani; Pearson Education,Chennai

Reference:

1. Text Book of Environmental Studies, Deeshita Dave & P. UdayaBhaskar, CengageLearning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, NewDelhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, NewDelhi
4. Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik, New AgeInternational Publishers, 2014

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I Year - II Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-M2					

Course Objectives:

- To instruct the concept of Matrices in solving linear algebraicequations
- To elucidate the different numerical methods to solve nonlinear algebraicequations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and theirapplications.

Course Outcomes: At the end of the course, the student will be able to

- develop the use of matrix algebra techniques that is needed by engineers for practical applications(L6)
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel(L3)
- evaluate approximating the roots of polynomial and transcendental equations by different algorithms(L5)
- apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals(L3)
- apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations(L3)

Unit I: Solving systems of linear equations, Eigen values and Eigen vectors: (10 hrs)

Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous equations linear equations – Gauss Elimination for solving system of equations – Eigen values and Eigen vectors and their properties (article-2.14 in text book-1).

Unit-II: Cayley-Hamilton theorem andQuadraticforms: (10 hrs)

Cayley-Hamilton theorem (without proof) – Applications – Finding the inverse and power of a matrix by Cayley-Hamilton theorem – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms – Reduction of quadratic form to canonical forms by orthogonal transformation.

Singular values of a matrix, singular value decomposition (text book-3).

UNIT III:Iterative methods: (8 hrs)

Introduction – Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations) – Jacobi and Gauss-Seidel methods for solving system of equations numerically.

UNITIV:Interpolation: (10 hrs)

Introduction – Errors in polynomial interpolation – Finite differences – Forward differences – Backward differences – Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula – Newton's divide difference formula.

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UNIT V: Numerical differentiation and integration, Solution of ordinary differential equations withinitial conditions: (10 hrs)

Numerical differentiation using interpolating polynomial – Trapezoidal rule– Simpson's 1/3rd and 3/8th rule– Solution of initial value problems by Taylor's series– Picard's method of successive approximations– Euler's method – Runge-Kutta method (second and fourth order).

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, 43rd Edition, KhannaPublishers.

2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

3. David Poole, Linear Algebra- A modern introduction, 4th Edition,Cengage.

Reference Books:

1. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. GrawHillEducation.

2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and EngineeringComputation, New Age InternationalPublications.

3. Lawrence Turyn, Advanced Engineering Mathematics, CRCPress.

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B. Tech-FOOD ENGINEERING

I Year - II Semester		L	T	P	C
		3	0	0	3
ENGINEERING PHYSICS					

UNIT-IWAVEOPTICS (12hrs)

INTERFERENCE: Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications -Colors in thin films- Newton's Rings-Determination of wavelength and refractiveindex.

DIFFRACTION: Introduction - Fresnel and Fraunhofer diffraction - Fraunhofer diffraction due to single slit, double slit - N-slits (Qualitative) – Grating - Dispersive power and resolving power of Grating (Qualitative).

POLARIZATION: Introduction-Types of polarization - Polarization by reflection, refraction and double refraction - Nicol's Prism -Half wave and Quarter wave plates.

Outcome:

The students will be able to

- Explain the need of coherent sources and the conditions for sustained interference(L2)
- Identify engineering applications of interference(L3)
- Analyse the differences between interference and diffraction with applications(L4)
- Illustrate the concept of polarization of light and its applications(L2)
- Classify ordinary polarized light and extraordinary polarized light(L2)

UNIT-II LASERS ANDFIBEROPTICS (10hrs)

LASERS: Introduction – Characteristics of laser – Spontaneous and Stimulated emissions of radiation – Einstein's coefficients – Population inversion –Lasing action- Pumping mechanisms –Ruby laser – He-Ne laser - Applications oflasers

FIBER OPTICS: Introduction –Principle of optical fiber- Acceptance Angle-Numerical Aperture- Classification of optical fibers based on refractive index profile and modes – Propagation of electromagnetic wave through optical fibers – Applications.

Outcome:

The students will be able to

- Understand the basic concepts of LASER light Sources (L2)
- Apply the concepts to learn the types of lasers(L3)
- Identifies the Engineering applications of lasers(L2)
- Explain the working principle of optical fibers(L2)
- Classify optical fibers based on refractive index profile and mode of propagation(L2)
- Identify the applications of optical fibers in various fields(L2)

UNIT-IIIENGINEERINGMATERIALS (8hrs)

DIELECTRIC MATERIALS: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility and Dielectric constant - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field- Clausius- Mossotti equation-Piezoelectricity.

MAGNETIC MATERIALS: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability - Origin of permanent magnetic moment -

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Classification of magnetic materials: Dia, para, Ferro, antiferro&Ferrimagnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials- Eddy currents- Engineering applications.

Outcome:

The students will be able to

- Explain the concept of dielectric constant and polarization in dielectric materials(L2)
- Summarize various types of polarization of dielectrics(L2)
- Interpret Lorentz field and Claussius- Mosotti relation indielectrics(L2)
- Classify the magnetic materials based on susceptibility and their temperature dependence(L2)
- Explain the applications of dielectric and magnetic materials(L2)
- Apply the concept of magnetism to magnetic devices(L3)

UNIT-IV ACOUSTICSANDULTRASONIC (10hrs)

ACOUSTICS: Introduction – requirements of acoustically good hall– Reverberation – Reverberation time– Sabine's formula (Derivation using growth and decay method) - Absorption coefficient and its determination – Factors affecting acoustics of buildings and their remedial measures.

ULTRASONICS: Introduction - Properties - Production by magnetostriction and piezoelectric methods– Detection - Acoustic grating - Non Destructive Testing – pulse echo system through transmission and reflection modes - Applications

Outcome:

The students will be able to

- Explain how sound is propagated in buildings(L2)
- Analyse acoustic properties of typically used materials in buildings(L4)
- Recognize sound level disruptors and their use in architectural acoustics(L2)
- Identify the use of ultrasonics in different fields(L3)

UNIT-V CRYSTALLOGRAPHY ANDX-RAY DIFFRACTION (10hrs)

CRYSTALLOGRAPHY: Space lattice, Basis, Unit Cell and lattice parameters – Bravais Lattice – crystal systems (3D) – coordination number - packing fraction of SC, BCC & FCC - Miller indices – separation between successive (hkl)planes.

X- RAY DIFFRACTION: Bragg's law - X-ray Diffractometer – crystal structure determination by Laue'sandpowdermethods

Outcome:

The students will be able to

- Classify various crystal systems(L2)
- Identify different planes in the crystal structure(L3)
- Analyse the crystalline structure by Bragg's X-ray diffractometer(L4)
- Apply powder method to measure the crystallinity of a solid(L4)

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Textbooks:

1. Engineering Physics – Dr. M.N. Avadhanulu& Dr. P.G. Kshirsagar, S. Chand and Company.
2. Engineering physics – D.K. Battacharya and Poonam Tandon, Oxford Universitypress.
3. Engineering Physics by P.K.PalanisamySciTechpublications.

Reference Books:

1. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley&Sons
2. Engineering Physics – M.R.Srinivasan, New AgePublications
3. Engineering Physics – D K Pandey, S. Chaturvedi, CengageLearning
4. Engineering Physics - Sanjay D. Jain, D. Sahasrambudhe and Girish, UniversityPress

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

I Year - II Semester		L	T	P	C
		3	0	0	3
ENGINEERING MECHANICS					

Objectives: The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion, friction and application of work - energy method.

UNIT – I

Objectives: The students are to be exposed to the concepts of force and friction, direction and its application.

Introduction to Engg. Mechanics – Basic Concepts.

Systems of Forces: Coplanar Concurrent Forces – Components in Space – Resultant – Moment of Force and its Application – Couples and Resultant of Force Systems.

Friction: Introduction**,** limiting friction and impending motion, coulomb's laws of dry friction, coefficient of friction, cone of friction

UNIT II

Objectives: The students are to be exposed to application of free body diagrams. Solution to problems using graphical methods and law of triangle offorces.

Equilibrium of Systems of Forces: Free Body Diagrams, ,Lami'sTheorm, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses.

UNIT – III

Objectives: The students are to be exposed to concepts of centre of gravity. The students are to be exposed to concepts of moment of inertia and polar moment of inertia including transfer methods and their applications.

Centroid: Centroids of simple figures (from basic principles) – Centroids of Composite Figures

Centre of Gravity: Centre of gravity of simple body (from basic principles), centre of gravity of composite bodies, Pappus theorems.

Area moments of Inertia: Definition – Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia.

Mass Moment of Inertia: Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, mass moment of inertia of compositebodies.

UNIT – IV

Objectives: The students are to be exposed to motion in straight line and in curvilinear paths, its velocity and acceleration computation and methods of representing plane motion.

Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics- Work Energy method and applications to particle motion- Impulse momentum method.

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UNIT – V

Objectives: The students are to be exposed to rigid motion kinematics and kinetics

Rigid body Motion: Kinematics and kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse momentum method.

TEXT BOOK:

1. Engg. Mechanics - S.Timoshenko&D.H.Young., 4th Edn- , Mc Graw Hill publications.

Course outcomes:

1. The student should be able to draw free body diagrams for FBDs for particles and rigidbodies in plane and space and problems to solve the unknown forces, orientations and geometric parameters.
2. He should be able to determine centroid for lines, areas and center of gravity for volumesandtheircomposites.
3. He should be able to determine area and mass movement of inertia for compositesections
4. He should be able to analyze motion of particles and rigid bodies and apply the principlesof motion, work energy and impulse –momentum.

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B. Tech-FOOD ENGINEERING

I Year - II Semester		L	T	P	C
		3	0	0	3
BASIC ELECTRICAL & ELECTRONICS ENGINEERING					

Preamble:

This course covers the topics related to analysis of various electrical circuits, operation of various electrical machines and electronic components to perform well in their respective fields.

Learning Objectives:

- To learn the basic principles of electrical circuital law's and analysis ofnetworks.
- To understand principle of operation and construction details of DCmachines.
- To understand principle of operation and construction details of transformers,alternator and 3-Phase inductionmotor.
- To study operation of PN junction diode, half wave, full wave rectifiers andOP-AMPs.
- To learn operation of PNP and NPN transistors and variousamplifiers.

Unit - I

Electrical Circuits

Basic definitions – types of network elements – Ohm's Law – Kirchhoff's Laws – inductive networks – capacitive networks – series – parallel circuits – star-delta and delta-star transformations.-Numerical Problems.

Unit - II

DC Machines

Principle of operation of DC generator – EMF equation – types of DC machines – torque equation characteristics of DC motors – applications – three point starter – speed control methods of DC motor – Swinburne's Test-Brake test on DC shunt motor-Numericalproblems.

Unit - III

AC Machines:

Transformers

Principle of operation and construction of single phase transformers – EMF equation – Losses – OC & SC tests – efficiency and regulation-Numerical Problems.

AC Rotating Machines

Principle of operation and construction of alternators – types of alternators Regulation of alternator by synchronous impedance method – principle of operation of synchronous motor – principle of operation of 3-Phase induction motor – slip-torque characteristics – efficiency – applications- Numerical Problems.

Unit IV

Rectifiers & Linear ICs

PN junction diodes – diode applications (half wave and bridge rectifiers). Characteristics of operation amplifiers (OP-AMP) – application of OP-AMPs (inverting, non-inverting, integrator and differentiator)-Numerical Problems.

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Unit V

Transistors

PNP and NPN junction transistor, transistor as an amplifier– frequency response of CE amplifier – Basic concepts of feedback amplifier-Numericalproblems.

Learning Outcomes:

The student should be able to:

- Analyse various electrical networks.
- Understand operation of DC generators,3-point starter and DC machine testing by Swinburne's Test and Braketest.
- Analyse performance of single-phase transformer and acquire proper knowledge and working of 3-phase alternator and 3-phase inductionmotors.
- Analyse operation of half wave, full wave bridge rectifiersandOP-AMPs.
- Understanding operations of CE amplifier and basic concept of feedbackamplifier.

Text Books:

1. Electrical Technology by Surinder Pal Bali, PearsonPublications.
2. Electronic Devices and Circuits by R.L. Boylestad and Louis Nashelsky, 9th edition, PEI/PHI 2006.

Reference Books:

1. Electrical Circuit Theory and Technology by John Bird, Routledge Taylor &FrancisGroup
2. Basic Electrical Engineering by M.S.Naidu and S.Kamakshiah, TMHPublications
3. Fundamentals of Electrical Engineering by Rajendra Prasad, PHI Publications, 2ndedition
4. Basic Electrical Engineering by Nagsarkar, Sukhija, Oxford Publications, 2ndedition
5. Industrial Electronics by G.K. Mittal,PHI

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I Year - II Semester		L	T	P	C
		2	0	2	3

COMPUTER AIDED ENGINEERING DRAWING

Course Objective: To enhance the student's knowledge and skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing and modelling.

UNIT-I:

Objective: The knowledge of projections of solids is essential in 3D modelling and animation. The student will be able to draw projections of solids. The objective is to enhance the skills they already acquired in their earlier course in drawing of projection.

PROJECTIONS OF SOLIDS: Projections of Regular Solids inclined to both planes – AuxiliaryViews.

UNIT-II:

The knowledge of sections of solids and development of surfaces is required in designing and manufacturing of the objects. Whenever two or more solids combine, a definite curve is seen at their intersection.

SECTIONS OF SOLIDS: Sections and Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views.

DEVELOPMENT AND INTERPENETRATION OF SOLIDS: Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid, Cone and their parts.

UNIT-III:

The intersection of solids also plays an important role in designing and manufacturing. The objective is to impart this knowledge through this topic. A perspective view provides a realistic 3D View of an object. The objective is to make the students learn the methods of Iso and Perspective views.

INTERPENETRATION OF RIGHT REGULAR SOLIDS: Intersection of Cylinder Vs Cylinder, Cylinder Vs Prism, Cylinder Vs Cone, Prism Vs Cone.

PERSPECTIVE PROJECTIONS: Perspective View: Points, Lines, Plane Figures and Simple Solids, Vanishing Point Methods (General Method only).

In part B computer aided drafting is introduced.

UNIT IV:

The objective is to introduce various commands in AutoCAD to draw the geometric entities and to create 2D and 3D wire frame models.

INTRODUCTION TO COMPUTER AIDED DRAFTING: Generation of points, lines, curves, polygons, dimensioning. Types of modelling: object selection commands – edit, zoom, cross hatching, pattern filling, utility commands, 2D wire frame modelling, 3D wire frame modelling,.

UNIT V:

By going through this topic the student will be able to understand the paper-space environment thoroughly.

VIEW POINTS AND VIEW PORTS: view point coordinates and view(s) displayed, examples to exercise different options like save, restore, delete, joint, single option

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

The objective is to make the students create geometrical model of simple solids and machine parts and display the same as an Isometric, Orthographic or Perspective projection.
COMPUTER AIDED SOLID MODELING: Isometric projections, orthographic projections of isometric projections, Modeling of simple solids, Modeling of Machines & Machine Parts.

TEXT BOOKS:

1. Engineering drawing by N.D Bhatt, Charotarpublications.
2. Engineering Graphics, K.C. john, PHIPublications

REFERENCES:

1. Mastering Auto CAD 2013 and Auto CAD LT 2013 – George Omura, Sybex
2. Auto CAD 2013 fundamentals- Elisemoss, SDCPubl.
3. Engineering Drawing and Graphics using Auto Cad – T Jeyapoovan,vikas
4. Engineering Drawing + AutoCAD – K Venugopal, V. Prabhu Raja, NewAge
5. Engineering Drawing – RK Dhawan, SChand
6. Engineering Drawing – MB Shaw, BC Rana,Pearson
7. Engineering Drawing – KL Narayana, P Kannaiah,Scitech
8. Engineering Drawing – Agarwal and Agarwal, Mc GrawHill
9. Engineering Graphics – PI Varghese, Mc GrawHill
10. Text book of Engineering Drawing with auto-CAD, K.venkatareddy/B.S.publications.
11. Engineering Drawing with Auto CAD/ James D Bethune/PearsonPublications
12. Engineering Graphics with Auto CAD/Kulkarni D.M, Rastogi A.P, SarkarA.K/PHI Publications

End Semester examination shall be conducted for **Four** hours with the following pattern:
a) Two hours-Conventionaldrawing
b) Two hours – Computer AidedDrawing

Course outcomes:

1. Student get exposed on working of sheet metal with help of development ofsurfaces.
2. Student understands how to know the hidden details of machine components with the help of sections and interpenetrations ofsolids.
3. Student shall exposed to modeling commands for generating 2D and 3D objects using computer aided drafting tools which are useful to create machine elements for computer aided analysis

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B. Tech-FOOD ENGINEERING

I Year - II Semester		L	T	P	C
		0	0	3	1.5
WORKSHOP PRACTICE LAB					

Course Objective: To impart hands-on practice on basic engineering trades and skills.
Note: At least two exercises to be done from each trade.
Trade:

1. **Carpentry**	1. T-LapJoint
	2. Cross LapJoint
	3. Dovetail Joint
	4. Mortise and TenonJoint
2. Fitting	1. Vee Fit
	2. SquareFit
	3. Half RoundFit
	4. DovetailFit
3. BlackSmithy	1. Round rod to Square
	2. S-Hook
	3. Round Rod to FlatRing
	4. Round Rod to Square headedbolt
4. HouseWiring	1. Parallel / Series Connection of threebulbs
	2. Staircasewiring
	3. Florescent LampFitting
	4. Measurement of Earth Resistance
5. **TinSmithy**	1. Taper Tray
	2. Square Box withoutlid
	3. OpenScoop
	4. Funnel
6. **ITWorkshop**	1.Assembly & Disassembly ofComputer

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I Year - II Semester		L	T	P	C
		0	0	3	1.5
ENGINEERING PHYSICS LAB					

(Any 10 of the following listed 15 experiments)

LIST OF EXPERIMENTS:

1. Laser: Determination of wavelength using diffractiongrating.
2. Young's modulus of given material by Strain gaugemethod.
3. Study of variation of magnetic field along the axis of a current carrying circular coil by Stewart &Gee'smethod.
4. Determination of ultrasonic velocity in given liquid (Acousticgrating).
5. Determination of dielectric constant using charging and dischargingmethod.
6. Study the variation of B versus H by magnetizing the magnetic material (B-Hcurve).
7. Estimation of Planck's constant using photoelectriceffect.
8. Rigidity modulus of material of a wire-dynamic method (Torsionalpendulum).
9. Determination of numerical aperture and acceptance angle of an opticalfiber.
10. Determination of thickness of thin object by wedgemethod.
11. Determination of radius of curvature of given plano convex lens by Newton'srings.
12. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidenceconfiguration.
13. Determination of dispersive power of theprism.
14. Sonometer: Verification of laws ofstring.
15. Measurement of magnetic susceptibility by Kundt'stubemethod

References:

S. Balasubramanian, M.N. Srinivasan "A Text book of Practical Physics"- S ChandPublishers, 2017.

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I Year - II Semester		L	T	P	C
		0	0	3	1.5
BASICS ELECTRICAL & ELECTRONICS ENGINEERING LAB					

Learning Objectives:

- To predetermine the efficiency of dc shunt machine using Swinburne'stest.
- To predetermine the efficiency and regulation of 1-phase transformer withO.C and S.C tests.
- To obtain performance characteristics of DC shunt motor &3-phase inductionmotor.
- To find out regulation of an alternator with synchronous impedancemethod.
- To control speed of dc shunt motor using Armature voltage and Field fluxcontrol methods.
- To find out the characteristics of PN junction diode &transistor
- To determine the ripple factor of half wave & full waverectifiers.

Section A: Electrical Engineering:

The following experiments are required to be conducted as compulsory experiments:

1. Swinburne's test on D.C. Shunt machine (predetermination of efficiency of a given D.C. shunt machine working as motor andgenerator).
2. OC and SC tests on single phase transformer (predetermination of efficiency andregulation at given powerfactors).
3. Brake test on 3-phase Induction motor (determination of performancecharacteristics)
4. Regulation of alternator by Synchronous impedancemethod.
5. Speed control of D.C. Shunt motor by

a) Armature Voltage control b) Field flux control method

6. Brake test on D.C. ShuntMotor.

Section B: Electronics Engineering:

The following experiments are required to be conducted as compulsory experiments:

1. PN junction diode characteristics a) Forward bias b) Reverse bias (Cut in voltage and resistance calculations)
2. Transistor CE characteristics (input andoutput)
3. Half wave rectifier with and withoutfilters.
4. Full wave rectifier with and without filters.
5. CEamplifiers.
6. OP- amp applications (inverting, non-inverting, integrator anddifferentiator)

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Learning Outcomes:

The student should be able to:

- Compute the efficiency of DC shunt machine without actual loading of themachine.
- Estimate the efficiency and regulation at different load conditions and power factors for single phase transformer with OC and SCtests.
- Analyse the performance characteristics and to determine efficiency of DC shunt motor &3-Phase inductionmotor.
- Pre-determine the regulation of an alternator by synchronous impedancemethod.
- Control the speed of dc shunt motor using Armature voltage and Field flux control methods.
- Draw the characteristics of PN junction diode &transistor
- Determine the ripple factor of half wave & full waverectifiers.

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B. Tech-FOOD ENGINEERING

I Year - II Semester		L	T	P	C
		2	0	0	0
CONSTITUTION OF INDIA					

Course Objectives:

- To Enable the student to understand the importance ofconstitution
- To understand the structure of executive, legislature andjudiciary
- To understand philosophy of fundamental rights andduties
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
- To understand the central and state relation financial andadministrative.

UNIT-I

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Learning outcomes:

After completion of this unit student will

- Understand the concept of Indianconstitution
- Apply the knowledge on directive principle of statepolicy
- Analyze the History, features of Indianconstitution
- Evaluate Preamble Fundamental Rights andDuties

UNIT-II Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions;

Learning outcomes: -After completion of this unit student will

- Understand the structure of Indiangovernment
- Differentiate between the state and central government
- Explain the role of President and PrimeMinister
- Know the Structure of supreme court and Highcourt

UNIT-III

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

Learning outcomes: -After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and ChiefMinister
- Explain the role of stateSecretariat
- Differentiate between structure and functions of statesecretariat

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B. Tech-FOOD ENGINEERING

UNIT-IV

A.Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

Learning outcomes: -After completion of this unit student will

- Understand the localAdministration
- Compare and contrast district administration role andimportance
- Analyze the role of Myer and elected representatives ofMunicipalities
- Evaluate Zillapanchayat block levelorganisation

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women

Learning outcomes:-After completion of this unit student will

- Know the role of Election Commission applyknowledge
- Contrast and compare the role of Chief Election commissioner andCommissiononerate
- Analyze role of state electioncommission
- Evaluate various commissions of viz SC/ST/OBC andwomen

References:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt.Ltd..NewDelhi
2. SubashKashyap, Indian Constitution, National BookTrust
3. J.A. Siwach, Dynamics of Indian Government &Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government andPoliticsHans
7. J. Raj IndianGovernmentandPolitics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in ConstitutionalLaw, Prentice – Hall of India Pvt.Ltd..NewDelhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press2012

E-resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

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B. Tech-FOOD ENGINEERING

Course Outcomes:

At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- Understand historical background of the constitution making and its importance for building a democraticIndia.
- Understand the functioning of three wings of the government ie., executive, legislative andjudiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and localself-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustainingdemocracy.

1. Know the sources, features and principles of IndianConstitution.
2. Learn about Union Government, State government and itsadministration.
3. Get acquainted with Local administration and PachayatiRaj.
4. Be aware of basic concepts and developments of HumanRights.
5. Gain knowledge on roles and functioning of ElectionCommission

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
PROBABILITY AND STATISTICS (Common to all Branches)					

Course Objectives

- To familiarize the students with the foundations of probability and statistical methods.
- To impart probability concepts and statistical methods in various applications Engineering.

Course Outcomes

Upon successful completion of this course, the student should be able to

- Classify the concepts of data science and its importance (L4) or (L2)
- Interpret the association of characteristics and through correlation and regression tools (L4)
- Make use of the concepts of probability and their applications (L3)
- Apply discrete and continuous probability distributions (L3)
- Design the components of a classical hypothesis test (L6)
- Infer the statistical inferential methods based on small and large sampling tests (L4)

Unit – I: Descriptive statistics and methods for data science: (10 hrs)

Data science – Statistics Introduction – Population vs Sample –Collection of data – primary and secondary data – Type of variable: dependent and independent Categorical and Continuous variables – Data visualization – Measures of Central tendency – Measures of Variability (spread or variance) – Skewness Kurtosis.

UNIT – II: Correlation and Curve fitting:

Method of least squares – Correlation – Correlation coefficient – Rank correlation – Regression coefficients and properties – Regression lines –Straight line – Parabola – Exponential – Power curves.

UNIT – III: Probability and Distributions: (10 hrs)

Probability– Conditional probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory: (8 hrs)

Introduction – Population and Samples– Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Representation of the normal theory distributions– Introduction to t, χ^2 and F-distributions – Point and Interval estimations – Maximum error of estimate.

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UNIT – V: Tests of Hypothesis: (10 hrs)

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples) – Tests on proportions.

Textbooks:

1. **Miller and Freund's**, Probability and Statistics for Engineers,7/e, Pearson, 2008.
2. **S. C. Gupta and V.K. Kapoor**, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.

Reference Books:

1. **Shron L. Myers, Keying Ye, Ronald E Walpole,** Probability and Statistics Engineers and the Scientists,8th Edition, Pearson 2007.
2. **Jay l. Devore,** Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
3. **Sheldon M. Ross**, Introduction to probability and statistics Engineers and the Scientists, 4th Edition, Academic Foundation, 2011.
4. **Johannes Ledolter and Robert V. Hogg**, Applied statistics for Engineers and Physical Scientists, 3rd Edition, Pearson, 2010.

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B. Tech-FOOD ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
PRINCIPLES OF FOOD ENGINEERING - I					

Course Objectives

- To familiarize the importance and usage of units.
- To understand the fundamental laws and principles and its application.

Course Outcomes

- Students will learn the importance of units.
- Students will understand the basic laws and principles and its application in Food engineering.

UNIT I

Introduction to Food Engineering: Definition of terms, System of measurements, The S.I System, Conversion of Units

Learning Outcomes

At the end of unit, students will be able to

1. Basic terminology related to Food Engineering.
2. Importance and how to use the units.
3. Convert the units.

UNIT II

Steam Generation & Utilization: Concept of normal boiling point, Properties of Steam: Wet, dry saturated, superheated steam. Dryness fraction of steam. Pressure-Enthalpy diagram, Problems; Boilers: Classification, Types, Criteria for selection, Maintenance & Applications

Learning Outcomes

At the end of unit, students will be able to

1. Basic knowledge on steam properties.
2. Importance of steam tables.
3. Classify the boilers and their selection.

UNIT III

Basic principles of Physics & Chemistry: PVT relationships

Gases and Vapors: Behavior of Gases – Kinetic Theory of gases – Perfect Gas – Gas laws – Ideal gas laws – Real gas- Van der Waal's equation -pure component vapour pressure- partial pressure Dalton's law. Pure component volume-Amagat's law; Problems.

Learning Outcomes

At the end of unit, students will be able to

1. Explain the Ideal gas law and PVT relationships.
2. Importance and applicability of these laws.

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UNIT IV

Thermodynamics: Basic concepts of Thermodynamics: Definitions, approaches, thermodynamic processes (Adiabatic, Isothermal, Isobaric, Isocratic), thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work.

Zeroth law of thermodynamics: concept of temperature, heat, Gibb's free energy, Entropy

First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law.

Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, thermodynamic temperature scale.

Learning Outcomes

At the end of unit, students will be able to

1. Explain the terminology related to thermodynamics.
2. Applications of laws of thermodynamics.

UNIT V

Refrigeration: Basic concepts, Joule-Thomson effect, Refrigerants-Classification &selection,Refrigeration Load, Problems, Refrigeration types- Vapor compression refrigeration and vapor absorption refrigeration, comparison of both systems. Applications

Learning Outcomes

At the end of unit, students will be able to

1. Basic concepts of refrigeration.
2. Knowledge on selection of refrigerant.
3. Various refrigeration systems.

Textbooks

1. Rajput RK. Engineering thermodynamics: A computer approach (SIunits version). Jones & Bartlett Publishers; 2009 Mar 12.
2. SMITH PG. Introduction to food process engineering. Chemical engineer. 2003(742):56-.

References

1. Smith JM. Introduction to chemical engineering thermodynamics, 2005.
2. Paul Singh R, Heldman DR. Introduction to food engineering, 2009
3. Berk Z. Food process engineering and technology. Academic press; 2018 Feb 13.
4. Rao DG. Fundamentals of food engineering. PHI Learning Pvt. Ltd.; 2009 Nov 30.
5. Geankoplis CJ. Transport processes and separation process principles:(includes unit operations). Prentice Hall Professional Technical Reference; 2003.
6. McCabe WL, Smith JC, Harriott P. Unit operations of chemical engineering. New York: McGraw-hill; 1993.

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B. Tech-FOOD ENGINEERING

II Year -I Semester		L	T	P	C
		3	0	0	3
MECHANICAL OPERATIONS IN FOOD PROCESSING					

Course Objectives

To impart knowledge to the students on principles and operation of various food processing equipment viz.cutting, grinding, screening, sedimentation, filtration, centrifugation, mixing extruder and enrobers.

Course Outcomes

By the end of the course, the students will be able to

- Understand different food processing equipment that are being used in food industries.
- Study about the principles, operation, and maintenance of food processing equipment viz., material handling, cleaning, grading, mixing, forming, size reduction, cutting, grinding, centrifugation, filtration, evaporation and drying.

UNITI

Size reduction**:** Review of Theory: Mechanisms of grinding, grinding laws, properties of materials, factors affecting grinding. Equipment: Types and selection, calculation of crushing strength, work index and power. Advances: Cryogenic grinding. Screening**:** Review of Theory: Average particle size, distribution, standard sieves. Equipment: Types and selection of screens, calculation of screen effectiveness.

Learning Outcomes

At the end of unit, students will be able to

1. Describe the size reduction and principles, equipment, and recent developments.
2. Acquire basic knowledge on screening and their equipment.

UNITII

Grading**:** Review of Theory. Equipment: Types of graders and their working principle, Destoner, Air classifier, Paddy Separators, Indent cylinder, magnetic, cyclone and color separator. Grading efficiency & Selection of graders. Sedimentation**:** Principle of sedimentation, batch sedimentation, minimum area of thickener for continuous sedimentation and sedimentation equipment.

Learning Outcomes

At the end of unit, students will be able to

1. Get various types of separators/Graders and its application.
2. Acquires knowledge on using graders for different food materials.
3. Know the detailed working mechanism of sedimentation and design calculations.

UNITIII

Filtration: Introduction, Mechanism of Filtration, Constant pressure and constant rate filtration and types of filtration equipment, Plate and frame filter press, Pressure leaf filter press and Rotary vacuum filter press, selection of filter press and application of filtration in food processing includingmembrane filtration. Centrifugation**:** Principle of centrifugation, classification of centrifuges; Tubular centrifuge, Disc bowl centrifuge, Basket centrifuge and applications in Food Processing.

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Learning Outcomes

At the end of unit, students will be able to

1. Acquire basic knowledge on filtration and their equipment.
2. Explain the principles of centrifugation and equipment used.
3. Learn various applications in filtration and centrifugation in food processing.

UNITIV

Mixing**:** Review of Theory: Characteristics of mixtures, mixing index, mixing time. Equipment: Types of mixing equipment for solids (powder and particle); planetary mixer, kneader, ribbon mixer, double cone mixer and pastes, liquids and gases, power required for mixing, selection of mixers and applications. Coating: Enrobing, dusting and pan coating; soft, hard & chocolate coating.

Learning Outcomes

At the end of unit, students will be able to

1. Know the importance of mixing in solid and liquid foods.
2. Understand working of mixing equipment for various foods.
3. Gain knowledge in coating and enrobing technology used in processed foods.

UNITV

Extrusion: Principle of working, types of extruders, Single screw extruder: principle of working, net flow, factors affecting extrusion process, co-kneaders. Twin screw extruder: counter rotating and co-rotating twin screw extruder. Screw design, screw speed, screw configurations, die design.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the process and significance of extrusion process.
2. Acquire knowledge on factors affecting the extrusion.
3. Know types and applications of extrusion.

Textbooks

1. Rao DG. Fundamentals of food engineering. PHI Learning Pvt. Ltd.; 2009 Nov 30.
2. Earle RL, Earle MD. Unit operations in food engineering,1983.

References

1. Sahay KM, Singh KK. Unit operations of agricultural processing. Vikas Publishing House Pvt. Ltd.; 1996.
2. Cabe Mc., Smith J.C and Harriot P. Unit operations of Chemical Engineering. McGraw Hill Publishers. New Delhi.
3. Toledo, R. T. Fundamental of Food Process Engineering, CBS.
4. Coulson JM, Richardson JF. Chemical and biochemical reactors and process control. Elsevier; 1994 Jan 15.
5. Fellows PJ. Food processing technology: principles and practice. Elsevier; 2009 Jun 22.

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B. Tech-FOOD ENGINEERING

II Year -I Semester		L	T	P	C
		3	0	0	3
FLUID MECHANICS IN FOOD PROCESSING					

Course Objectives

- The basic concepts of fluid types and fluid-flow phenomena.
- To enable the students to understand the concept and importance of friction factor.
- To understand the friction losses through pipes.
- To classify and select the pumps depending on suitability and acquire knowledge on power requirements in pumps.

Course Outcomes

By the end of the course the students will be able to

- Gain knowledge on various types of fluids available and their classification with examples.
- Acquires knowledge on different types of flow regimes that fluid can flow.
- Know the applications and usage of Bernoulli's theory, Buckingham's Pi theorem, Hagen-Poiseuilli and Rabinowitsch-Mooney equation.
- Gain the knowledge on significance of friction factor and their calculations.
- Understand frictional losses through pipes and pipe fittings.
- Have knowledge on selection of pumps and their performance evaluation.

UNIT I

Types of Fluids: Newtonian & Non-Newtonian Fluids-dilatant, pseudoplastic, bingham plastic, binghampseudoplastic; classification of fluids based on time dependance: Thixotropic and Rheopectic; classification of fluids based on density Compressible and incompressible fluids.

Learning Outcomes

At the end of unit, students will be able to

1. Differentiate Newtonian and non-Newtonian fluids.
2. Get basics behind classification of fluids.
3. Differentiate fluids with examples.

UNIT II

Fluid Flow:Reynold'sexperiment, Laminar and turbulent flows, Reynolds Number; Equation of Continuity, Bernoulli's equation, applications of Bernoulli's equation, Cavitation, laminar and turbulent flow in pipes (Concept of Boundary Layer & Entrance Length)

Learning Outcomes

At the end of unit, students will be able to

1. Know basic types of flows in fluids.
2. Acquire knowledge on Equation of continuity and application of Bernoulli's equation.
3. Get concept of Boundary layer and Entrance length.

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UNIT III

Friction Factor: Definition of Friction Factor; relationship between Friction factor and Reynolds Number by using Dimensionless analysis, concept of Friction Factor: Derivation of friction factor for Laminar Flow, Hagen-Poiseuille equation; Friction Factor for Turbulent Flow, Moody Chart, Friction factor for Non- Newtonian Fluids (Power Law Fluids); Generalized Reynolds Number; Rabinowitsch-Mooney equation and Friction Chart.

Learning Outcomes

At the end of unit, students will be able to

1. Know the study of friction factor.
2. Concept of Reynold number and friction factor using Dimensionless analysis.
3. Understand the friction factor by using Hagen-Poiseuille and Rabinowitsch-Mooney equation.
4. Get the knowledge on Generalized Reynold number and Friction charts.

UNIT IV

Pressure Losses in Pipes & Flow Measurement**:** Energy equation for steady flow of fluids: Pressure, Kinetic & Potential Energy. Major Losses: Frictional Losses; Minor losses: Energy Losses due to sudden expansion, contraction & energy losses due to pipe fittings; Measurement of Flow in Pipes: Venturimeter, Pitot tube, Rotameter and others.

Learning Outcomes

At the end of unit, students will be able to

1. Know the energy equations used for steady flow of fluids.
2. Calculate the frictional losses (major and minor) in pipes & pipe fittings.
3. Knowledge on various flow measurement devices.

UNIT V

Pumps, Pipes & Fittings: Classification of Pumps: Centrifugal pumps, Reciprocating pumps, Rotary Pumps; Pressure Head, Suction Head, Discharge Head, Net Positive Suction Head; Power requirement of Pump; Selection of Pumps & Performance Evaluation. Pipe & Pipe Fittings & their selection.

Learning Outcomes

At the end of unit, students will be able to

1. Know various types of pumps.
2. Calculate power requirements for pumps.
3. Understand how to select the pumps and their evaluation in terms of performance.
4. Have needed knowledge on selection of pipe and pipe fittings.

Textbooks

1. Rao DG. Fundamentals of food engineering. PHI Learning Pvt. Ltd.; 2009 Nov 30.
2. SMITH PG. Introduction to food process engineering. Chemical engineer. 2003(742):56-.

References

1. Geankoplis CJ. Transport processes and separation process principles:(includes unit operations). Prentice Hall Professional Technical Reference; 2003.
2. Paul Singh R, Heldman DR. Introduction to food engineering.2009
3. Berk Z. Food process engineering and technology. Academic press; 2018 Feb 13.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year -I Semester		L	T	P	C
		3	0	0	3
FOOD MICROBIOLOGY					

Course Objectives

- To impart knowledge on importance of microbes in foods and their classification along with the calculations of shelf life.
- To understand microbial types (and their levels where possible) that can be expected under normal conditions in different food groups.
- To gain proper knowledge on the difference between harmful and beneficial micro-organisms, the factors affecting microbial growth and microbial growth characteristics.

Course Outcomes

At the end of the unit students will gain knowledge on:

- Basic information that is important to understand the mechanisms of food spoilage, foodborne diseases, food bioprocessing and strain improvement, and their detection from food.
- Microorganisms are present in mixed cultures in food and can interact with each other during growth.

UNIT I

The science of microbiology**:**Its origin and scope. Importance of micro-organisms in foods. Classification of microbes:Bacteria, yeast, moulds, viruses. Common bacterial groups in foods. Calculation of shelf life, shelf-life environments, deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf-life simulation for moisture, oxygen, and light sensitive products.

Learning Outcomes

At the end of the unit students will gain knowledge on:

1. Importance of micro-organisms in foods and their classification.
2. Calculations of shelf life of products in particular environment, their deteriorative reactions and shelf-life simulation of product for different parameters.

UNIT II

Factors influencing microbial growth:Intrinsic factors (food environment): Nutrients in foods, growth factors and inhibitors in foods. Water activity: principle, water activity of foods, water activity and microbial growth. pH: principle, pH in foods, pH and microbial growth. Redox potential and oxygen: principle, redox potential in foods, redox potential, and microbial growth. Extrinsic factors: RH & presence of other gases, temperature-principle, food and temperature, microbial growth, and viability.

Learning Outcomes

At the end of the unit students will gain knowledge on:

1. Extrinsic and intrinsic factors influencing microbial growth.
2. Different factors interacting with the foods containing micro-organisms.

UNIT III

Microbial growth characteristics**:** Microbial growth or reproduction: Binary fission, generation time (or) doubling time, specific growth rate, optimum growth, growth curve. Nature of microbial growth in food: Mixed population, sequence of growth, symbiotic growth, synergistic growth and antagonistic growth.

Learning Outcomes

At the end of the unit students will gain knowledge on:

1. Basic information that is important to understand the mechanisms of food spoilage, foodborne diseases, food bioprocessing and strain improvement, and their detection from food.
2. Microorganisms are present in mixed cultures in food and can interact with each other during growth.

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UNIT IV

Harmful Micro-organism and Beneficial Micro-organism: Food borne diseases – food infection and food intoxication, Food borne viruses: types of food involved, noroviruses, Rota viruses, prion diseases, toxicity, and symptoms. Microbial toxins: Bacterial toxins, fungal toxins, algal toxins – symptoms, causes and control measures. Microorganisms as food- Single Cell Protein, Fermented food- pickles, sauerkraut- vinegar and lactic acid.

Learning Outcomes

At the end of the unit students will gain knowledge on:

1. Uses of beneficial micro-organisms and effects of harmful micro-organisms on health.
2. Food infections and food intoxications caused by food borne viruses and microbial toxins produced by micro-organisms.

UNIT V

Microbiological quality of foods and its significance: Fruits and vegetables, nuts, cereals, starches, and gums, RTE meat products, Raw and pasteurized milk, fish and shellfish, shell egg and liquid egg, canned foods, soft drinks, fruits and vegetables drinks,bottled water, spices and condiments, sugars and confectionaries, mayonnaise, and salad dressing.

Learning Outcomes

At the end of the unit students will gain knowledge on:

1. Microbial population in a food comes from those that enter from different sources as well as from growth of the contaminants before a food is examined.
2. Effect of conditions on microbial load.
3. Information on normal microbial load helps to determine microbiological quality of a food and to set up microbiological standards and specifications.

Textbooks

1. BanawartGJ, BasicFood Microbiology. 2nd Ed. AVI Publ, 1989.
2. Frazier J &Westhoff DC, Food Microbiology. 4th Ed. McGraw Hill, 1988
3. Garbutt J., Essentials of Food Microbiology. Arnold Heinemann. 1997.
4. Jay JM, Loessner MJ, Golden DA. Modern food microbiology. Springer Science & Business Media; 2008 Feb 5.
5. Ray B., Fundamentals of Food Microbiology.3rd Ed. CRC. 2004

References

1. K. S. Bilgrami; Essentials of Microbiology; CBS Publishers, Delhi
2. Pelczar, Chan and Krieg, Microbiology; Tata McGraw Hill, Delhi
3. M. R. Adams, Food Microbiology.
4. Bisen, Handbook of Microbiology.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year -III Semester		L	T	P	C
		0	0	3	1.5
MECHANICAL OPERATIONS IN FOOD PROCESSING LAB					

Course Objectives

To impart practical orientation of usage of different mills, concept of terminal and settling velocity. Calculation of filter cake resistances.

Course Outcomes

By the end of the course, the students will be able to

- Find out screen efficiency, grading efficiency & separation efficiency.
- Find out particle size distribution.
- Find out grinding index.
- How to find out resistances in filtration.

Laboratory Experiments

1. Particle size distribution using sieve shaker.
2. To find out the screen effectiveness of a given sample by vibratory screen.
3. To find out the grading efficiency of a given sample by destoner.
4. To find out the grading efficiency of a given sample in specific gravity separator.
5. To find out the grading efficiency of a given sample in spiral separator.
6. Estimation of work index of material in grinding.
7. Mixing experimentation and determination of mixing index in Ribbon Mixer &Sigma Mixer.
8. Determination of power consumption in mixing/agitation.
9. Determination of equivalent and specific cake resistance in filtration (Plate & Frame Filter Press, Leaf Filter, Rotary Vacuum Filter).
10. Determine the efficiency of Cyclone separator.
11. Determination of Settling velocity of a particle by sedimentation.
12. Determination of separation efficiency of suspension by using tubular bowl/nozzle centrifuge/Basket Centrifuge.
13. Determine the efficiency of Ball Mill, Hammer Mill & Rod Mill for grinding a material of known work index (Wi).

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year -I Semester		L	T	P	C
		0	0	3	1.5
FLUID MECHANICS IN FOOD PROCESSING LAB					

Course Objectives

To impart knowledge on coefficient of discharge, friction factor, pressure drop on different fluids. Importance of pipe fittings and application of various pumps in food industry.

Course Outcomes

By the end of the course the students will be able to

- Know the measurement of fluid pressure, measurement of discharge and measurement of time.
- Know how to determine the Coefficient of discharge from the pitot tube experiment.
- Know how to measure the water level from 'U' tube manometer.

List of Experiments

1. To determine the coefficient of discharge of an orifice (or a mouthpiece) of a given shape.
2. Determination of Coefficient of discharge for a small orifice and mouthpiece by a constant headand variable head method.
3. Determination of Coefficient of loss of head in a sudden contraction and friction factor.
4. To calibrate an orifice meter and study the variation of the coefficient of discharge with the Reynolds number.
5. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
6. To study the velocity distribution in a pipe and to compute the discharge by integrating the velocity profile.
7. To study the variation of friction factor, 'f' for turbulent flow in smooth and rough commercial pipes.
8. To determine the loss coefficients for the pipe fittings.
9. To verify Bernoulli's equation experimentally.
10. To determine the flow rate and coefficient of discharge using Venturi meter.
11. To measure discharge through Rotameter.
12. To determine the Reynolds number and types of flow (Laminar or Turbulent), the flow rate and coefficient of discharge using Orifice meter.
13. To determine losses due to pipe fitting, sudden enlargement, and contraction.
14. Measurement of viscosity and surface tension of liquids.
15. To determine the characteristics of centrifugal pump and to find out total head, pump efficiency and overall efficiency of pump.
16. Study of various types of pipes and pipe fittings.
17. Study of different types of valves.
18. Study of reciprocating pump.
19. Determination of frictional coefficient of given pipe.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year -I Semester		L	T	P	C
		0	0	3	1.5
FOOD MICROBIOLOGY LAB					

Course Objectives

The major learning objective of this course will be to study:

- Important genera of microorganisms associated with food and their characteristics.
- To learn various techniquesfor enumeration and control of microorganisms in food.

Course Outcomes

Upon successful completion of this course student should be able to:

- Describe the characteristics of foodborne, waterborne and spoilage microorganisms, and methods for their isolation, detection, and identification.
- Explain the significance and activities of microorganisms in food.

List of Experiments

1. Microscope its parts and utility in identification and differentiation of various microorganism asbacteria, yeast and mould.
2. Familiarization with common techniques for handling pure culture serial dilution, Inoculation, slidepreparation incubation, counting etc.
3. Simple and differential staining of microorganisms and their examination.
4. Preparation and sterilization of media and glassware for microbial counts.
5. Determination of Standard Plate Count (SPC) in natural and/or processed foods.
6. Isolation of bacteria and moulds from foods.
7. Microbial examination of cereal and cereal products: Identification, isolation, and confirmation.
8. Microbial examination of vegetable and fruits: Identification, isolation, and confirmation.
9. Microbial examination of vegetable and fruits: Identification, isolation, and confirmation.
10. Microbial examination of fish and other sea foods: Identification, isolation, and confirmation.
11. Microbial examination of fish and other sea foods: Identification, isolation,and confirmation.
12. Microbial examination of milk and milk products: Identification, isolation, andconfirmation.
13. Microbial examination of sugar, salts, and spices.
14. Microbial examination of canned products: Identification, isolation, andconfirmation.
15. Determination and enumeration of pathogenic and indicator organisms infoods (*Coliform/Enterococcus*)
16. Thermal death time determination
17. Detection of *Salmonella* from food sample.
18. Detection of *coliforms* from water by MPN method.
19. Detection of *Staphylococcusaureus* from food sample.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year -I Semester		L	T	P	C
		2	0	0	2
FOOD HANDLING & STORAGE ENGINEERING					

Course Objectives

- To study the all the equipment used for handling of foods.
- To develop appropriate storage structures with engineering principles.

Courses Outcomes

By the end of the course the students will be able to

- To understand the design of storage systems.
- To learn about the types, selection and design of food conveying systems.

UNIT I

Pneumatic conveying system: air-pressure and vacuum system, lean and dense phases, capacity and power requirement; Gravity conveyor design considerations, capacity and power requirement. Selection, design and applications of pneumatic conveyors. Hydraulic conveyors. Hygienic considerations

Learning Outcomes

At the end of unit, students will be able to

1. Understand the concept of pneumatic conveying systems.
2. Know the importance of lean and dense phases in pneumatic systems.
3. Get knowledge on hydraulic conveyors and hygienic considerations for pneumatic conveying systems and hydraulic conveyors.

UNIT II

Mechanical Conveyors: Belt conveyor - Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper; Uniform belt and segmented belt conveyors and their applications. Screw conveyor: Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors. Hygienic considerations

Learning Outcomes

At the end of unit, students will be able to

1. Acquire knowledge on belt conveyors from principle to design considerations.
2. Understand the concept regarding details of screw conveyors.
3. Know the hygienic considerations for belt and screw conveyors.

UNIT III

Mechanical Conveyors: Bucket elevator: Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types; Selection, design and applications of Bucket elevator.

Roller and stake wheel conveyors, chain conveyors, Flexible conveyors, Mobile Transport Systems, Hoists Cranes, and Elevators. Vibratory conveyors and overhead conveyors. Robots. Hygienic considerations

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Learning Outcomes

At the end of unit, students will be able to

1. Learn about bucket elevators from principle to all concepts.
2. Understand the various other mechanical conveyors like Roller and stake wheel conveyors, chain conveyors, Mobile Transport Systems, Hoists Cranes, and Elevators. Vibratory conveyors, overhead conveyors&Robots.
3. Know the hygienic considerations for remaining mechanical conveyors.

UNIT IV

Storage structures Traditional storage structures, improved storage structures, modern storage structures, godown layout, staking pattern and rodent proof godown design; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos.Storage of perishables Cold storage controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage.

Learning Outcomes

At the end of unit, students will be able to

1. Get knowledge on storage structures both traditional and improved methods.
2. Understand the concepts involved while storing perishables and different types of storage methods.

UNIT V

Design of storage structures Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, functional, structural and thermal design of cold stores.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the design criteria for various storage structures.
2. Know the significance of important parameters involved in silo load calculations.

Textbooks

1. Saravacos GD, Kostaropoulos AE. Handbook of food processing equipment. Kluwer Academic/Plenum; 2002.
2. Sahay KM, Singh KK. Unit operations of agricultural processing. Vikas Publishing House Pvt. Ltd.; 1996.

References

1. William Andrew, Inc., Norwich, Handbook of Farm, Dairy, and Food Machinery; 2004.
2. L.W. Newbaver and H.B. Walker, Principal of Agricultural Engineering, 2003.
3. Hall CW, Olsen WC, editors. The literature of agricultural engineering. Cornell University Press; 1992.
4. Hall CW. Drying and storage of agricultural crops. AVI Publishing Company Inc.; 1980.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year -I Semester		L	T	P	C
		2	0	0	0
PROFESSIONAL ETHICS & HUMAN VALUES					

Course Objectives

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and Loyalty.
- To appreciate the rights of others.
- To create awareness on assessment of safety and risk.

Course Outcomes

Students will be able to:

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field.
- Identify the multiple ethical interests at stake in a real-world situation or practice.
- Articulate what makes a particular course of action ethically defensible.
- Assess their own ethical values and the social context of problems.
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects.
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work.
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research.

Unit I

Human Values:Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others –Living Peacefully –Caring –Sharing –Honesty -Courage-Cooperation–Commitment – Empathy –Self Confidence Character –Spirituality.

Learning Outcomes

1. Learn about morals, values & work ethics.
2. Learn to respect others and develop civic virtue.
3. Develop commitment.
4. Learn how to live peacefully.

Unit II

Engineering Ethics**:** Senses of 'Engineering Ethics-Variety of moral issued –Types of inquiry –Moral dilemmas –Moral autonomy –Kohlberg's theory-Gilligan's theory-Consensus and controversy –Models of professional roles-Theories about right action-Self-interest -Customs and religion –Uses of Ethical theories –Valuing time –Cooperation –Commitment.

Learning Outcomes

1. Learn about the ethical responsibilities of the engineers.
2. Create awareness about the customs and religions.
3. Learn time management.
4. Learn about the different professional roles.

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B. Tech-FOOD ENGINEERING

Unit III

Engineering as Social Experimentation**:** Engineering as Social Experimentation –Framing the problem – Determining the facts –Codes of Ethics –Clarifying Concepts –Application issues –Common Ground -General Principles –Utilitarian thinking respect for persons.

Learning Outcomes

1. Demonstrate knowledge to become a social experimenter.
2. Provide depth knowledge on framing of the problem and determining the facts.
3. Provide depth knowledge on codes of ethics.
4. Develop utilitarian thinking.

UNIT IV

Engineers Responsibility for Safety and Risk:Safety and risk –Assessment of safety and risk –Risk benefit analysis and reducing risk-Safety and the Engineer-Designing for the safety-Intellectual Property rights (IPR).

Learning Outcomes

1. Create awareness about safety, risk & risk benefit analysis.
2. Engineer's design practices for providing safety.
3. Provide knowledge on intellectual property rights.

UINIT V

Global Issues: Globalization –Cross-culture issues-Environmental Ethics –Computer Ethics –Computers as the instrument of Unethical behavior –Computers as the object of Unethical acts –Autonomous Computers-Computer codes of Ethics –Weapons Development -Ethics and Research –Analyzing Ethical Problems in research.

Learning Outcomes

1. Develop knowledge about global issues.
2. Create awareness on computer and environmental ethics.
3. Analyze ethical problems in research.
4. Give a picture on weapons development.

Textbooks

1. M.Govindarajan, S.NatarajanV.S.SenthilKumarEngineering Ethics includes Human Values;2009.
2. Harris, Pritchard RabinsEngineering Ethics, India Edition, 2009.
3. Mike W. Martin Roland SchinzingerEthics in Engineering. Tata McGraw-Hill–2003.
4. A.R.Aryasri, DharanikotaSuyodhanaProfessional Ethics and Morals. Maruthi Publications.
5. Alavudeen A, Rahman RK, Jayakumaran M. Professional ethics and human values. Firewall Media;2008.
6. D.R.KiranProfessional Ethics and Human Values.
7. PSR Murthy Indian Culture, Values and Professional Ethics. BS Publication.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year - II Semester		L	T	P	C
		3	0	0	3
PYTHON PROGRAMMING (Common to all Branches)					

Course Objectives

The Objectives of Python Programming are

- To learn about Python programming language syntax, semantics, and the runtime environment
- To be familiarized with universal computer programming concepts like data types, containers
- To be familiarized with general computer programming concepts like conditional execution, loops & functions
- To be familiarized with general coding techniques and object-oriented programming

Course Outcomes

- Develop essential programming skills in computer programming concepts like data types, containers.
- Apply the basics of programming in the Python language.
- Solve coding tasks related conditional execution, loops.
- Solve coding tasks related to the fundamental notions and techniques used in object-oriented programming.

UNIT I

Introduction: Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from theKeyboard, Performing Calculations, Operators. Type conversions, Expressions, More about DataOutput.

Data Types, and Expression: Strings Assignment, and Comment, Numeric Data Types andCharacter Sets, Using functions and Modules.

Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested DecisionStructures, Comparing Strings, Logical Operators, Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops.

UNIT II

Control Statement: Definite iteration for Loop Formatting Text for output, Selection if and if else Statement Conditional Iteration the While Loop

Strings and Text Files: Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods Text Files.

UNIT III

List and Dictionaries: Lists, Defining Simple Functions, Dictionaries

Design with Function: Functions as Abstraction Mechanisms, Problem Solving with Top-Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program's Namespace, Higher Order Function.

Modules: Modules, Standard Modules, Packages.

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UNIT IV

File Operations: Reading config files in python, Writing log files in python, Understanding read functions, read (), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations

Object Oriented Programming: Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance, overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using Oops support

Design with Classes: Objects and Classes, Data modeling Examples, Case Study an ATM, Structuring Classes with Inheritance and Polymorphism

UNIT V

Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Redefined Clean-up Actions.

Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI -Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.

Programming: Introduction to Programming Concepts with Scratch.

Textbooks

1. Lambert KA, Osborne M. Fundamentals of Python. Delmar Learning; 2011 Mar 1.
2. VamsiKurama, Pearson Python Programming: A Modern Approach,

References

1. Gowrishankar S, Veena A. Introduction to Python Programming. CRC Press; 2018 Dec 7.
2. Liang YD. For Introduction to Programming Using Python. displays. 2013;8(8):8.

e-Resources

1. https://www.tutorialspoint.com/python3/python_tutorial.pdf

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year - II Semester		L	T	P	C
		3	0	0	3
PRINCIPLES OF FOOD ENGINEERING - II					

Course Objectives

To impart knowledge to the students on basic concepts and applications of Psychrometric chart, humidifiers, and dehumidifiers. Problems on material and energy balance, importance of dimensional analysis and engineering properties of foods.

Course Outcomes

- Understand the fundamental concepts of psychrometric chart.
- Learn about the material and energy balances for equipment sizing.
- Gain knowledge on properties of foods and its applicability.

UNITI

Humidity & Humidification: Humidity & Relative Humidity, Saturation Humidity, Percentage Humidity, Humid Heat, Humid volume, Dew point, Enthalpy of Humid air, Dry bulb temperature, Wet bulb temperature, Problems, Psychrometric Chart-Utilization, problems; Humidifiers &Dehumidifiers, Applications. Water activity – concepts and importance. sorption isotherms, three stages of water, phase diagram for water, vapor pressure-temperature curve for water, heat requirement for vaporization, measurement of humidity.

Learning Outcomes

At the end of unit, students will be able to

1. Study the importance of properties of water vapor.
2. Learn the concept of water activity.
3. Understand the psychrometric chart.

UNITII

Material balance: Law of Conservation of mass- Process flow diagram-system boundaries -overall mass balance – component mass balance –basis and tie material- Continuous vs. Batch-Recycle and bypass-unsteady state - mass balance problems on concentration, dehydration, evaporation, crystallization, mixing, solvent extraction – multistage process.Problems

Learning Outcomes

At the end of unit, students will be able to

1. Know the significance of material balance in food processing.
2. Calculate the material balance for various unit operations in food processing.

UNITIII

Energy balance and evaluation of Heat requirements: Heat capacity – gases – solids – liquids -Latent heat – sensible heat -energy balance for a closed system and open system -total energy balances. Energy balance problems in heat exchangers- Problems

Learning Outcomes

At the end of unit, students will be able to

1. Understand the importance of energy balance in food processing.
2. Calculate the energy balance for various unit operations in food processing.

UNITIV

Dimensional Analysis Dimensional Consistency, Fundamental -derived units. Definitions of some basic physical quantities – Force, momentum, pressure, work and energy, power, heat, and enthalpy. Mole – atomical molar

mass, Conversion of Dimensional equations – Uses, Methods (Rayleigh's &Buckingham's) Examples: Nusselts Number, Reynolds number, Prandtl's number, Froude's number.

Learning Outcomes

At the end of unit, students will be able to

1. Know the concept of dimensional analysis.
2. Derive various parameters by using dimensional analysis.

UNITV

Engineering properties of Food Materials: Mass- volume- area related properties of foods, rheological properties of fluid foods & solid foods, thermal properties of frozen & unfrozen foods, electrical conductivity of foods, dielectric properties of foods, colorimetric properties of foods, surface properties, ultrasound properties.

Learning Outcomes

At the end of unit, students will be able to

1. Study the important engineering properties.
2. Know the significance of other properties useful in food processing.

Textbooks

1. Paul Singh R, Heldman DR. Introduction to food engineering, 2009.
2. Berk Z. Food process engineering and technology. Academic press; 2018 Feb 13.

References

1. Smith JM. Introduction to chemical engineering thermodynamics,2005
2. Rao DG. Fundamentals of food engineering. PHI Learning Pvt. Ltd.; 2009 Nov 30.
3. MA R, Syed SH R, Ashim K D. Engineering properties of foods,2005.
4. Rajput RK. Engineering thermodynamics: A computer approach (siunits version). Jones & Bartlett Publishers; 2009 Mar 12.
5. McCabe WL, Smith JC, Harriott P. Unit operations of chemical engineering. New York: McGraw-hill; 1993.
6. SMITH PG. Introduction to food process engineering. Chemical engineer. 2003(742):56-.
7. Geankoplis CJ. Transport processes and separation process principles:(includes unit operations). Prentice Hall Professional Technical Reference; 2003.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

II Year - II Semester		L	T	P	C
		3	0	0	3
FOOD CHEMISTRY					

Course Objectives

- To impart knowledge to the students on chemistry involved in foods and their importance in foods along with introduction to different analytical methods followed.
- To provide basic knowledge about nutritional composition of foods like carbohydrates, proteins, fats, vitamins & minerals and their analysis.
- To provide knowledge on chromatographic techniques with their principle, working procedure, accessories, and its applications in food industry.

Course Outcomes

- Understand the concepts of Techniques in food analysis,
- Understand proximate analysis of foods.
- Understand Biochemical methods and approaches used in Food analysis.

UNITI

Introduction to food chemistry, Importance of food chemistry. Official analytical methods: AOAC, AACC, ASTA. Sampling and sampling techniques used for foods. Determination of moisture, PH, Titrable acidity, acid value, Total soluble solids (TSS) and free fatty acids (FFA) in foods.

Learning Outcomes

At the end of unit, students will be able to

1. Briefs of different analytical methods and its importance in food chemistry.
2. Some basic analysis of foods like moisture, pH, Titrable acidity, acid value, TSS and free fatty acids (FFA) along with their principle, working procedure and instruments (or) equipment's used for it.

UNITII

Carbohydrates: Introduction to carbohydrate, classification of carbohydrates and its properties. Carbohydrates Analysis: - Chromatographic & electrophoretic methods, chemical methods, enzymatic methods, physical methods, Immunoassay.

Learning Outcomes

At the end of unit, students will be able to

1. Carbohydrates structure, types of carbohydrates, the foods containing different sugars and their properties when processed.
2. Analysis of reducing and non-reducing sugars by different analytical methods

UNITIII

Proteins and Fats: Introduction to protein, classification of proteins and its properties. Protein Analysis: Kjeldhal method, Titration method, Dumas method, protein assays: Biuret method, Lowry method, Bicinchronic acid method, UV-280nm absorption method. Fats: - Introduction to fat, classification of fat and its properties. Fat Analysis: soxhlet method, Gerber fat method, Babcock methods of fat extraction and other methods.

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Learning Outcomes

At the end of unit, students will be able to

1. Protein and fat structures, types of proteins and fats, the foods containing different proteins and fatty acids and their properties when processed.
2. Analysis of proteins and fats by different analytical methods.

UNITIV

Vitamins and Minerals: Introduction to vitamins, classification of vitamins & its deficiency, susceptibility to light, air, heatand its properties. Vitamin Analysis: liquid chromatography, HPLC, Redox titration and fluorimetry. Minerals: Introduction to minerals, classification of minerals and its properties. Mineral Analysis: Determination ash content, colorimetric methods, Gravimetric analysis, EDTA complexometric titration, Atomic absorption spectroscopy.

Learning Outcomes

At the end of unit, students will be able to

1. Different types of vitamins and minerals, sources of food and their deficiency causing diseases.
2. Analysis of vitamins and minerals by different analytical methods.

UNITV

Chromatographic Techniques: Definition of chromatography, different types of chromatographic techniques, planar chromatography:paper chromatography, thin layer chromatography. Column chromatography: size exclusion chromatography, affinity chromatography, high performance chromatography, gas chromatography,reverse phase chromatography, hydrophobic interaction chromatography.

Learning Outcomes

At the end of unit, students will be able to

1. Different types of chromatographic techniques, principle, working procedure and accessories.
2. Wide applications of chromatographic techniques in food industry.

Textbooks

1. S.S. Nilson, Food Analysis, Aspen Publishers, Gaithery Berg, Mary Land. AOAC methods For Food Analysis.
2. Y. Pomeranz and C.E. Meloan, Food Analysis, Theory and practice, A.V.I Publishing Company, INC West Port, Connecticut, U.S.A.
3. R.Fennema –Food chemistry (Third edition)

References

1. Mu P, Plummer DT. Introduction to practical biochemistry. Tata McGraw-Hill Education; 2001.
2. Sadasivam S. Biochemical methods. New age international; 1996.
3. Mano RanjanKalia, Food Analysis and Quality Control. Kalyani Publishers, 2002
4. Jayaraman J, Jayaraman J. Laboratory manual in biochemistry. Delhi: Wiley Eastern; 1981.

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II Year - II Semester		L	T	P	C
		3	0	0	3
PROCESSING OF CEREALS, PULSES AND OILSEEDS					

Course Objectives

- To learn about the processing of major cereals, pulses&oil seeds.
- To acquaint with production trends, structure, composition, quality evaluation and processing technologies for product development and value addition of various cereals, pulses, and oilseeds.

Course Outcomes

At the end of this module, the student will be able to:

- Understand the basic composition and structural parts of food grains.
- Aware the importance of physico-chemical properties of food grains.
- Understand the basics of milling operations for food grains.
- Identify the problems associated with milling of grains and their solution.
- Get information about the classification of various grains.
- Exposed to various processing methods and machinery used.
- Learn value added products from all grains.

UNITI

Importance of Cereals Pulses and Oilseeds, Composition, Structure and processing characteristics of Cereal grains, Legumes and Oilseeds, Post-harvest technology, Post-harvest processing practices for safe storage. Rice: Structure, types, composition, quality characteristics and physicochemical properties of Rice. Milling and parboiling of paddy, Curing, and ageing of paddy and rice. Criteria and assessment of milling, cooking, nutritional and storage qualities of raw & parboiled rice. Processed rice products (flaked, expanded, and puffed rice), By-products of rice milling.

Learning Outcomes

At the end of unit, students will be able to

1. Learn composition, structure and processing of cereals, legumes & oilseeds.
2. Know the post processing operations for storage and further processing.
3. Knowledge of milling and parboiling of paddy and other processing methods.
4. Importance of quality assessment related to rice and rice products.
5. Knowledge on value added products and by products of rice.

UNITII

Wheat-Structure, Composition, Types, quality characteristics for milling into flour and Semolina. Flour milling, Turbo grinding and air classification, blending of flours, Flour grades and their suitability for baking purposes, Milling equipment and milled products (Dalia, Atta, Semolina and flour). Assessment of flour quality and characteristics, Macaroni products. Dough rheology- influence of flour constituents in dough rheology.Baked products-Ingredients Technology and quality parameters: Bread, Biscuits and Cakes, Crackers.

Learning Outcomes

At the end of unit, students will be able to

1. Acquired knowledge on fundamentals of wheat and its milling.
2. Detailed description of quality parameters and value-added products from wheat.

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UNITIII

Other Cereals: Corn- Structure, types and composition. Dry and wet milling of Corn. Starch and conversion products. Processed corn products (popped corn, corn flakes etc.) Structure and composition of Barley, Malting of barley, Bajra, Jowar and other cereal grains and millets. Pearling of millets. Parched and snack products. Cereal Malts: Basic malting process, malting plant, malt storage, malt characteristics, malt extract, uses; Breakfast cereals – types and manufacturing methods.

Learning Outcomes

At the end of unit, students will be able to

1. Variations in processes of dry and wet milling of corn.
2. Advantages of value-added products from corn.
3. Knowledge of millets and malting process.

UNITIV

Pulses: Pulses production, types, chemical composition, anti-nutritional factors, milling of pulses, milling equipment, factors affecting quality, secondary processing of pulses, processed products, fermented products, traditional products, Value addition; effect of processing on nutritive value. Milling of legume-pulses by traditional and improved processes.

Learning Outcomes

At the end of unit, students will be able to

1. Description of pulses and their importance.
2. Impact of anti-nutritional factors in pulses on processing.
3. Knowledge on milling of pulses and value-added products.

UNITV

Processing of oil seeds for direct use and consumption, Oil extraction methods- mechanical (Ghani and Expellers) and chemical methods (solvent extraction), Processing of extracted oil: Refining, Hydrogenation, Interesterification. Processing of deoiled cake into protein concentrates and isolates, Texturized vegetable protein, Functional protein preparations. Peanut butter, Margarine and Spread.

Learning Outcomes

At the end of unit, students will be able to

1. Explanation of oil extraction methods
2. Need of refining and other processes like hydrogenation etc.
3. Importance of protein derivatives from oilseeds

Textbooks

1. Matz SA. Chemistry and technology of cereals as food and feed. Springer Science & Business Media; 1991 Apr 30.
2. Owens G, editor. Cereals processing technology. CRC Press; 2001 Apr 12.

References

1. D.A.V. Dendy and B.J.Dobraszczyk,Cereals and Cereal products: Chemistry and Technology. Springer, 2001.
2. B.O.Juliano, Rice: Chemistry and Technology, AACC, 2nd Edition, 1985.
3. Y.Pomeranz, Wheat: Chemistry and Technology, AACC, 3rd Edition, 1988.
4. Briggs, Malts and Malting, D. E. Kluwer Academic Publication, 1st Edition, 1997.
5. A. Karleskind, Oils and Fats manual, Lavoisier Publisher, Paris, 1st Edition, 1996.
6. R.H. Mathews, Marcel Dekker, Legumes: Chemistry, Technology and Human Nutrition, 1st Edition, 1989.
7. D. Swer, John Wiley & Sons, Bailey's Industrial Oil & Fat Products, 5th Edition, 2005.
8. K. Kulp and J. G. Ponte. Jr., CRC, Handbook of Cereal Science and Technology, 2nd Edition, 2000.

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II Year - II Semester		L	T	P	C
		3	0	0	3
MANAGERIAL ECONOMICS & FINANCIAL ANALYSIS (Common to all Branches)					

Course Objectives

- The Learning objectives of this paper are to understand the concept and nature of Managerial Economics and its relationship with other disciplines and to understand the Concept of Demand and Demand forecasting.
- To familiarize about the Production function, Input Output relationship, Cost-Output relationship, and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation.
- Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Unit-I

Introduction to Managerial Economics and demand Analysis:

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects – Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

Unit – II:

Theories of Production and Cost Analyses:

Theories of Production function- Law of Variable proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs-Fixed costs, Variable Costs and Total costs –Cost –Volume-Profit analysis-Determination of Breakeven point(problems)-Managerial significance and limitations of Breakeven point.

Unit – III:

Introduction to Markets, Theories of the Firm & Pricing Policies:

Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson's models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing, Business Cycles : Meaning and Features – Phases of a Business Cycle. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and their forms.

Unit – IV:

Introduction to Accounting & Financing Analysis:

Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow analysis (Problems)

Unit – V:

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Capital and Capital Budgeting: Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index)

Course Outcomes:

- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for a product.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.
- The pupil is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis.
- The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

TEXTBOOKS:

A R Aryasri, Managerial Economics and Financial Analysis, The McGraw – Hill companies.

REFERENCES:

1. Varshney R.L, K.L Maheswari, Managerial Economics, S. Chand & Company Ltd,
2. JL Pappas and EF Brigham, Managerial Economics, Holt, R & W; New edition edition
3. N.P Srinivasn and M. SakthivelMurugan, Accounting for Management, S. Chand & Company Ltd,
4. MaheswariS.N,AnIntroduction to Accountancy, Vikas Publishing House Pvt Ltd
5. I.M Pandey, Financial Management , Vikas Publishing House Pvt Ltd
6. V. Maheswari, Managerial Economics, S. Chand & Company Ltd,

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II Year - II Semester		L	T	P	C
		0	0	3	1.5
PYTHON PROGRAMMING LAB (Common to all Branches)					

Course Objectives

The aim of Python Programming Lab is

- To acquire programming skills in core Python.
- To acquire Object Oriented Skills in Python
- To develop the skill of designing Graphical user Interfaces in Python
- To develop the ability to write database applications in Python.

Course Outcomes

By the end of this lab, the student can

- Write, Test and Debug Python Programs
- Use Conditionals and Loops for Python Programs
- Use functions and represent Compound data using Lists, Tuples and Dictionaries
- Use various applications using python.

1. Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
2. Write a program that asks the user to enter three numbers (use three separate input statements). Create variables called total and average that hold the sum and average of the three numbers and print out the values of total and average.
3. Write a program that uses a for loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86, 89.
4. Write a program that asks the user for their name and how many times to print it. The program should print out the user's name the specified number of times.
5. Use a for loop to print a triangle like the one below. Allow the user to specify how high the triangle should be.

   ```
   *
   **
   ***
   ****
   ```
6. Generate a random number between 1 and 10. Ask the user to guess the number and print a message based on whether they get it right or not.
7. Write a program that asks the user for two numbers and prints Close if the numbers are within .001 of each other and Not close otherwise.
8. Write a program that asks the user to enter a word and prints out whether that word contains any vowels.
9. Write a program that asks the user to enter two strings of the same length. The program should then check to see if the strings are of the same length. If they are not, the program should print an appropriate message and exit. If they are of the same length, the program should alternate the characters of the two strings. For example, if the user enters abcde and *ABCDE* the program should print out *AaBbCcDdEe*.
10. Write a program that asks the user for a large integer and inserts commas into it according to the standard American convention for commas in large numbers. For instance, if the user enters 1000000, the output should be 1,000,000.

11. In algebraic expressions, the symbol for multiplication is often left out, as in 3x+4y or 3(x+5). Computers prefer those expressions to include the multiplication symbol, like 3*x+4*y or 3*(x+5). Write a program that asks the user for an algebraic expression and then inserts multiplication symbols where appropriate.
12. Write a program that generates a list of 20 random numbers between 1 and 100.
    (a) Print the list.
    (b) Print the average of the elements in the list.
    (c) Print the largest and smallest values in the list.
    (d) Print the second largest and second smallest entries in the list
    (e) Print how many even numbers are in the list.
13. Write a program that asks the user for an integer and creates a list that consists of the factors of that integer.
14. Write a program that generates 100 random integers that are either 0 or 1. Then find the longest run of zeros, the largest number of zeros in a row. For instance, the longest run of zeros in [1,0,1,1,0,0,0,0,1,0,0] is 4.
15. Write a program that removes any repeated items from a list so that each item appears at most once. For instance, the list [1,1,2,3,4,3,0,0] would become [1,2,3,4,0].
16. Write a program that asks the user to enter a length in feet. The program should then give the user the option to convert from feet into inches, yards, miles, millimeters, centimeters, meters, or kilometers. Say if the user enters a 1, then the program converts to inches, if they enter a 2, then the program converts to yards, etc. While this can be done with if statements,it is much shorter with lists and it is also easier to add new conversions if you use lists.
17. Write a function called *sum_digits* that is given an integer num and returns the sum of the digits of num.
18. Write a function called *first_diff* that is given two strings and returns the first location in which the strings differ. If the strings are identical, it should return -1.
19. Write a function called *number_of_factors* that takes an integer and returns how many factors the number has.
20. Write a function called *is_sorted* that is given a list and returns True if the list is sorted and False otherwise.
21. Write a function called root that is given a number x and an integer n and returns x1/n. In the function definition, set the default value of n to 2.
22. Write a function called primes that is given a number n and returns a list of the first n primes. Let the default value of n be 100.
23. Write a function called merge that takes two already sorted lists of possibly different lengths, and merges them into a single sorted list.
    (a) Do this using the sort method. (b) Do this without using the sort method.
24. Write a program that asks the user for a word and finds all the smaller words that can be made from the letters of that word. The number of occurrences of a letter in a smaller word can't exceed the number of occurrences of the letter in the user's word.
25. Write a program that reads a file consisting of email addresses, each on its own line. Your program should print out a string consisting of those email addresses separated by semicolons.
26. Write a program that reads a list of temperatures from a file called temps.txt, converts those temperatures to Fahrenheit, and writes the results to a file called ftemps.txt.

27. Write a class called Product. The class should have fields called name, amount, and price, holding the product's name, the number of items of that product in stock, and the regular price of the product. There should be a method get_price that receives the number of items to be bought and returns the cost of buying that many items, where the regular price is charged for orders of less than 10 items, a 10% discount is applied for orders of between 10 and 99 items, and a 20% discount is applied for orders of 100 or more items. There should also be a method called make_purchase that receives the number of items to be bought and decreases amount by that much.
28. Write a class called Time whose only field is a time in seconds. It should have a method called convert_to_minutes that returns a string of minutes and seconds formatted as in the following example: if seconds is 230, the method should return '5:50'. It should also have a method called convert_to_hours that returns a string of hours, minutes, and seconds formatted analogously to the previous method.
29. Write a class called Converter. The user will pass a length and a unit when declaring an object from the class—for example, c = Converter(9,'inches'). The possible units are inches, feet, yards, miles, kilometers, meters, centimeters, and millimeters. For each of these units there should be a method that returns the length converted into those units. For example, using the Converter object created above, the user could call c.feet() and should get 0.75 as the result.
30. Write a Python class to implement pow(x, n).
31. Write a Python class to reverse a string word by word.
32. Write a program that opens a file dialog that allows you to select a text file. The program then displays the contents of the file in a textbox.
33. Write a program to demonstrate Try/except/else.
34. Write a program to demonstrate try/finally and with/as.

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B. Tech-FOOD ENGINEERING

II Year - II Semester		L	T	P	C
		0	0	3	1.5
FOOD CHEMISTRY LAB					

Course Objectives

To expertise the students to analyze the proximate composition and other important constituents present in the food.

Course Outcomes

By the end of the practical exercises, the students will be able to

- Adapts suitable method for food analysis.
- Apply the knowledge of Techniques in Food Analysis,
- Differentiate between Qualitative identification and Quantitative estimations.

Laboratory Experiments

1. Sampling plan; Sampling requirements, Sample collection and preparation for analysis procedures and methods
2. Determination of pH
3. Determination of moisture content of foods by oven drying and distillation methods.
4. Determination of Total and Acid insoluble ash content in foods
5. Determination of crude fat content by solvent extraction methods in foods
6. Determination of crude Protein by Kjeldahl, Lowry method & other methods
7. Determination of reducing and total sugar content in foods
8. Determination of crude fiber content in foods
9. Determination of specific mineral contents such as Calcium, Iron, Phosphorus, Chlorideetc. in foods.
10. Determination of specific vitamin content of food such as ascorbic acid, carotenes etc.
11. Determination of specific Natural and/ or added Coloring Matters in foods
12. Determination of specific added food Preservatives in foods

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II Year - II Semester		L	T	P	C
		0	0	3	1.5
PROCESSING OF CEREALS, PULSES AND OILSEEDS LAB					

Course Objectives

- Determination of parameters by qualitative and quantitative methods.
- Study on some important unit operations used for some grains.
- Preparation of standard food products.

Course Outcomes

- Students are exposed to learn various parameters determination and quantification.
- Students will be able to prepare and understand the technology involved in foods from grains.
- Students will acquire more knowledge by visiting industries.

Laboratory Experiments

1. Determination of physical properties (Bulk Density, Porosity, Sphericity, Angle of repose, Test weight, Particle size, Sieve analysis) of different grains.
2. Determination of Gluten content, sedimentation value, alcoholic acidity, water absorption capacity and Polenske value of wheat flour.
3. Determination of adulterant ($NaHCO_3$) in wheat flour/ Maida.
4. Determination of alkali score and gelatinization temperature of rice.
5. Effect of Traditional and improved pre-treatmentdehusking of some legumes.
6. Removal of anti-nutritional compounds from selected pulses and oilseeds.
7. Study of cooking quality of Dhal.
8. Pearling of some millets.
9. Determination of yeast activity.
10. Determination of different quality parameters of oils.
11. Determination of efficiency of oil extraction techniques (mechanical expelling and solvent extraction).
12. Preparation of Bread.
13. Preparation of Biscuits.
14. Preparation of Cookies.
15. Preparation of Cake.
16. Preparation of Rusk.
17. Preparation of Crackers.
18. Visit to a Bakery, Confectionery Unit
19. Visit to a modern roller flour mill and FCI godowns.
20. Visit to rice mill.

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B. Tech-FOOD ENGINEERING

II Year - II Semester		L	T	P	C
		1	0	2	2
INSTRUMENTATION & PROCESS CONTROL					

Course Objectives

- To understand the different instruments used in different operations of food industries.
- To impart knowledge about the various techniques used for the measurement of primary industrial parameters like flow, level, temperature, pressure etc.

Course Outcomes

- The students become familiar with the identification of different instruments and controls used in various operations.
- Solutions to tackle the problems encountered in use and operation of different instruments.

UNIT I

Introduction, definitions, characteristics of instruments, functional elements, performance characteristics of instrumentation systems-static and dynamic characteristics; Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers.

Learning Outcomes

At the end of unit, students will be able to understand the following:

1. Introduction, definitions, characteristics of instruments, functional elements
2. Performance characteristics of instrumentation systems-static and dynamic characteristics
3. Temperature and temperature scales
4. Various types of thermometers; thermocouples, resistance thermometers and pyrometers

UNIT II

Pressure and pressure scales, manometers, pressure elements differential pressure; Liquid level measurement, different methods of liquid level measurement; Flow measurement: Kinds of flow, rate of flow, total flow differential pressure meters, variable area meters, food flow metering; Weight measurement: Mechanical scale, electronic tank scale, conveyor scale.

Learning Outcomes

At the end of unit, students will be able to understand the following:

1. Pressure and pressure scales, manometers, pressure elements differential pressure
2. Liquid level measurement, different methods of liquid level measurement
3. Flow measurement: Kinds of flow, rate of flow, total flow differential pressure meters, variable area meters, food flow metering
4. Weight measurement: Mechanical scale, electronic tank scale, conveyor scale

UNIT III

Measurement of moisture content, specific gravity, measurement of humidity, measurement of viscosity, turbidity, color, measurement of density, brix, pH, enzyme sensors, automatic valves; Transmission: Pneumatic and electrical; Control elements, control actions, pneumatic and electrical control systems.

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Learning Outcomes

At the end of unit, students will be able to understand the following:

1. Measurement of moisture content, specific gravity and humidity
2. Measurement of viscosity, turbidity, color
3. Measurement of density, brix, pH, enzyme sensors, automatic valves
4. Transmission: Pneumatic and electrical; Control elements, control actions, pneumatic and electrical control systems

UNIT IV

Process control: Definition, simple system analysis, dynamic behavior of simple process, Laplace transform, process control hardware; Frequency response analysis, frequency response characteristics, Bode diagram and Nyquist plots and stability analysis; Transducers: Classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices;

Learning Outcomes

At the end of unit, students will be able to understand the following:

1. Definition of Process control, simple system analysis, dynamic behaviour of simple process, Laplace transform, process control hardware.
2. Frequency response analysis, frequency response characteristics, Bode diagram and Nyquist plots and stability analysis.
3. Transducers: Classification, self-generating transducers, variable parameter type, digital, actuating and controlling devices.

UNIT V

Controllers and indicators: Temperature control, electronic controllers, flow ratio control, atmosphere control, timers and indicators, food sorting and grading control, discrete controllers, adaptive and intelligent controllers; Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing.

Learning Outcomes

At the end of unit, students will be able to understand the following:

1. Temperature control, electronic controllers, flow ratio control, atmosphere control, timers, and indicators
2. food sorting and grading control, discrete controllers, adaptive and intelligent controllers
3. Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing

Textbooks

1. E O Doeblin and D N Manik. Measurement Systems: Applications and Design - Tata McGraw Hill, 2003.
2. Lipták BG, editor. Instrument Engineers' Handbook, Volume One: Process Measurement and Analysis. CRC press; 2003 Jun 27.
3. Johnson CD. Process control instrumentation technology. Pearson; 2014.
4. D.V.S. Murty. Transducers and Instrumentation. Prentice-Hall of India Pvt. Ltd. New Delhi, 2004.

References

1. Harriott P. Process control. Tata McGraw-Hill Education; 1984.
2. Bandyopadhyay R, Patranabis D. A new autotuning algorithm for PID controllers using dead-beat format. ISA transactions. 2001 Jul 1;40(3):255-66.
3. B C Kuo. Automatic Control Systems, 2002.
4. Process system Analysis & Control, D.R. Coughanoowr, McGraw Hill Publication.

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B. Tech-FOOD ENGINEERING

INSTRUMENTATION & PROCESS CONTROL LAB

Course Objectives

- To calibrate and determine the time lag of various first and second order instruments.
- To determine the response in single and two capacity systems with and with-out interaction.
- To understand the advanced control methods used for complex processes in the industries. Different experiments like Flow, Level and Cascade control can be configured and studied.
- To study the open loop (Manual control) and the ON/OFF controller, Proportional controller, PI controller, PD controller, PID controller, Tuning of controller (Open loop and close loop methods).
- To understand the control valve operation and its flow characteristics.
- To determine the damping coefficient and response of U-tube manometer.

Course Outcomes

The student will be able to

- Understand the hysteresis of pressure gauge tester and control valves.
- Characteristics of different types of temperature sensors.
- Determine the discharge coefficient for different types of flow measurement apparatus.
- Estimate the dynamic characteristics of first and second order systems.
- Apply the advanced control methods used for complex processes in the industries.
- Screen and suggest controllers like On/Off, P, PI, PD and PID for process systems.
- Identify the stability of the system.

List of Experiments

1. Study of hysteresis of bourdon tube pressure gauge tester
2. Temperature Measurement apparatus:
    a) Study the characteristics of different types of temperature sensors: RTD, Thermistor,Temperature transmitter and thermocouple.
    b) Determine the time constant and study the characteristics of bi-metallic thermometer.
    c) Study the see back effect.
3. Flow measurement apparatus:
   Study of different types of flow measurement devices: Venturi meter, orifice meter, watermeter,rotameter, and Pitot tube.
4. Determination of time constant & transportation lag for mercury in glass thermometer with and without thermal well.
5. Sinusoidal response of mercury in glass thermometer with and without thermal well.
6. Study of dynamic response of single tank liquid level system, two tank non-interacting andinteracting liquid level systems.
7. Study of dynamic response of two tank Determination of damping coefficient for U-tube:
    a) Water manometer
    b) Mercury manometer
8. Study of control valve characteristics and determine valve flow coefficient for the following valves:
    a) Equal percentage valve
    b) Quick opening valve
    c) Linear valve

9. Determination of hysteresis for the following valves:
    a) Equal percentage valve
    b) Quick opening valve
    c) Linear valve
10. Temperature control trainer:
    a) Open loop response
    b) On-off control
    c) P-control
    d) PID-control
    e) Auto tuning
11. Level control trainer:
    a) Open loop response
    b) On-off control
    c) P-control
    d) PID-control
    e) Auto tuning
12. Pressure control trainer:
    a) Open loop response
    b) On-off control
    c) P-control
    d) PID-control
    e) Auto tuning
13. Force Measurement.
14. Measurement of level by capacitance method.

COURSE STRUCTURE AND SYLLABUS

FOR UG – R20

B. TECH - FOOD ENGINEERING

(Applicable for batches admitted from 2020-2021)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Heat Transfer in Food Processing	3	0	0	3
2		Processing of Fruits, Vegetables, Spices and Plantation Crops	3	0	0	3
3		Food Plant Design and Process Economics	3	0	0	3
4		Open Elective Course/Job Oriented Elective	2	0	2	3
5		Professional Elective Courses	3	0	0	3
6		Heat Transfer in Food Processing Lab	0	0	3	1.5
7		Processing of Fruits, Vegetables, Spices and Plantation Crops (LAB)	0	0	3	1.5
8		**Food Extrusion Processing***	**1**	**0**	**2**	**2**
9		Mandatory Course (AICTE suggested)	2	0	0	0
Summer Internship 2 Months (Mandatory) after second year (to be evaluated during V semester)			0	0	0	1.5
					Total Credits	**21.5**
Honors/Minor			4	0	0	**4**

III YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Mass Transfer in Food Processing	3	0	0	3
2		Processing of Milk, Meat and Marine Products	3	0	0	3
3		Food Packaging Technologies	3	0	0	3
4		Professional Elective Courses	3	0	0	3
5		Open Elective Course/Job Oriented Elective	2	0	2	3
6		Mass Transfer in Food Processing (LAB)	0	0	3	1.5
7		Processing of Milk, Meat and Marine Products (LAB)	0	0	3	1.5
8		Food Packaging Technologies (LAB)	0	0	3	1.5
9		**Retort Process Engineering***	**1**	**0**	**2**	2
10		Mandatory Course (AICTE)	2	0	0	0
					Total Credits	**21.5**
Honors/Minor			4	0	0	**4**

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IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Professional Elective Courses	3	0	0	3
2		Professional Elective Courses	3	0	0	3
3		Professional Elective Courses	3	0	0	3
4		Open Elective Courses/ Job Oriented Elective	2	0	2	3
5		Open Elective Courses/ Job Oriented Elective	2	0	2	3
6		Humanities and Social Science Elective	3	0	0	3
7		**Food Safety and Quality Certification***	1	0	2	2
Summer Internship 2 Months (Mandatory) after third year (to be evaluated during VII semester			0	0	0	3
					Total Credits	**23**
Honors/Minor			4	0	0	**4**

IV YEAR II SEMESTER

S. No.	Code	Course Title	Category	Hours per week			Credits
1		Project work, Seminar, and Internship in industry	PROJECT	0	0	0	**12**
	INTERNSHIP (6 MONTHS)						
						Total Credits	**12**

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Dr. Ramachandra Pradhan Member	**Dr. Jathindra K Sahu** Member	**Er. K. Sri Varsha** Member	**Shri. P. Ramakrishna** Member-Convener	**Mr. Jaddu Samuel** Invitee

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LIST OF PROFESSIONAL ELECTIVE COURSES

S. No.	Course Name	L-T-P	Credits
PROFESSIONAL ELECTIVE – 1			
1	Transport Phenomena in Food Engineering	3-0-0	3
2	Statistical Methods in Food Engineering	3-0-0	3
3	Process Modeling and Simulation	3-0-0	3
PROFESSIONAL ELECTIVE – 2			
1	Separation Techniques in Food Processing	3-0-0	3
2	Thermal Operations in Food Processing	3-0-0	3
3	Automation in Food Industry	3-0-0	3
PROFESSIONAL ELECTIVE – 3			
1	Advances in Drying and Dehydration	3-0-0	3
2	Process Kinetics in Food Engineering	3-0-0	3
3	Non-Thermal Operations in Food Processing	3-0-0	3
PROFESSIONAL ELECTIVE – 4			
1	Food Process Equipment Design	3-0-0	3
2	Sensors in Food Processing	3-0-0	3
3	New Product Development	3-0-0	3
PROFESSIONAL ELECTIVE – 5			
1	Entrepreneurship in Food Industries	3-0-0	3
2	Food Supply Chain Management	3-0-0	3
3	Food Business Management and Economics	3-0-0	3

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LIST OF OPEN ELECTIVES

S. No.	Course Name	L-T-P	Credits
OPEN ELECTIVE- 1			
1	Food Material Science and Engineering	3-0-0	3
2	Biochemical Engineering	3-0-0	3
3	Food Thermodynamics	3-0-0	3
OPEN ELECTIVE- 2			
1	Membrane Technology in Food Engineering	3-0-0	3
2	Renewable Energy Systems	3-0-0	3
3	TQM in Food Industry	3-0-0	3
OPEN ELECTIVE- 3			
1	Food Sanitation, Management and Hygiene	3-0-0	3
2	Energy Conservation and Audit	3-0-0	3
3	Food Waste Management	3-0-0	3
OPEN ELECTIVE- 4			
1	Food Refrigeration and Cold Chain	3-0-0	3
2	Food Plant Operations and Maintenance	3-0-0	3
3	ICT Applications in Food Processing	3-0-0	3
MOOC's programme will be notified by HOD at the beginning of the semester with minimum 12 weeks in duration to earn the 3 credits.			

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HONORS PROGRAM

S. No.	Course Name	L-T-P	Credits
	POOL – 1		
1	Bakery and Confectionery Technology	3-1-0	4
2	Fermentation Technology	3-1-0	4
3	Fats and Oil Technology	3-1-0	4
	POOL – 2		
1	Beverage Technology	3-1-0	4
2	Food Nanotechnology	3-1-0	4
3	Enzyme Technology	3-1-0	4
	POOL – 3		
1	Specialty Foods: Neutraceuticals and Functional Foods	3-1-0	4
2	Food Rheology and Microstructures	3-1-0	4
3	Food Additives and Preservatives	3-1-0	4
	POOL – 4		
1	Food Fortification and Technology	3-1-0	4
2	Traditional Foods	3-1-0	4
3	Future Foods	3-1-0	4
MOOC's programme will be notified by HOD at the beginning of the semester with minimum 8/12 weeks in duration to earn the 2 credits.			

Professional electives which are not studied, in any form during the program can also be selected for Honors Program

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B. Tech-FOOD ENGINEERING

MINOR PROGRAM
GENERAL TRACK

S. No.	Subject	L-T-P	Credits
1	Food Processing Operations - I	3-1-0	4
2	Food Processing Operations - II	3-1-0	4
3	Current Trends in Food Packaging	3-1-0	4
4	Food Plant Design & Economics	3-1-0	4

MINOR PROGRAM
SPECIALIZED TRACKS

S. No.	Course Name	L-T-P	Credits
TRACK 1- FOOD SCIENCE			
1	Food Nutrition	3-1-0	4
2	Food Preservation Technology	3-1-0	4
3	Food Biochemistry	3-1-0	4
4	Industrial Microbiology	3-1-0	4
TRACK 2- FOOD TECHNOLOGY			
1	Process Technology for Convenience and RTE Foods	3-1-0	4
2	Flavor Technology	3-1-0	4
3	Brewing Technology	3-1-0	4
4	Advances in Milling Technology	3-1-0	4
TRACK 3- FOOD PLANT OPERATIONS			
1	Effluent Treatment in Food Processing	3-1-0	4
2	Food Plant Maintenance	3-1-0	4
3	Energy Management in Food Industries	3-1-0	4
4	Food Plant Utilities and Services	3-1-0	4
TRACK 4 - FOOD SAFETY AND QUALITY			
1	Emerging Technologies in Food Safety and Quality	3-1-0	4
2	Food Licensing and Registration System	3-1-0	4
3	Food Safety and Quality Standards	3-1-0	4
4	Traceability and Recall in Food System	3-1-0	4
TRACK 5 – IT APPLICATIONS IN FOOD PROCESSING			
1	Computer Applications in Food Processing	3-1-0	4
2	Robotics and Computer Controlled Machines	3-1-0	4
3	Computations in Food Engineering	3-1-0	4
4	IT in Food Processing	3-1-0	4
MOOC's programme will be notified by HOD at the beginning of the semester with minimum 8/12 weeks in duration to earn the 2 credits.			

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B. Tech-FOOD ENGINEERING

III Year – I Semester		L	T	P	C
		3	0	0	3
HEAT TRANSFER IN FOOD PROCESSING					

Course Objectives

- To study about the types of heat transfer and their engineering principles
- To study about the exchange of heat transfer in equipment used in food industries

Course Outcomes

By the end of the course, the students will be able to

- To understand the principles of heat transfer
- To learn about the types, design of food engineering equipment used in exchange of heat

UNIT I

Introduction to heat transfer, general concepts of heat transfer by conduction, convection and radiation. Conduction - Basic concepts of conduction in solids, liquids and gases, steady state temperature fields and one-dimensional conduction without heat generation, e.g., through plane walls, cylindrical and spherical surfaces, composite layers, etc. Insulation materials, critical and optimum insulation thickness.

Learning Outcomes

At the end of unit, students will be able to

1. Understand about the types of heat transfer present in the environment
2. Study the conduction takes places in different states of matter and through different objects

UNIT II

Convection: Fundamentals of convection, basic concepts and definitions, natural and forced convection, hydrodynamic and thermal boundary layers, laminar and turbulent heat transfer inside and outside tubes, dimensional analysis, and determination of individual and overall heat transfer coefficients.

Learning Outcomes

At the end of unit, students will be able to

1. Brief knowledge about the convective heat transfer and its thermal behavior on pipes
2. Know dimensional analysis and calculation of overall heat transfer coefficient

UNIT III

Radiation: Basic laws of heat transfer by radiation, black body and gray body concepts, view factors, Kirchhoff's law, solar radiations, combined heat transfer coefficients by convection and radiation.

Learning Outcomes

At the end of unit, students will be able to

1. Detail study of radiation mode of heat transfer and different laws included
2. Study combined methods of convective and radiation heat transfer

UNIT IV

Introduction to evaporator, types and operation methods. Types. Overall heat transfer coefficient in evaporator. Calculation methods for evaporators. Condensers used in evaporators and evaporation in biological materials.

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Learning Outcomes

At the end of unit, students will be able to

1. Understand about the types and operation methods of evaporator
2. Calculations of evaporators and its applications on biological products

UNIT V

Heat Exchangers: Types of heat exchangers, Overall heat transfer coefficient, Fouling factor, Analysis of heat exchangers, LMTD, Effectiveness -NTU method, Correction factor, Effectiveness of heat exchangers.

Learning Outcomes

At the end of unit, students will be able to

1. Brief learning of types of heat exchangers used and design considerations
2. Knowledge on different analysis carried out in heat exchangers

Textbooks

1. Ibarz, A., & Barbosa-Cánovas, G. V. (2002). *Unit operations in food engineering*. CRC press.
2. Rajput, R. K. (2015). A textbook of heat and mass transfer. S. Chand.
3. Badger, W. L. (1955). *Introduction to chemical engineering* (No. 660.28 B33). Mc Graw-Hill Inc.

References

1. Sinnott, R., Richardson, J. F., & Coulson, J. M. (2013). *Chemical engineering: An introduction to chemical engineering design*. Elsevier.
2. Holman, J. P. (2008). *Heat Transfer (SI Units) Sie*. Tata McGraw-Hill Education.

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III Year – I Semester		L	T	P	C
		3	0	0	3

PROCESSING OF FRUITS, VEGETABLES, SPICES, AND PLANTATION CROPS

Course Objectives

- To enable the students to understand the processing of fruits and vegetables
- To impart technical knowledge of about how to develop products and preservation
- To understand the methods of dehydration

Course Outcomes

The students will be able to

- Understand the production status and Post harvest handling methods of fruits and vegetables.
- Learn the methods of processing and preservation of freshly harvested and cut fruits and vegetables.
- Enumerate the processing and preservation of fruits and vegetables by heat treatment
- Illustrate the production and preservation methods of fruit juices.

UNIT I

Introduction on fruits & vegetables: Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India; Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables.

Learning Outcomes

At the end of the unit, students will be able to

1. Know the about Production and Processing scenario of fruits & Vegetables in worldwide
2. Understand the Principles and Preservation Methods of Fruits and vegetables
3. Get the knowledge on of Supply chain of Fruits & Vegetables

UNIT II

Post harvesting handling: Unit Operations Involved in Fruits & Vegetables Processing; Peeling, slicing, cubing, cutting, and other size reduction operations for fruits and vegetables, blanching of Fruits & Vegetables. FSSAI specifications, preparation, and preservation of juice, squash, syrup, sherbet, nectar, cordial, crush, etc. Processing Flow sheet and equipment Involved for the above products; FSSAI specifications; Preparation, preservation, and equipment for the manufacture of crystallized fruits and preserves, Candies, Candies, Jam, Jelly and Marmalades, defects in making.

Learning Outcomes

At the end of the unit, students will be able to

1. Acquire knowledge on Unit Operations Involved in Fruits & Vegetables Processing
2. Description of FSSAI specifications, preparation, and preservation of Different F &V Products.
3. Basic Knowledge on Equipment Involved during F&V processing

UNIT III

Processing of fruits and vegetables: FSSAI specifications, Preparation, preservation, and equipment for the manufacture of Chutney, Pickles, Sauce, Puree, Paste, Ketchup; Toffee, Cheese, Lather. Production of pectin and

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vinegar. Dehydration of Fruits and Vegetables: Methods, packaging, storage, quality control. Dehydration Products like wafers, papads, soup powders. Minimally processed fruits and vegetables: Minimally processed fruits & vegetable introduction, Factors affecting shelf life and the quality of minimally processed fruits and vegetables.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the concept of preparation and Preservation of different processed fruits & vegetable products.
2. Acquire knowledge of FSSAI specifications of different processed fruits & vegetable products.
3. Explanation of Minimally processed fruits and vegetables.

UNIT IV

Importance and processing of spices**:** Classification, chemical composition, and principal constituents, History of usage & Spice trade in India and the world. Spices – production and importance – stage of harvesting and harvesting methods -processing of major and minor spices – Ginger, Chilli, Turmeric, Onion and Garlic, Pepper, Cardamom. Allspice, Aniseed, Sweet basil; Caraway seed, Cassia, Cinnamon; Clove, Coriander, Cumin, Dill seed, Fennel seed, Nutmeg, Mace, Mint, Marjoram. Rosemary, saffron, sage, Savory, thyme, Asafetida, curry leaves. Unit operations involved – equipment used- value addition of spices.

Learning Outcomes

At the end of the unit, students will be able to

1. Basic Knowledge on Classification & Chemical Composition of Spices
2. Acquire the knowledge on Processing of Major & Minor Spices
3. Know the Equipment & Value Addition involved in Processing of Major & Minor Spices.

UNIT V

Processing of Plantation Crops**:** Processing of Coffee, Tea, Cocoa, Coconut, Arecanut, Vanilla and Cashew nut. Production and importance, harvesting and stages of harvest, drying, cleaning and grading, processing methods, and equipment, value-added products grading, and types packaging and storage.

Spice Oils & Oleoresins: Flavor extraction from Spices by different methods.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the Processing of Coffee, Tea and Cocoa, Coconut, Arecanut, Vanilla, and Cashew nut
2. Acquire knowledge about the Pre-Harvesting & Post Harvesting Technologies involved.
3. Get the concept of Oleoresin & Flavor extraction of different Spices by suing different extractive methods.

Textbooks

1. R. P. Srivastava and Kumar, S. (2003) *Fruit and Vegetable Preservation: Principles and Practices*, 6th edition, International Book Distributors.
2. Pruthi, J. S. (1993). *Major spices of India. Crop management and post-harvest technology.* Indian Council of Agricultural Research.
3. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S.(2010). *Handbook of Post-Harvest technology – cereals, fruits, vegetables, tea and spices.* Marcel Dekker Inc.

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References

1. Jacob, P. (2008). *A handbook on post harvest management of fruits and vegetables*. Daya Books.
2. Chakraborty, I., Ilahy, R., Vikram, B., OJ, M. S., & Mani, M. A. (2020). *Recent Trends and Advances in Food Science and Post Harvest Technology*. Satish Serial Publishings.
3. Clark, C. J., Hockings, P. D., Joyce, D. C., & Mazucco, R. A. (1997). Application of magnetic resonance imaging to pre-and post-harvest studies of fruits and vegetables. *Postharvest Biology and Technology*, *11*(1), 1-21.

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III Year – I Semester		L	T	P	C
		3	0	0	3
FOOD PLANT DESIGN & PROCESS ECONOMICS					

Course Objectives

- To Impart knowledge to the students on strategies used in design of Food process plant
- To provide basic economic analysis of food plant viz. basic concepts in engineering economics, plant design, safety features and its importance to chemical engineering.

Course Outcomes

By the end of the course, the student will be able to

- To develop a feasibility report and perform a complete economic analysis of the plant
- Study about strategies used in design of Food Process plat and economic analysis.

UNIT I

Introduction to Plant Design, important and special features of food processing plants, Plant Location; site selection criteria, factors influencing plant location, location analysis and techniques, general design consideration for location of food plants. Layout; basic concepts of layout, types of layouts and types of layout, factors influencing layout, understanding of equipment layout and applicability of layout

Learning Outcomes

At the end of the unit, student will be able to

1. Acquire knowledge on selection of site for food industry
2. Capable of design a basic layout for food industry

UNIT II

Selection of Process, flow sheet, basic flow sheet, food processing step flow sheet, process equipment flow sheet, material balance & energy balance, selection of equipment., floor plant types of layouts, Food building planning, preparation of machinery layout for fruit, vegetables and meat-size reduction machinery layout.

Learning Outcomes

1. Acquire knowledge on peculiarities of different food industries
2. Know the calculations of material and energy balance and equipment selection.

UNIT III

Evaporation plant layout-single, multiple, vacuum and film evaporators-types and concepts, drying plant layout, drying process, dryer types, selection of dryers. Baking oven and frying plant-types, concepts and layout. Filling, closing and labelling of plant layout. Organization and trends in plant layout - sample layout, installation procedure for food processing plant.

Learning Outcomes

1. Understand the special features of the different drying plant and layouts
2. Gains the knowledge on installation procedures

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KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

UNIT IV

Cost Engineering Time value of money and equivalence, Interest, cost comparisons by present worth, Annual equivalent cost and capitalized cost methods, Uniform gradient and series. Depreciation, Taxes and Insurances, Nature of depreciation, Methods of determining depreciation, depreciation rates in current Indian situation, Types of taxes and insurances, Procedure for cost comparison after taxes.

Learning Outcomes

1. Understand the cost comparisons and interest calculation
2. Acquires the knowledge on depreciation

UNIT V

Cost Estimation- Types of cost estimation, capital investment cost, fixed capital cost, working capital cost, start-up costs and process equipment cost estimation, cost index, Equipment costs due to inflation, Battery limit investments, estimation of plant cost, Estimation of total product cost, Manufacturing cost, General expenses. Profitability Criteria of profitability, Payback period, return on investment, Present value, Cash flow analysis, Alternative investment analysis, Sensitive analysis in project profitability. Preparation of techno-economic feasibility report.

Learning Outcomes

1. Know the cost estimation for manufacturing product
2. Understand the cash flow analysis and investment analysis methods
3. Capable of preparation of techno economic feasibility report for various products

Textbooks

1. López-Gómez, A., & Barbosa-Cánovas, G. V. (2005). *Food plant design*. CRC Press.
2. Maroulis, Z. B., & Saravacos, G. D. (2007). *Food plant economics*. CRC Press.

References

1. Peters, M. S., Timmerhaus, K. D., & West, R. E. (2003). *Plant design and economics for chemical engineers* (Vol. 4). New York: McGraw-Hill Education.
2. Clark, J. P. (2005). *Food plant design*. *Food Eng*, 4, 683-696. Encyclopedia of Life support Systems.

Dr K. V. S. G. Murali Krishna **Chairperson (i/c)**	**Dr P Srinivasa Rao** **Member**	**Dr. N. N. Misra** **Member**	**Dr. K. S. M. S. Raghava Rao** **Member**	**Dr. S. Kaleemullah** **Member**
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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

III Year – I Semester		L	T	P	C
		0	0	3	1.5
HEAT TRANSFER IN FOOD PROCESSING LAB					

Course objectives

- To study about the types of heat transfer and their engineering principles
- To study about the exchange of heat transfer in equipment used in food industries

Course outcomes

By the end of the course the students will be able to

- To understand the principles of heat transfer
- To learn about the types, design of food engineering equipment used in exchange of heat

1. To find the thermal conductivity of metallic rod at different temperature and draw the temperature profile for steady and unsteady state conduction.
2. To find out the thermal conductivity of insulating powder.
3. To find the thermal conductivity of liquids/gases.
4. To find the emissivity of grey plate with respect to black plate
5. To study the critical heat flux behavior of a liquid
6. To find the heat transfer coefficient for parallel and counter current flow condition for a double pipe heat exchanger
7. To study the shell & Tube heat exchanger and find the heat duty and over all heat transfer coefficient for parallel flow condition.
8. To study the shell & Tube heat exchanger and find the heat duty and over all heat transfer coefficient for counter flow condition.
9. To study the Plate heat exchanger and find the overall heat transfer coefficient
10. To study the performance of heat pipe.
11. To find the heat transfer coefficient for open pan evaporator for steady and unsteady state condition.
12. To determine the steam economy of single/double/multiple effect evaporator

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B. Tech-FOOD ENGINEERING

III Year – I Semester		L	T	P	C
		0	0	3	1.5
PROCESSING OF FRUITS, VEGETABLES, SPICES AND PLANTATION CROPS LAB					

Course Objectives

The major learning objective of this course will be

- To enable the students to understand the processing of fruits and vegetables
- To impart Practical knowledge of about how to develop products and preservation
- To understand the methods of dehydration.

Course Outcomes

Upon successful completion of this course students should be able to

- Perform the experiments of processing and preservation of freshly harvested fruits and vegetables.
- Enumerate the processing and preservation of fruits and vegetables by heat treatment
- Illustrate the production and preservation methods of fruit juices.
- Understand Extraction Methods involved in Spices & Plantation Crops
- Perform the Experiments on Estimation of Bio-Active Component Present in Spices

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1. Canning of fruits and vegetables,
2. Preparation of syrup, squash, crush, fruit juices e.g., carambola, orange, pineapple, mango, etc
3. Preparation of jams and jellies, fruit candy, marmalade, and determination of TSS and viscosity
4. Preparation of pickles, chutneys
5. Preparation of tomato products like ketchup, sauces, and determination of TSS
6. Determination & extraction of pectin (identification of pectin-rich foods, chemistry, and interaction of pectin with other components) in fruits and vegetable products.
7. Drying of fruit and vegetables (Soup powders, dried products, Curry Powder)
8. Preparation of potato and banana wafers
9. Visit fruits and vegetable processing industries & canning plant.
10. Solvent extraction of crude oil from clove & pepper
11. Detection of adulterants in spices
12. Extraction of oleoresin from ginger

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Dr. Ramachandra Pradhan Member	**Dr. Jathindra K Sahu** Member	**Er. K. Sri Varsha** Member	**Shri. P. Ramakrishna** Member-Convener	**Mr. Jaddu Samuel** Invitee

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B. Tech-FOOD ENGINEERING

III Year – I Semester		L	T	P	C
		1	0	2	2

FOOD EXTRUSION PROCESSING

Course Objectives

- To familiarize the students with concepts of extrusion, a key unit operation in food processing
- To inculcate basic knowledge about applications and industrial technologies of food extrusion

Course Outcomes

- Understanding basic fundamentals, design considerations, processing of different extruded products, and selection of food extrusion equipment
- Understanding suitability of raw materials, preconditioning, process variables and extruder types for extrusion and its impact on extrusion process, rheological behavior, and product quality
- Understanding chemical and nutritional changes occurring in the extrusion process and packaging requirement of extruded products

UNIT I

Food Extrusion: Introduction to extrusion technology, Raw materials for extrusion of foods, Types of extrusion, Nutritional changes during extrusion cooking, Effect on rheological properties of materials during the extrusion process

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on extrusion, and its types
2. Gain insights on the effect of extrusion on food components

UNIT II

Extrusion Technology: Introduction to extruders, principles, and uses of extruders in the food industry, Pre-conditioning of raw materials used in the extrusion process, Extruder selection, design, and operation for different food applications.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on equipment involved in end to end extrusion processing
2. Be made aware of design and operation considerations of extrusion equipment

UNIT III

Types of Extruders: Single screw extruder- Principle of working, Net flow, Operations, factors affecting extrusion, process. Twin-screw extruder- Counter-rotating and co-rotating twin-screw extruder, Process characteristics of the twin-screw extruder, Advantages of Twin Screw Extruder. Packaging materials for extruded product

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Learning Outcomes

At the end of the unit students will

1. Understand about types of extruders, equipment and processes
2. Gain insights on the characteristics of the extruders and packaging materials for extruded products

UNIT IV

Breakfast cereals by Extrusion technology: Classification of breakfast Cereals, raw materials, process, and quality testing for ready to eat breakfast cereals. Texturized vegetable protein, definition, manufacturing process and quality parameters of TVP, other Products like manufacturing process and quality testing of pasta, macaroni, vermicelli

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on different types of extruded products
2. Gain insights on the manufacturing processes and quality testing's of extruded products

UNIT V

Recent Advances on Extrusion Technology**:** Carbon dioxide or nitrogen assisted extrusion technology, Extrusion in confectionary technology, Non-thermal extrusion of protein products, industrial application of extrusion for development of snack products including co-injection and pellet technologies.

Learning Outcomes

At the end of the unit students will

1. Be made aware of various industrial advances in extrusion
2. Gain insights on the recent applications in food industries

Textbooks

1. Choudhury, G. S., & Gogoi, B. K. (1996). Extrusion processing of fish muscle: a review. *Journal of aquatic food product technology*, *4*(4), 37-67.
2. Harper, J. M. (1994). *The technology of extrusion cooking*. N. Frame (Ed.). Glasgow: Blackie Academic & Professional.
3. Guy, R. (Ed.). (2001). *Extrusion cooking: technologies and applications*. Woodhead publishing. Riaz M.N. CRC Press, 2000.

References

1. Berk, Z. (2018). *Food process engineering and technology*. Academic press.
2. Fellows, P. J. (2009). *Food processing technology: principles and practice*. Elsevier.

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III Year – I Semester		L	T	P	C
		1	0	2	2
FOOD EXTRUSION PROCESSING LAB					

Course Objectives

- To impart knowledge about extrusion and its practical applications
- To familiarize students with design of extruders

Course Outcomes

At the end of course student able to produce

- Traditional food products and breakfast cereal products
- Texturized vegetable protein and vermicelli
- Different factors responsible for quality degradation of extruded foods

1. Design of a single screw extruder
2. Design of twin screw extruder
3. Extrusion of breakfast cereal product
4. Extrusion of texturized vegetable protein
5. Estimation of costing of extrusion of any product
6. Understanding national and international standards for extruded products
7. Extrusion of pasta product/vermicelli
8. Extrusion of crispbreads/ toffees
9. Determination of degree of expansion and bulk density of extruded food products
10. Determination of oil and water absorption capacities of extruded products

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B. Tech-FOOD ENGINEERING

III Year – II Semester		L	T	P	C
		3	0	0	3

MASS TRANSFER IN FOOD PROCESSING

Course Objectives

- To familiarize the students with concepts of mass transfer and its principles
- To inculcate basic knowledge about food processing operations involving mass transfer

Course Outcomes

- Understanding fundamentals of mass transfer
- Knowledge about mass transfer equations, models related to different geometries
- Understanding the underlying principles, processes and equipment of mass transfer operations
- Knowing recent trends and applications of mass transfer operations in food processing industries

UNIT I

Introduction to mass transfer: Mass transfer - Modes of mass transfer, Terms and definitions related to mass transfer. Water activity, Prediction of water activity, Methods for determination of water activity, sorption isotherms, types, Hysteresis, Equilibrium moisture content– Isotherm models –Basic problems on water activity and isotherm models

Learning Outcomes

At the end of the unit students will

1. Understanding on basics of mass transfer
2. Gain knowledge on concepts of water activity and sorption in detail

UNIT II

Mass Transfer Laws: Fick's laws for molecular diffusion, Molecular diffusion in solids, liquids, gases and biological solutions, Steady state mass diffusion, Mass diffusion equations for plane, cylindrical and spherical geometries, Counter diffusion. Unsteady state mass diffusion, Mass transfer coefficient, Convective mass transfer and Numerical on steady and unsteady state mass diffusion

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on modes and laws of diffusion
2. Understanding mass transfer through different geometries

UNIT III

Drying and Extraction: Mass transfer in Drying, Rate of drying curves - Drying kinetics – Drying equipment. Extraction, Principles of extraction, Equipment for extraction. Solid-Liquid extraction – Leaching, Equipment, Applications of leaching in food processing.

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Super critical fluid extraction – Principles, Extraction systems, Solvents, Applications

Learning Outcomes

At the end of the unit students will

1. Be aware of concepts, processes and models of drying processes
2. Gain insights on concepts of leaching and super critical fluid extraction

UNIT IV

Distillation and Gas absorption: Vapor-Liquid Equilibria, Relative volatility, Types of distillation, Equipment, Applications of distillation in food processing. Gas Absorption, Principles of gas absorption, Equipment used for gas absorption, Concepts of NTU, HTU and HEPT Application – Applications of gas absorption.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on process, laws and industrial applications of distillation
2. Understand the concept of gas absorption, equipment and applications in food industries

UNIT V

Adsorption and Ion Exchange: Types of Adsorption, Nature of adsorbents, Adsorption equilibrium, Adsorption of a single component from a gas mixture/liquid solution. Multistage cross current and counter current adsorption, Continuous contact adsorption. Ion exchange, Principle of ion exchange, Equilibria and rate of ion-exchange, Applications of adsorption and ion exchange processes in food industries

Learning Outcomes

At the end of the unit students will

1. Gain insights on adsorption, its principles and related concepts
2. Gain knowledge on ion exchange process and its applications in food processes

Textbooks

1. Saravacos, G. D., & Maroulis, Z. B. (2011). *Food process engineering operations*. CRC Press.
2. Rajput, R. K. (2007). *Heat and mass transfer*. S. Chand.
3. Geankoplis, C. J., Hersel, A. A., & Lepek, D. H. (2018). *Transport processes and separation process principles* (Vol. 4). Boston, MA, USA: Pearson Education.
4. Rao, D. G. (2009). *Fundamentals of food engineering*. PHI Learning Pvt. Ltd.

References

1. Singh, R. P., & Heldman, D. R. (2001). *Introduction to food engineering*. Gulf Professional Publishing.
2. Berk, Z. (2018). *Food process engineering and technology*. Academic press.

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III Year – II Semester		L	T	P	C
		3	0	0	3
PROCESSING OF MILK, MEAT AND MARINE PRODUCTS					

Course Objectives

- To understand about the composition, nutritive value of milk, meat, and marine products
- To know about processing technology of milk, meat and fish
- To learn the value addition and packaging of milk, meat, and marine products

Course Outcomes

The student will be able to understand

- Precautions that need to be taken while handling products from this segment.
- The Different types of meat, milk and fish and the processes involved in their processing.
- The challenges in developing new value-added products from this segment.
- Hygienic and safe handling of Meat, Fish and Dairy Product

UNIT I

Dairy Chemistry and Microbiology: Introduction - Basic dairy terminology - milk as raw material, composition, nutritive value, Physicochemical constituents of milk and its constituents, contaminants, the microbiology of milk-milk collection, cooling and milk transport, milk reception, Quality control tests, applications of enzymes in the dairy industry. Technology and standards of commercial liquid milk products.

Learning Outcomes

At the end of the unit, students will gain knowledge on

1. Basics terminology of dairy products
2. Acquire knowledge on microbiology of milk
3. Study about physicochemical characteristics of milk

UNIT II

Dairy Processing and Equipment: Milk processing equipment, filtration/clarification, pasteurization – HTST – LTLT – UHT methods, storage tanks, Cream separating Centrifuges, Homogenization theory, working principle of homogenizers, homogenization efficiency. Cream separation principles of gravity and centrifugal separation centrifugal separator parts construction and working principle separation efficiency. Process Technology and standards of manufacturing of malted milk drinks, Infant Foods, Fermented Milk and Other Milk Products

Learning Outcomes

At the end of the unit, students will be able to

1. Basic knowledge of Equipment and Machinery used in milk processing
2. Acquire knowledge on pasteurization, homogenization and cream separation
3. Understand the principles of pasteurization, homogenization and cream separation

UNIT III

Chemistry and Microbiology of Meat: Status of the Meat industry in India; Meat composition from different sources; Definitions and measurements, Explanation of muscle structure and compositions and its modifiers,

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White and Red Meat, description of bone and its modifiers; Post mortem muscle chemistry, Meat colour, flavors of meat products, meat microbiology, and safety. Pre-slaughter operations for animals.

Learning Outcomes

At the end of the unit, students will gain knowledge on

1. Meat composition and sources
2. Muscle structure and composition
3. Pre slaughter operations

UNIT IV

Slaughtering and Processing of Meat Products: Slaughtering operations for animals, stunning, methods of stunning, bleeding-skinning of animals. Ante-mortem inspection, Evaluation of animal carcasses. Modern abattoirs and some features, Carcass processing equipment, Operational factors affecting meat quality, effects of processing on meat tenderization; meat processing equipment. Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat. Different kinds of sausages – Equipment used for all the process operations; Meat plant hygiene, Good manufacturing practice, and HACCP.

Learning Outcomes

At the end of the unit, students will be able to learn

1. Basic knowledge of slaughtering operations for animals
2. Modern abattoirs and Carcass processing equipment
3. Acquire knowledge on the processing of meat products and plant hygiene

UNIT V

Fish and other Marine Products Processing: Commercially important marine products from India, Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, merits and demerits; preservation of fish by different methods: chilling, freezing, modified atmosphere packaging, canning, curing, marinate; changes in fish proteins on storage; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, IQF, Canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate and fish oil, fish sauce, hygiene in fish processing spoilage of fish; effect of processing on nutritive value; contaminants and naturally occurring toxicants in fish; by-product utilization

Learning Outcomes

At the end of the unit, students will be able to gain

1. Basic knowledge of commercially important marine products from India
2. Basic biochemistry, spoilage factors of fish
3. Preservation by different methods

Textbooks

1. Huang, T. C., & Nip, W. K. (2001). *Meat science and applications*, 403-442. Marcel Dekker.
2. De, S. (1980). Indian dairy products. *Outlines of dairy technology. Oxford University Press, New Delhi, India*, *412*.
3. Warner, J. N. (1976). Principles of dairy processing, Wiley Eastern, New Delhi.

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References

1. Nollet, L. M., Boylston, T., Chen, F., Coggins, P., Hydlig, G., McKee, L. H., & Kerth, C. (Eds.). (2012). *Handbook of meat, poultry and seafood quality*. John Wiley & Sons.
2. Mead, G. (Ed.). (2004). *Poultry meat processing and quality*. Woodhead Publishing.

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Member	**Member**	**Member**	**Member-Convener**	**Invitee**

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III Year – II Semester		L	T	P	C
		3	0	0	3

FOOD PACKAGING TECHNOLOGIES

Course Objectives

- To learn about the importance of packaging used in food applications
- To develop appropriate packaging techniques for storing of foods

Course Outcomes

By the end of the course the students will be able to

- To understand the packaging uses in foods
- To learn about the types, selection and design the packaging techniques for foods

UNIT I

Introduction to food packaging: functions of packaging and package environments. Shelf life of packaged foods: factors controlling shelf life and its estimation Packaging material characteristics and its properties (Mechanical, optical and barrier properties)

Learning Outcomes

At the end of unit, students will be able to

1. Understand the functions of packaging in foods
2. Know the importance of shelf life of food product through packaging
3. Learn about the characteristics of packaging

UNIT II

Modified Atmosphere Packaging (MAP): Principles, gases used in MAP and methods for creating MA conditions, factors affecting MAP and design of MAP. Modified Atmosphere Packaging (MAP) for fresh cut produce. Controlled atmosphere storage (CAS).

Learning Outcomes

At the end of unit, students will be able to

1. Acquire the brief knowledge in MAP and CAP
2. Understand its application in food products

UNIT III

Retort packaging foods, pillow pouch packaging, shrink wrapping packaging, aseptic packaging of foods, Active and intelligent packaging: introductions. Ethylene and moisture regulation in packaging of fresh fruits and vegetables.

Learning Outcomes

At the end of unit, students will be able to

1. Know the importance of retort, pillow and shrink packaging
2. Learn about the aseptic packaging in foods
3. Study of active and intelligent packaging and its applications in foods

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UNIT IV

Edible and Biodegradable packaging, antimicrobial food packaging – Introduction, antimicrobial agents and factors affecting its effectiveness. Non-Migratory Bioactive Polymers (NMBP) in food packaging: Introduction, advantages and limitations

Learning Outcomes

At the end of unit, students will be able to

1. Acquire knowledge on alternative plastic packaging
2. Learn about the antimicrobial uses in food packaging
3. Know the significant importance of NMBP in food applications

UNIT V

Packaging of fresh fruits and vegetables, cereals, snack foods, bakery, confectionary and dairy products.

Learning Outcomes

At the end of unit, students will be able to

1. Learn about the packaging materials used in fruits, vegetables and dairy products
2. Learn about the packaging materials used in cereals and snack foods
3. Learn about the packaging materials used in bakery and confectionary

Textbooks

1. Robertson, G. L. (2005). *Food packaging: principles and practice*. CRC press.
2. Ahvenainen, R. (Ed.). (2003). *Novel food packaging techniques*. Elsevier.
3. Crosby, N. T. (1981). Food *packaging materials; Aspects of analysis and migration of contaminants.* Food and Agriculture Organization.
4. Coles, R., McDowell, D., & Kirwan, M. J. (Eds.). (2003). *Food packaging technology* (Vol. 5). CRC press.

References

1. Paine, F. A., & Paine, H. Y. (2012). *A handbook of food packaging*. Springer Science & Business Media.
2. Han, J. H. (Ed.). (2005). *Innovations in food packaging*. Elsevier.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

III Year – II Semester		L	T	P	C
		0	0	3	1.5

FOOD PACKAGING TECHNOLOGIES LAB

Course Objectives

- To acquire the skills on quality of packaging materials
- Evaluate the migration characteristics of packaging materials.
- Develop suitable packaging methods for food products.

Course Outcomes

- Describe different food packaging materials and their properties
- Describe packaging of various food commodities
- Explain and interpret various tests used in evaluating quality and safety of food packaging materials against invading pathogens
- Comprehend food and packaging material interactions

1. GSM measurement of a packaging material
2. To determine the grammage of packaging material
3. Calculation of moisture in packaging material using moisture meter
4. To evaluate the strength of corrugated boxes by crush tester
5. Vibration testing of different packages
6. Coating of packaging material for using automatic film applicator
7. Drop test of packaging material
8. Bursting strength of packaging material
9. Heat sealing of packaging material
10. Compression testing for packaging material
11. Universal testing machine for packaging material
12. Dart impact testing of packaging material
13. Seal strength of the packaging material
14. Leak proof detector of packaged food
15. Crock meter-digital motorized of the packaged film

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SCHOOL OF FOOD TECHNOLOGY

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III Year – II Semester		L	T	P	C
		0	0	0	1.5

MASS TRANSFER IN FOOD PROCESSING LAB

Course Objectives

- To familiarize the students with concepts of mass transfer and its principles
- To inculcate basic knowledge about food processing operations involving mass transfer

Course Outcomes

Student acquires knowledge and will be able to

- Calculate the Knowledge about mass transfer equations, models related to different geometries
- Understanding the underlying principles, processes and equipments of mass transfer operations
- Knowing recent trends and applications of mass transfer operations in food processing industries

1. Drying of foods using rotary dryer
2. Crystallization of food solutions by crystallizer
3. To perform solid-liquid extraction using Packed bed type extractor
4. Studies on Bubble cap/ tray/ fractional column
5. To perform liquid-liquid extraction using packed towers
6. To study the performance of water cooling tower
7. Drying of fruits in a forced draft tray dryer
8. Drying of food particles using fluidized bed dryer
9. To perform distillation using vapor-liquid equilibrium setup
10. Steam distillation of spices
11. Study on adsorption of food materials in a packed bed type adsorber
12. Humidification and dehumidification of foods
13. Ion exchange columns

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III Year – II Semester		L	T	P	C
		0	0	0	1.5

PROCESSING OF MILK, MEAT AND MARINE PRODUCTS LAB

Course Objectives

- To familiarize students with different practical processes involved in milk, meat and marine food processing
- To impart knowledge on quality testing of milk, meat and marine products

Course Outcomes

The students will be able to

- Prepare or manufacture different food products from milk and its derivatives
- Understand quality parameters involved in milk, meat and marine products processing or preservation

1. Process technology of butter and ghee
2. Process technology of channa and paneer
3. Process technology of khoa and kalakhand
4. Determination of selected quality parameters of selected dairy products
5. Visit dairy plant and enumeration of different commercial dairy products
6. Slaughtering and dressing of meat animals- poultry
7. Study of post-mortem changes
8. Meat cutting and handling- poultry
9. Preservation of meat by curing and pickling
10. Study of anatomy and dressing of fish
11. Identification of different types of fish - selection and grading
12. Quality evaluation of fish, chilling and freezing of fish

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B. Tech-FOOD ENGINEERING

III Year – II Semester		L	T	P	C
		1	0	2	2
RETORT PROCESS ENGINEERING					

Course Objectives

- To make students understand the concepts of Retort process and its application in food industry, and able to select retort process for corresponding product
- To impart knowledge on the thermal processing design of different food products.

Course Outcomes

The student will be able to understand

- Retort Technology and types of retorts.
- Importance and applications of retort process in Food industry.
- The challenges in developing retort pouch.
- Process time evaluation and thermal destruction of microorganisms - D, Z, F_O values

UNIT I

Retort Technology: Introduction, basic retort cycle, cycle of operation of retort, venting process, importance in canning. Selection of container, selection of retort - temperature and pressure requirement. Types of retorts; batch retort, steam/ air retort, full water immersion retort, spray water retorts and rotary retorts, cycle of operation and application in food processing.

Learning Outcomes

The student will be able to

1. Understands the retort cycle operation
2. Acquire knowledge on types of retorts
3. Under various application of retort process

UNIT II

Continuous retorts, hydrostatic retort, hydrolock retort, reel and spiral retort; cycle of operation and application in food processing. Packaging systems for retorting; Retort pouch processing of foods, characteristics of retort pouches, common structures used for retort processing, Construction, sealing, processing and packaging, methods for improving glass packaging, Future trends.

Learning Outcomes

The student will be able to

1. Understands the different packaging systems for retorting
2. Understands the structure of retort pouch
3. Advances and latest trends

UNIT III

Thermal Processing Design and Optimization: Basic principles in thermal destruction of microorganisms - D, Z, F_0 values, Thermal processing, sterilization classification U.H.T. systems, recent advances in design of thermal processes. Survival curves, thermal death curves, analysis of thermal resistance data, process time evaluation. Regulatory considerations, Critical factors related to the design of thermal treatments for the products packaged prior to treatment.

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Learning Outcomes

The student will be able to

1. Understands the thermal destruction of microorganisms
2. Student able calculate the D, Z, Fo values
3. Acquire knowledge on process time evaluation

UNIT IV

Retort Processing Technology for preparation of instant cooked rice, carrot and other cereals based food products Technology of ready to eat instant premixes based on cereals, pulses etc and numerical on Z and Fo values

Learning Outcomes

The student will be able to

1. Understand the Technology of instant food
2. Understand the Technology of instant Premixes
3. Able calculate the Z and Fo values for different instant foods

UNIT V

Retort Processing Technology for curried vegetables and breakfast food etc. Technology for ready-to-cook and ready to eat meat and meat food products and numerical on Z and Fo values

Learning Outcomes

The student will be able to

1. Understand the Technology of curried vegetables
2. Understand the Technology Breakfast
3. Able calculate the Z and Fo values for different instant foods

Textbooks

1. Sandeep, K. P. (Ed.). (2011). *Thermal processing of foods: control and automation*. John Wiley & Sons.
2. Tucker, G., & Featherstone, S. (2021). *Essentials of thermal processing*. John Wiley & Sons.
3. Richardson, P. (Ed.). (2004). *Improving the thermal processing of foods*. Woodhead Publishing.

References

1. Thorpe, R. H. (1975). Canning retorts and their operation. Food and Agriculture Organization.
2. May, N. (1997). Guidelines for performing heat penetration trials for establishing thermal processes in batch retort systems.

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B. Tech-FOOD ENGINEERING

III Year – II Semester		L	T	P	C
		1	0	2	2
RETORT PROCESS ENGINEERING LAB					

Course Objectives

- To understand commercialization aspects of traditional or ethnic dishes which are important due to their delicacy and are high in demand.
- To impart knowledge on heating of low acid food prone to microbiological spoilage in hermetically sealed container to extend shelf life.

Course Outcomes

The students will be able to understand

- Calculation of F_0 and Z values for different foods
- Shelf life of retort processed foods
- The Retorting Technology

1. Determination of F_0 and Z values for Retort processed plain rice
2. Determination of F_0 and Z values for Retort processed ginger garlic paste
3. Determination of F_0 and Z values for Retort processed jeera rice
4. Determination of F_0 and Z values for Retort processed sambar
5. Determination of F_0 and Z values for Retort processed tomato curry
6. Determination of F_0 and Z values for Retort processed chilli sauce
7. Determination of F_0 and Z values for Retort processed mixed vegetable curry
8. Determination of F_0 and Z values for Retort processed onion paste
9. Determination of F_0 and Z values for Retort processed vegetable biryani
10. Determination of F_0 and Z values for Retort processed upma

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B. Tech-FOOD ENGINEERING

III Year – II Semester		L	T	P	C
		1	0	2	2
FOOD SAFETY AND QUALITY CERTIFICATION					

Course Objectives

- To familiarize students with certificate programs, hands-on trainings involved in food Industry, safety and quality assurance.

Course Outcomes

The students will be able to

- Understanding of Food safety and quality
- To get Knowledge on ISO 9001 : 2000
- To get Knowledge on ISO 22000: 2005
- To Understand BRC standards

UNIT I

Management Systems. Auditing and Accreditation. Introduction to Management Systems, Auditing, GMP, GHP and its importance in food industry. Standard and Accreditation.

Learning Outcomes

The students will be able to understand

1. Management Systems
2. Standard and Accreditation

UNIT II

ISO 9001: 2008, ISO 9001:2008: An overview, ISO 9001:2008: Structure, Clause wise Interpretation of ISO 9001 : 2008, ISO 9001:2008 : Case Studies

Learning Outcomes

The students will be able to understand 1. ISO 9001:2000

2. Interpretation of ISO 9001 with case studies

UNIT III

ISO 22000: 2015, ISO 22000: 2015: An overview, ISO 22000: 2015: Structure, Clause wise Interpretation of ISO 22000:2015, ISO 22000: 2015: Case Studies

Learning Outcomes

The students will be able to understand 1. ISO 22000: 2005

2. Interpretation of ISO 22000:2005 with case studies

UNIT IV

Laboratory Quality Management System, an Overview and Requirements of ISO 17025, Requirements Specific to Food Testing Laboratories – Physical and Chemical Parameters, Requirements Specific to Food Testing Laboratories – Biological Parameters, General Topics: Related to Food Testing Laboratories

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Learning Outcomes

The students will be able to understand

1. Requirements of ISO 17025
2. Requirements Specific to Food Testing Laboratories

UNIT V

Retailer Standards: BRC Food and BRC IOP Standards: An Overview, IFS: International Food Standard, SQF: 1000 SQF: 2000, Global Gap and India Gap

Learning Outcomes

The students will be able to understand

1. BRC Food and BRC IOP Standards
2. International Food Standards

Textbooks

1. Luning, P. A., Marcelis, W. J., & Jongen, W. M. (2002). *Food quality management: a techno-managerial approach*. Wageningen Pers.
2. Kill, R. (2012). *The BRC Global standard for food safety: A guide to a successful audit*. John Wiley & Sons.

References

1. Vasconcellos, J. A. (2003). *Quality assurance for the food industry: a practical approach*. CRC press. Inteaz Alli. 2004. Food quality assurance - Principles & practices. CRC Press. NewYork.
2. Mortimore, S., & Wallace, C. (2013). *HACCP: A practical approach*. Springer Science & Business Media.

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III Year – II Semester		L	T	P	C
		1	0	2	2
FOOD SAFETY AND QUALITY CERTIFICATION LAB					

Course Objectives

- To demonstrate applicable statutory and regulatory food safety requirements.
- To ensure conformity with specified customer requirements and enhancing customer satisfaction.
- To Promote Food safety throughout our organization and to our society.
- To ensure that relevant food safety policy, Objectives and targets established, monitored and enhanced continually.

Course Outcomes

The students will

- Have knowledge on tools that can use to effectively communicate food safety issues within our organization and how these are addressed and in turn communicated to interested parties and throughout the food chain as well.

1. Development of GHP and GMP Plan for a food factory
    a. Identifying gaps in its implementation and
    b. Closure plans for identified gaps in a food factory/ food outlet
2. Development of FSMS
    a. Data collection and hazard identification (Physical, Chemical and microbiological)
    b. Hazard analysis.(Usage of FMEA technique for risk assessment)
3. Development of methodology (decisions tree) as per clause 7.4.4 of ISO 22000 for a food establishment
4. Food laws: Identification of legal requirements for following food groups product standards :
    a. Fruit/Vegetables,
    b. Dairy.
5. Food laws: Identification of legal requirements for following food groups product standards
    a. Meat & Meat products
    b. Cereal, Pulses and Oilseeds
6. Food laws: Identification of legal requirements for following food groups product standards
    a. fish and sea foods and ready to eat foods (specific legal requirements)
7. Application of ISO 9001 Model
    a. Understanding Process approach
    b. defining quality policy and Objectives
    c. Correction Corrective action and preventive action
    d. Continual improvement
8. Understanding ISO 17025 requirements for FSMS and QMS Audits relating to clause 7.6 in ISO 9001 and clause 8.3 in ISO 22000 (Establishing Traceability to national/ international standards

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9. Development of FSMS
    a. Development of OPRP (operational pre-requisite programme) and development of HACCP Plan (critical limits (including rationale for limits), monitoring procedure, correction and corrective measures)
    b. Managing unsafe product
10. Matrix preparation to find correspondence between ISO 22000, HACCP series and BRC and any other related standard (Food Retail management- basic requirements)

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B. Tech-FOOD ENGINEERING

LIST OF PROFESSIONAL ELECTIVES

S. No.	Course Name	L-T-P	Credits
PROFESSIONAL ELECTIVE- 1			
1	Transport Phenomena in Food Engineering	3-0-0	3
2	Statistical Methods in Food Engineering	3-0-0	3
3	Process Modeling and simulation	3-0-0	3
PROFESSIONAL ELECTIVE- 2			
1	Separation Techniques in Food Processing	3-0-0	3
2	Thermal Operations in Food Processing	3-0-0	3
3	Automation in Food Industry	3-0-0	3
PROFESSIONAL ELECTIVE- 3			
1	Advances in Drying and Dehydration	3-0-0	3
2	Process Kinetics in Food Engineering	3-0-0	3
3	Non Thermal Operations in Food Processing	3-0-0	3
PROFESSIONAL ELECTIVE- 4			
1	Food Process Equipment Design	3-0-0	3
2	Biosensors in Food Processing	3-0-0	3
3	New Product Development	3-0-0	3
PROFESSIONAL ELECTIVE- 5			
1	Entrepreneurship in Food Industries	3-0-0	3
2	Food Supply Chain Management	3-0-0	3
3	Food Business Management and Economics	3-0-0	3

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B. Tech-FOOD ENGINEERING

	PROFESSIONAL ELECTIVE – 1	L	T	P	C
		3	0	0	3
TRANSPORT PHENOMENA IN FOOD ENGINEERING					

Course Objectives

- To familiarize students with basics and principles transport processes of foods
- To impart knowledge on derivation of related equations of mass, energy and momentum transfer
- To make students understand the equipments and processes relating mass, energy and momentum transfer and their industrial applications

Course Outcomes

The students will

- Know about principles and fundamentals of mass, energy and momentum transfer
- Gain knowledge on equipments, governing equations and industrial processes of transport phenomena

UNIT I

Dimensional Analysis: Buckingham Pi-theorem and matrix method, application to transport phenomena, analysis among mass, heat and momentum transfer, Reynolds' analogy. Boundary layer concept - Theoretical and exact solutions for heat, mass and momentum transfer.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics of dimensional analysis
2. Understand the theoretical and practical solutions of dimensional analysis for mass, energy and momentum transfer

UNIT II

Introduction to Transport Phenomena: Molecular transport mechanism, transport properties and their proportionality constants in momentum, energy and mass transfer. Steady state conduction through solid surfaces. Heat exchangers - Performance analysis of parallel flow and counter flow heat exchangers. LMTD and effectiveness NTU approach. Application of computational software for process heat transfer applications. Unsteady state heat conduction: Concept of Biot number, Lumped parameter analysis, transient heat flow in semi-infinite solids, use of Heisler charts.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basic concepts of momentum, energy and mass transfer
2. Understand heat transfer equations and performance evaluation of heat exchangers using various parameters.

UNIT III

Heat Transfer: Condensation and boiling heat transfer - Film wise condensation on vertical surface, Nusselt equation, regimes of boiling, boiling heat transfer. Forced convection heat transfer in flow over a flat surface - hydrodynamic and thermal boundary layer, continuity equation, momentum equation and energy equation, heat transfer coefficient/ Nusselt number in laminar and turbulent region of boundary layer. Forced convection heat

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transfer in flow through tubes - Nusselt number in the entrance region and fully developed laminar and turbulent region.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on process and equations related to condensation and boiling
2. Understand the concepts of natural and forced convection, transport equations and applications

UNIT IV

Momentum Transfer: Overall momentum balance, momentum transport equations for Newtonian and non-Newtonian fluids, continuity equation in different co-ordinates. Equations of motion – Navier- Stokes equations and their application in viscous fluid flow between parallel plates and through pipes. Turbulent transport mechanism - Mathematical analysis, eddy viscosity and eddy diffusivity, velocity, temperature and concentration distribution.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics of momentum transfer process
2. Gain insights on motion equations and transport mechanism in turbulent regime

UNIT V

Mass Transfer: Fick's law of diffusion, steady state and unsteady state diffusion of gases and liquids through solids, numerical methods, equimolar diffusion, isothermal evaporation of water into air, mass transfer coefficients. Governing equation for mass transfer, boundary conditions. Various non- dimensional numbers and their analogy to heat transfer. Convective mass transfer. Examples of simultaneous heat and mass transfer process

Learning Outcomes

By the end of the unit students will

1. Gain insights on laws and governing equations of mass transfer
2. Understand different analogies in relation to mass transfer

Textbooks

1. Swaney, R. E., & Bird, R. B. (2019). *Transport phenomena and thermodynamics: Multicomponent mixtures*. *Physics of Fluids*, *31*(2), 021202.

2. Jorge, W.C., Jorge, F.V.R & Gustavo, V.B.C. (2003). *Transport Phenomena in Food Processing*. CRC Press

3. Mc Cabe W. L., Smith J. C., & Harriot P. (2017). *Unit Operations in Chemical Engineering. McGraw Hill*

4. Geankoplis, C. J., Hersel, A. A., & Lepek, D. H. (2018). *Transport processes and separation process principles* (Vol. 4). Boston, MA, USA: Prentice hall.

References

1. Treybal, R. E. (1980). *Mass transfer operations*. *New York*, *466*. McGraw – Hill.

2. Yuan, S. W. (1967). *Foundations of Fluid Mechanics*. Englewood Cliffs, N. J., Prentice-Hall, INC., 1967. 627 P.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	PROFESSIONAL ELECTIVE – 1	L	T	P	C
		3	0	0	3
STATISTICAL METHODS IN FOOD ENGINEERING					

Course Objectives

- This course is meant for exposing the students in the usage of various statistical packages for analysis of data.
- It would provide the students hands on experience in the analysis of their research data. This course is useful to all disciplines.

Course Outcomes

Student will able to understand

- Applications of statistical procedures in food processing
- Experimental design of sensory and consumer data
- Statistical analysis of instrumental data
- Design application in food product development

UNIT I

Introduction and applications of statistical procedures in food processing, descriptive statistics, analysis of difference, types of significance test association, correlation and regression and experimental design

Learning Outcomes

At the end of unit, students will be able to

1. Understand the experimental design
2. Get knowledge on correlation and regression

UNIT II

Sensory and Consumer Data: Introduction, The quality and nature of sensory and consumer data, Experimental design issues, Consumer data (sensory and survey), Trained panel sensory data, Analysis of relationships

Learning Outcomes

At the end of unit, students will be able to

1. Experimental design of Sensory and consumer data
2. Develop data analysis sheet for Sensory and consumer data

UNIT III

Instrumental Data: Introduction, Quality and nature of instrumental data, Sampling and replication, Experimental design issues, Statistical analysis of instrumental data, Chemical analysis applications, Analysis of relationships, Multivariate applications - Introduction, Multivariate methods and their characteristics, Multivariate modes.

Learning Outcomes

At the end of unit, students will be able to

1. Statistical analysis of instrumental data
2. Understand Multivariate Analysis

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

UNIT IV

Relationship of consumer preference with sensory measures, Principal component analysis, Chemometrics, Partial least square, Response surface methodology, Mixture design, Fractal analysis, Cluster analysis, ANN and Fuzzy logic.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the Response surface methodology.
2. Know the Fractal analysis, Cluster analysis.

UNIT V

Food Product Formulation: Introduction, Design application in food product development, Single ingredient effects, Two or more ingredients, Screening of many ingredients, Formulation by constraints. Statistical quality control: Introduction, Types of statistical quality control, Sampling procedures, Control charts, Acceptance sampling

Learning Outcomes

At the end of unit, students will be able to

1. Use the statistical methods for product formulation
2. Design application in food product development

Textbooks

1. Bower, J. A. (2013). *Statistical methods for food science: Introductory procedures for the food practitioner*. John Wiley & Sons.
2. Granato, D., & Ares, G. (Eds.). (2014). *Mathematical and statistical methods in food science and technology*. John Wiley & Sons.

References

1. Barnsley, M. F. (2014). *Fractals everywhere*. Academic press.
2. Montgomery, D. C. (2017). *Design and analysis of experiments*. John wiley & sons.
3. Everitt, B. S., & Dunn, G. (2001). *Applied multivariate data analysis* (Vol. 2). London: Arnold.
4. Gkisser, S. (2017). *Predictive inference: an introduction*. Chapman and Hall/CRC.

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B. Tech-FOOD ENGINEERING

	PROFESSIONAL ELECTIVE– 1	L	T	P	C
		3	0	0	3
PROCESS MODELING AND SIMULATION					

Course Objectives

- To familiarize students with the basics of modeling concepts
- To make students understand the different types of modeling and their analysis
- To develop knowledge in application of mathematical and empirical modeling in different food processes

Course Outcomes

The students will be able to

- Understand the basics of different models, mathematical tools and validation processes
- Get insights on model analysis and technical aids used for modeling
- Apply the modeling concepts to basic food processes

UNIT I

Introduction: The Role of Models in Process Systems Engineering, A Systematic Approach to Model Building, Conservation Principles, Constitutive Relations, Basic mathematic tools for model solution.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on basic concepts of modeling and mathematic tools
2. Gain insights on different approaches for modeling building

UNIT II

Dynamic Models: Dynamic Models, Lumped Parameter Systems, Solution Strategies for Lumped Parameter Models, Dynamic Models, Distributed Parameter Systems Solution Strategies for Distributed Parameter Systems, Process Model Hierarchies

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on dynamic lumped parameter systems and their solutions
2. Gain insights on dynamic distributed parameter models and their solutions

UNIT III

Model Analysis: Basic Tools for Process Model Analysis, Statistical Model Calibration and Validation, Analysis of Dynamic Process Models, Process Modeling for Control and Diagnostic Purposes, Modeling Discrete Event Systems, Modeling Hybrid Systems, Modeling Applications in Process Systems, Computer Aided Process Modeling.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on concept of model analysis, tools employed and validation
2. Gain insights on process models, its uses, types applications

UNIT IV

Mathematical Modeling: Introduction, Developing mathematical relationship between the independent and dependent variables affecting the food processing operations by using physical and chemical principles governing

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the processes for, particulate size reduction, homogenization, centrifugation, packaging, mixing, conveying, extrusion, storage, heating, cooling, freezing, puffing, frying, distillation, extraction, concentration and drying.

Learning Outcomes

At the end of the unit students will

1. Understand the basics of mathematical models and related equations
2. Be able to apply mathematical models for different food processes

UNIT V

Empirical Modeling: Introduction, Empirical model building, Factorial, fractional-factorial and rotatable central composite experimental design, Developing empirical equations using experimental data. Usage of soft computing tools such as ANN, GA, fuzzy logic etc., in developing predictive models, optimization of processing parameters, modeling of sensory evaluation.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on concepts of empirical models, equation building and their food applications
2. Gain insights on usage of soft computing tools for predictive modeling of various attributes of food

Textbooks

1. Law, A. M., Kelton, W. D., & Kelton, W. D. (2007). *Simulation modeling and analysis* (Vol. 3). New York: Mcgraw-hill.
2. Cameron, I. T., & Hangos, K. (2001). *Process modelling and model analysis*. Elsevier.
3. Tijskens, L. M. M., Hertog, M. L. A. T. M., & Nicolaï, B. M. (Eds.). (2001). Food process modelling (Vol. 59). Woodhead Publishing.
4. Das, H. (1900). *Food processing operations analysis*. Global Media.

References

1. Ozilgen, M. (1998). *Food process modelling and control: Chemical engineering applications*. Gordon & Breach Science.
2. Bakalis, S., Knoerzer, K., & Fryer, P. J. (Eds.). (2015). *Modeling food processing operations*. Elsevier.

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SCHOOL OF FOOD TECHNOLOGY

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		L	T	P	C
	PROFESSIONAL ELECTIVE - 2	**3**	**0**	**0**	**3**

SEPARATION TECHNIQUES IN FOOD PROCESSING

Course Objectives

- To understand the basic principles involved and types of separation process.
- To apply the principles and equations of mass transfer in food processing operations.
- To perform calculations for basic separation processes in food processing.

Course Outcomes

The students will be able to

- Express various mass transfer and separation processes.
- Describe the types of separation processes in food engineering.
- Calculate the material balance and appraise the performance in food processing units.

UNIT I

Basic Principles of Separation Process: Basic principles of food processing, Conservation of mass and materials balances, energy and heat units, conservation of energy and heat balances. Pressure head in fluids devices, measurement of pressures - U tube manometer, Pitot tube, types of flow-laminar, turbulent, simple mass balance and continuity equation, pressure drop due to friction, drag coefficient, flow in packed beds.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on basic principles of separation process of food components
2. Gain insights on driving gradients for separation processes and their measuring devices

UNIT II

Vapour Liquid Separation Process: Vapor- liquid equilibrium relations, single stage equilibrium contact for vapor liquid system, relative volatility of vapor liquid system. Distillation - Steam distillation, applications and equipment. Evaporation - Needs, basic principles, Single and multiple effect evaporation, heat economy, vapour recompression, thermo and mechanical systems, boiling point elevation, Falling film, climbing film tubular evaporators, plate evaporators, thin film and scraped surface evaporators.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on separation principles and processes of vapor and liquid components
2. Learn about different unit operations that carryout vapor-liquid separation in detail

UNIT III

Extraction and Leaching: Mechanical extraction – Expellers, screw press, filter press. Liquid-liquid extraction, liquid-solid extraction, phase diagram determination of extraction steps by Mc Cabe- Thiele method. Super critical Fluid extraction - Super critical Fluid State, properties of super critical CO_2, density, viscosity, volatility etc. Supercritical phase equilibria, solubility, SCFE systems and components, Applications - extraction of fatty

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acids, oleoresins and essential oils, relative advantages, limitations and economics

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on principles and mechanism of extraction and leaching process
2. Gain in depth insights on super critical fluid extraction process.

UNIT IV

Mechanical Separation Process: Mechanical separation – screeners, sedimentation, gravity sedimentation, sedimentation of solid particles in gas media, stokes law. Filtration- constant volume filtration, constant pressure filtration, industrial applications and equipments for filtration and sedimentation. Centrifugal separation, basic equations. Different types of centrifuges. Importance of balancing of rotating masses, feed and discharge arrangement in each case, specific characteristics, advantages and applications.

Learning Outcomes

At the end of the unit students will

1. Gain insights on different mechanical separation processes
2. Understand the advances and applications of sedimentation, centrifugation and filtration in food industries

UNIT V

Filtration by Membrane Process: Definitions, Reverse Osmosis (RO), Nanofiltration (NF), Diafiltration, Ultrafiltration (UF) and Microfiltration (MF), molecular weight cut off in each case. Membranes and their characteristics, Cross flow filtration, configuration of membranes, membrane materials, pumps and other membrane equipment. Applications in food industry, relative advantages and limitations.

Learning Outcomes

At the end of the unit students will

1. Learn about different membrane separation processes
2. Gain insights on mechanisms, equipments and specific applications of all membrane concentration process

Textbooks

1. Mc Cabe W. L., Smith J. C., & Harriot P. (2017). *Unit Operations in Chemical Engineering. McGraw Hill*
2. Geankoplis, C. J., Hersel, A. A., & Lepek, D. H. (2018). *Transport processes and separation process principles* (Vol. 4). Boston, MA, USA: Prentice hall.
3. Sahu, J. K. (Ed.). (2014). *Introduction to advanced food process engineering*. CRC Press.

References

1. Richardson, J. F., Harker, J. H., & Backhurst, J. R. (2002). *Particle technology and separation processes*. Butterworth-Heinemann.
2. Ramaswamy, H. S., & Marcotte, M. (2005). *Food processing: principles and applications*. CRC Press.

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	PROFESSIONAL ELECTIVE- 2	L	T	P	C
		3	0	0	3

THERMAL OPERATIONS IN FOOD PROCESSING

Course Objectives

- To introduce concepts of heat transfer consideration in thermal processing
- To impart knowledge about basics of thermal operations involved in food processing
- To provide an idea on novel thermal technologies used in food industry

Course Outcomes

On completion of the course, the student would be able to

- Interpret the various thermal operation available for food processing
- Apply the techniques for preservation of foods
- Evaluate the suitability of the techniques for specific foods

UNIT I

Introduction: Measurement and prediction of thermophysical properties of foods, mass and energy balances, and heat transfer considerations for thermal processing of foods. Basic principles in thermal destruction of microorganisms - D, Z, F_o values.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on measurement and prediction of thermophysical properties of foods
2. Gain insights on the basic principles in thermal destruction of microorganisms

UNIT II

Pasteurization & Sterilization: Pasteurization - Methods, Batch and Continuous types of Pasteurization, Microbial Inactivation and Sterilization: Methods, Microbial destruction in batch and continuous sterilization - kinetics of loss of nutrients in sterilization, UHT processing, the action of chemicals on death kinetics of microbes.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on thermal operation like pasteurization & its effect on food processing
2. Gain insights on the sterilization & its effect on food processing

UNIT III

Evaporation: Concentration of liquid foods in batch and continuous type evaporators, heat and energy balance in multiple effect evaporators, design of calendria in the evaporators, falling and rising film evaporators, mechanical and thermal vapor recompression systems. Process time calculations.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on thermal operation like evaporation, its types & impact on food processing
2. Gain insights on the mechanical and thermal vapor recompression systems and process time calculations.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

UNIT IV

Overview on Drying: Drying of Foods: various mechanisms of moisture removal in solid and liquid foods during drying, properties of air-water vapor mixture. Drying operations based on conduction, convection, and radiation heat transfer, spray, freeze, roller, tray, and through-flow drying operations.

Learning Outcomes

At the end of the unit students will

1. Gain an overview of drying concepts
2. Gain insights on the drying operations based on conduction, convection, and radiation heat transfer
3. Understand different drying techniques and their food applications

UNIT V

Novel Thermal Technologies: Aseptic packaging, Retort system, Irradiation and Microwave processing of foods, Effects of heat, acid, and shortwave electromagnetic radiation on the kinetics of enzyme inactivation, Ohmic heating in food processes, Radio frequency dielectric heating, Infrared heating, and Pressure-assisted thermal processing.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on novel thermal technologies like Aseptic packaging, Retort system, Irradiation and Microwave processing of foods.
2. Gain insights on Ohmic heating in food processes, Radio frequency heating, Infrared heating, and Pressure-assisted thermal processing.

Textbooks

1. Rao, D. G. (2009). *Fundamentals of food engineering*. PHI Learning Pvt. Ltd.
2. Sun, D. W. (2005). *Thermal food processing: new technologies and quality issues*. CRC Press.
3. Sahu, J. K. (Ed.). (2014). *Introduction to advanced food process engineering*. CRC Press.
4. Richardson, P. (Ed.). (2004). *Improving the thermal processing of foods*. Woodhead Publishing.

References

1. Richardson, P. (Ed.). (2001). *Thermal technologies in food processing*. Elsevier.
2. Sandeep, K. P. (Ed.). (2011). *Thermal processing of foods: control and automation*. John Wiley & Sons.
3. Holdsworth, S. D., Simpson, R., & Barbosa-Cánovas, G. V. (2008). *Thermal processing of packaged foods* (Vol. 284). New York: Springer.

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B. Tech-FOOD ENGINEERING

		L	T	P	C
	PROFESSIONAL ELECTIVE – 2	**3**	**0**	**0**	**3**

AUTOMATION IN FOOD INDUSTRY

Course Objectives

- To introduce knowledge about microprocessor controls, SCADA and other control systems
- To familiarize students with application of automation in material handling, process control and supervision of food operations

Course Outcomes

On completion of the course, the student would be able

- To study automation, its role in material handling and manufacturing systems
- To study computer based industrial automation, SCADA, etc
- To understand the significance of automation in food industry

UNIT I

Introduction: Automation in Production System, principles and strategies of automation, basic elements of an automated system, advanced automation functions, levels of automation. Flow lines and transfer mechanisms, fundamentals of transfer lines.

Learning Outcomes

At the end of the unit students will

1. Understand the basic concepts of automation, its principles and elements
2. Gain insights on transfer lines and mechanisms involved

UNIT II

Material Handling and Identification Technologies: Overview of material handling systems, principles and design consideration, material transport systems, storage systems, overview of automatic identification methods.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on overview of automation in material handling and storage systems
2. Gain insights on the identification methods in automation

UNIT III

Automated Manufacturing Systems: Components, classification and overview of manufacturing systems, manufacturing cells, GT and cellular manufacturing, FMS, FMS and its planning and implementation. Quality control systems - Traditional and modern quality control methods, SPC tools, inspection principles and practices, inspection technologies.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on the types, features, manufacturing process involved in automated manufacturing systems

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2. Gain insights on the concepts of automation in quality control of foods

UNIT IV

Control Technologies in Automation: Industrial control systems. Manufacturing industries, continuous versus discrete control, computer process and its forms.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on control technologies and processes used in food industries
2. Gain deep insights on the control systems and their deployment in manufacturing foods

UNIT V

Computer based Industrial Control: Introduction and automatic process control, building blocks of automation systems - LAN, analog and digital I/O modules, SCADA systems and RTU. Distributed control system - Functional requirements, configurations and some popular distributed control systems. Industrial control applications in dairy and food processing industry. Microcontroller units (MCU), Arduino, raspberry pi sensors compatible with MCUs, temperature- RH, ultrasound
and infrared sensors.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on LAN, SCADA and RTU systems
2. Gain insights on the distributed control systems, their configurations and about microcontroller units

Textbooks

1. Cichocki, A., Ansari, H. A., Rusinkiewicz, M., & Woelk, D. (1997). *Workflow and process automation: concepts and technology* (Vol. 432). Springer Science & Business Media.
2. Groover, M. P. (2016). *Automation, production systems, and computer-integrated manufacturing*. Pearson Education India.
3. Moore, C. A. (2012). *Automation in the food industry*. Springer Science & Business Media.

References

1. Hollender, M. (2010). *Collaborative process automation systems*. ISA.
2. Caldwell, D. G. (Ed.). (2012). *Robotics and automation in the food industry: Current and future technologies*. Elsevier.

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		L	T	P	C
	PROFESSIONAL ELECTIVE – 3	**3**	**0**	**0**	**3**

ADVANCES IN DRYING AND DEHYDRATION

Course Objectives

- To familiarize students with basics and principles of drying of foods
- To impart knowledge on different types of recent drying technologies, their mechanisms
- To make the students understand their industrial applications, pros over conventional drying techniques

Course Outcomes

The students will be able to

- Know about principles and fundamentals of advanced drying techniques used in food industries
- Gain knowledge on processes, kinetics involved and applications of advanced dehydration technologies

UNIT I

Drying Fundamentals: Theories of drying, drying rate curve, heat and mass transfer mechanisms in drying, models for prediction of sorption isotherms, thermodynamics of sorption isotherms. Need for advanced drying technologies, classification and selection criteria- conventional versus novel technologies, Innovation and trends in drying technologies.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics of drying principles and process of sorption
2. Understand basics need and trends of advanced techniques for drying of foods

UNIT II

Impinging Steam Drying: Basic features, hydrodynamics and heat transfer. Pulsed fluid bed drying - principles and examples. Low pressure superheated steam drying - Basic principle of LPSSD, LPSSD of food and biomaterials, mathematical modeling of LPSSD. Airless drying, drying in mobilized beds. Vacuum jet drying, applications.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics, theory, mechanisms and practical applications of impinging steam drying and low pressure superheated steam drying
2. Understand the process involved and applications of airless drying, vacuum jet drying and drying using mobilized beds

UNIT III

Contact Sorption Drying: Mechanism, characteristics of sorbents/carriers, technology of contact sorption drying. Heat pump assisted drying - Classification of heat pump dryers, fundamentals of heat pump dryers, heat and mass transfer mechanisms, optimum use of heat pump in drying systems, innovative heat pump design systems. Refractance window drying, applications.

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Learning Outcomes

By the end of the unit students will

1. Gain knowledge on concepts of contact sorption drying
2. Gain insights on the principles of heat pump drying and refractance window drying

UNIT IV

Acoustic Drying, Sonic drying - Basic characteristics of sound, sound generation, mechanism of sonic drying, drying kinetics, sound assisted dryers. Pulse combustion drying - Principle, combustors design and construction, types of combustors, applications.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics, principles and mechanisms of sound assisted drying techniques
2. Gain insights on pulse combustion drying, working principles and applications in food

UNIT V

Hybrid Drying Technologies: Microwave - convective drying with cogeneration, microwave vacuum drying, RF vacuum drying, filtermat drying, spray fluid bed vibrated fluid bed dryer. Food dryer process controls - Need of process control, control parameters, control strategy, control philosophy, fundamental control methods, advanced control.

Learning Outcomes

By the end of the unit students will

1. Gain insights on hybrid drying technologies in food industries
2. Understand process controls, strategies and advances in drying process operation in industries.

Textbooks

1. Mujumdar, A. S., & Xiao, H. W. (Eds.). (2019). *Advanced drying technologies for foods*. CRC Press.
2. Barbosa-Cánovas, G. V., & Vega-Mercado, H. (1996). *Dehydration of foods*. Springer Science & Business Media.

References

1. Ratti, C. (Ed.). (2008). *Advances in food dehydration*. CRC Press.
2. Kudra, T. (2008). Energy aspects in food dehydration. In *Advances in food dehydration* (pp. 441- 464). CRC Press.

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	PROFESSIONAL ELECTIVE– 3	L	T	P	C
		3	0	0	3

PROCESS KINETICS IN FOOD ENGINEERING

Course Objectives

- To familiarize students with basics and principles of reaction and process kinetics
- To impart knowledge of process kinetics of different food processing operations
- To make the students understand various influencing factors and their effects on food processes

Course Outcomes

The students will

- Know about principles and fundamentals of reaction kinetics involved in food systems
- Gain knowledge on kinetics of different food processes that are commonly employed in food industries

UNIT I

Reaction Kinetics in Food Systems: Introduction, basic principles of kinetics, order of reaction, reaction rate, types of reaction, effect of temperature and pressure. Kinetics of biological processes. Kinetics of food components like vitamins and pigments. Application of reaction kinetics in food processing technologies

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on basics of reaction kinetics, types and effecting parameters
2. Gain insights on kinetics of different biological processes and food components

UNIT II

Measurement and Prediction of Thermophysical and Rheological Properties of Foods: Introduction to thermophysical properties. Thermal conductivity, theoretical and semi empirical models for thermal conductivity. Thermal diffusivity, specific heat, density and specific gravity. Predictive equations for determination of thermophysical properties of different food products. Rheological properties, related nomenclature. Prediction and correlation of rheological properties. Time dependent and independent models for non newtonian foods. Dependence of rheological properties on temperature and pressure of foods. Numericals.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge about different rheological and thermophysical properties
2. Be able to predict the thermal and rheological properties of different food products

UNIT III

Process Kinetics in Sterilization: Process and principles of sterilization, Thermal resistance of micro organisms, concepts of Z value, D value, F value, Lethality concept, Q_{10} value, activation energy and reaction rate constant. Heat penetration profiles and parameters during heating of foods. Thermal process calculations, improved and general methods. Related numericals

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on different parameters involved in killing of microbes during sterilization process
2. Gain insights on kinetics involved during sterilization process

UNIT IV

Process Kinetics in Drying, Evaporation and Freezing: Mass and energy balances in evaporation, heat transfer rates, boiling point rise, time temperature relationship in evaporation process. Drying models, drying kinetics, prediction of drying rates and drying times, diffusion model. Freezing time calculations, methods of prediction, mathematical models and numerical.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on drying process kinetics and prediction of various drying and evaporation parameters
2. Gain insights about freezing process models, prediction of freezing time and influence of other parameters

UNIT V

Kinetics of Food Deterioration and Shelf life Prediction: Kinetics of food deterioration, reaction modeling principles, effect of environmental factors on food deterioration. Applications of kinetic modeling for foods. Shelf life prediction and control, accelerated shelf life studies. Remaining shelf life prediction in inventories. Applications of shelf life modeling for foods with case studies.

Learning Outcomes

At the end of the unit students will

1. Gain knowledge on kinetics involved in food deterioration and influencing factors
2. Gain insights on shelf life prediction, control and modeling

Textbooks

1. Heldman, D. R., Lund, D. B., & Sabliov, C. (Eds.). (2018). *Handbook of food engineering*. CRC press.
2. Valentas, K. J., Rotstein, E., & Singh, R. P. (1997). *Handbook of food engineering practice*. CRC press.

References

1. Maroulis, Z. B., & Saravacos, G. D. (2003). *Food process design*. CRC Press.
2. Berk, Z. (2018). *Food process engineering and technology*. Academic press.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	PROFESSIONAL ELECTIVE – 3	L	T	P	C
		3	0	0	3

NON THERMAL OPERATIONS IN FOOD PROCESSING

Course Objectives

- To introduce the concept of processing and preserving of foods without heating
- To make students familiar about different non thermal techniques and their applications in food processing industries

Course Outcomes

On completion of the course, the student would be able to

- Recall the principles of preservation
- Interpret the various emerging non thermal techniques available for food processing
- Apply the techniques for preservation of foods
- Evaluate the suitability of the techniques for specific foods

UNIT I

Emerging Technologies in Food Processing: Membrane technology – Nanofiltration, Ultrafiltration, Reverse osmosis, Microfiltration, Applications. Supercritical fluid extraction. Property of near-critical fluids and extraction methods. Application of SCFE in food processing.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on membrane technology, types, principles and applications
2. Gain insights on the supercritical fluid extraction & other novel extraction methods

UNIT II

Hurdle Technology: Types of preservation techniques and their principles, the concept of hurdle technology and its applications. Irradiation in food products, principles and applications. Ozone processing in foods.

Learning Outcomes

At the end of the unit, students will

1. Gain Knowledge on the concept of hurdle technology
2. Gain insights on the mechanisms and applications of irradiation and ozone in food treatment

UNIT III

High Pressure Processing & Ultrasound Processing: HPP -Types of equipment, mechanism of microbial inactivation, effect of HPP on fruit juices, meat products and etc. Ultrasonic processing - Properties of ultrasonic, types of equipment, the effect of ultrasonic treatment on microbial inactivation, oil yield.

Learning Outcomes

At the end of the unit, students will

1. Gain Knowledge on high pressure processing & its applications
2. Gain insights on the ultrasound technology in food processing & its application

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UNIT IV

Pulse Light Technology: High-intensity pulse technique - Processing systems, design of static chambers, continuous chambers, other chamber designs, generation of different voltage waveforms. Oscillation magnetic fields for food processing, generation of magnetic fields, mechanisms of inactivation of microorganisms in food preservation. Application of high-intensity light in food processing. Pulse electric field-mechanism of inactivation, PEF generation system, PEF treatment.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on high-intensity pulse technique & its design and mechanism, applications
2. Gain insights on the pulse electric field & its design and mechanism, applications

UNIT V

Recent Non-Thermal Methods: Cold Plasma - Principle of cold plasma technology and its generation systems and its application. Cryogenic grinding - Properties of cryogens, systems, and their different applications.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on cold plasma and its food applications
2. Gain insights on cryogenic grinding

Textbooks

1. Chauhan, O. P. (Ed.). (2019). *Non-thermal processing of foods*. CRC Press.
2. Brennan, J. G., & Grandison, A. S. (Eds.). (2012). Wiley - VCH.
3. Sahu, J. K. (Ed.). (2014). *Introduction to advanced food process engineering*. CRC Press.

References

1. Barbosa-Cánovas, G. V., Tapia, M. S., & Cano, M. P. (Eds.). (2004). *Novel food processing technologies*. CRC press.
2. Gould, G. W. (Ed.). (1995). *New methods of food preservation*. Springer Science & Business Media.

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B. Tech-FOOD ENGINEERING

		L	T	P	C
	PROFESSIONAL ELECTIVE - 4	**3**	**0**	**0**	**3**
FOOD PROCESS EQUIPMENT DESIGN					

Course Objectives

- This imparts knowledge on the principles, mechanism, selection, and design of different pieces of equipment used in the food industry.
- To introduce students to a wide range of equipment such as heat exchangers, dryers, freezer, conveyors for different process operations, their design considerations, and material selection

Course Outcomes

On completion of the course, the student would be able to

- Know about the designing aspects of food processing equipment
- Gain knowledge on process parameters in mechanical, thermal, and mass transfer operations carried out in food processing

UNIT I

Introduction: General introduction about different food equipments and processes. Process flow sheets, Material and energy balances, Computer-aided food process design. Basic and secondary design considerations, materials of construction, strength of construction, selection of equipment. Fabrication and installation of equipment. Sizing and costing of equipment. Numerical related to mass and energy balance

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on different equipment in food processing
2. Gain insights on basic design considerations, process flow, costing involved in equipment design

UNIT II

Design of Mixing, Size Reduction and Conveying Equipments: Design consideration of mixing and blending equipment, Design of agitators and scale-up, Operation and maintenance. Design consideration of size reduction equipment, installation and maintenance. Design consideration of material conveying equipment, belt conveyor, screw conveyor, bucket elevator, pneumatic conveyor. Numerical related to design aspects of mixing, size reduction, and conveying equipment.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on different mixing, size reduction and conveying equipment
2. Gain insights on design parameters, maintenance, and scale-up of those requirements

UNIT III

Design of Heat Exchangers, Evaporators & Dryers: Design of heat exchangers, plate heat exchangers, shell and tube heat exchangers, design of finned type heat exchanger, materials of construction, installation and operation. Design of single effect evaporators, applications. Multiple effect evaporators, installation and maintenance. Design aspects and considerations for cabinet dryer, fluidized bed dryer, spray dryer, freeze dryer and foam mat dryer, Installation, Operation and Maintenance. Drying kinetics, drying models, drying time and drying rate prediction.

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Learning Outcomes

At the end of the unit students will

1. Gain knowledge on types and design considerations of various heat exchangers
2. Gain insights on the types, process models, construction and maintenance of dryers and evaporators.

UNIT IV

Design of Cold Storages and Freezers: Design of cold storage, factors to be considered, estimation of cooling load, operation-construction, installation and maintenance of cold storage. Design consideration for controlled atmospheric storage and modified atmospheric storage of perishables. Design of freezers, design considerations, construction and operation. Design of frozen storage, installation and operation. Freezing time calculations, methods of prediction, mathematical models and numerical.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on design, operation and maintenance of cold storages
2. Gain insights on design parameters of CAS, MAS and freezers, their process models.

UNIT V

Hygienic Design & Operational Safety of Food Processing Equipment: Introduction to hygienic design and safety measures. Hygienic standards and regulations, cleaning of food processing equipment. Good manufacturing practices, food safety program. GMP and HACCP. Testing of equipment. Design of Pressure and storage vessels. Design of sterilizing vats, pulpers, and crushers. Numerical related to the design of the above equipment.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on hygienic and safety design of food equipments
2. Gain insights on GMP, HACCP, and other regulations

Textbooks

1. Saravacos, G. D., & Kostaropoulos, A. E. (2002). *Handbook of food processing equipment* (Vol. 2012, pp. 331-381). Kluwer Academic/Plenum.
2. Maroulis, Z. B., & Saravacos, G. D. (2003). *Food process design*. CRC Press.

References

1. Heldman, D. R. (Ed.). (2012). *Food process engineering*. Springer Science & Business Media.
2. Hall, C. W. (1979). *Processing equipment for agricultural products* (No. 04; S698, H3 1979.). AVI Publications
3. Clark, J. P. (2005). *Food plant design*. Food Eng, *4*, 683-696. Encyclopedia of Life Support Systems.

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B. Tech-FOOD ENGINEERING

		L	T	P	C
	PROFESSIONAL ELECTIVES – 4	**3**	**0**	**0**	**3**
SENSORS IN FOOD PROCESSING					

Course Objectives

- To impart knowledge about sensors and their deployment in different food processing operations
- To inculcate facts regarding the applications, types and significance of biosensors in food industries

Course Outcomes

The students will be able to understand

- The types of sensors used in food technology applications
- The fundamentals of sensing for the food industry including process control
- The use of different types of sensor and E-Sensor systems in the food industries.

UNIT I

Sensors in Food Engineering: Introduction. Operating principles of biosensors. Basic construction and measurement principles. Electrochemical sensors, types. Applications of Amperometric and Potentiometric biosensors in food applications

Learning Outcomes

At the end of the unit, students will be able to

1. Gain insights on basic operating and construction principles of biosensors
2. Understand the working, construction and applications of electrochemical sensors in food applications

UNIT II

Optical Biosensors: Introduction, principles of optical detection, spectroscopic techniques, types of optical biosensors, Fluorescence Resonance Energy Transfer, Surface Plasmon Resonance. Optical biosensors in food quality and food safety maintenance.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the concept of optical sensing and its governing principles
2. Gain knowledge on types and applications of optical biosensors in food

UNIT III

Microbial Sensors: Introduction, principles, description of construction and operation of microbial biosensors. Detection of food borne pathogens using sensors

Learning Outcomes

At the end of the unit, students will be able to

1. Know about the working principles and components of microbial sensors.
2. Gain insights about application of sensors in microbial detection

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UNIT IV

Applications of Biosensors in Food Science and Manufacturing: Sensors to monitor packaging and shelf life of foods, Biosensors for food quality control and additive control. Biosensors for sensory evaluation of foods. Acoustic sensors.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the concept of sensing equipments for monitoring food during preservation period.
2. Acquire knowledge on recent applications of biosensors in sensory, quality and additive control.

UNIT V

Novel Sensors and their role in Food Safety: Novel sensing receptors, electronic nose, e-tongue and testers. Biosensors and Biosecurity. Biosensors and HACCP. Future trends of biosensors in food processing.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the concept of Sensory evaluation in food product development and sensory evaluation in quality control, by sensors
2. Acquire knowledge about the role of biosensors in food manufacturing.

Textbooks

1. Mutlu, M. (Ed.). (2016). *Biosensors in food processing, safety, and quality control*. CRC Press.
2. Kress-Rogers, E., & Brimelow, C. J. (Eds.). (2001). *Instrumentation and sensors for the food industry* (Vol. 65). Woodhead Publishing.
3. Takhistov, P. (2005). Biosensor technology for food processing, safety, and packaging. In *Handbook of Food Science, Technology, and Engineering-4 Volume Set* (pp. 2312-2331). CRC Press.

References

1. Tothill, I. (Ed.). (2003). *Rapid and on-line instrumentation for food quality assurance*. Elsevier.
2. Pohanka, M., & Skládal, P. (2008). Electrochemical biosensors—principles and applications. *Journal of applied biomedicine*, *6*(2). 57-64.

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		L	T	P	C
	PROFESSIONAL ELECTIVE – 4	**3**	**0**	**0**	**3**
NEW PRODUCT DEVELOPMENT					

Course Objectives

- To develop knowledge of new product development thereby adapting them to research and development skills
- To make the students understand the pre and post aspects of new product development.

Course Outcomes

The students will be able

- To perform a preliminary research on a new food product development
- To assess the external and internal influencing factors for new product development
- To understand the certification and licensing procedures relevant to new or medicinal or specialty foods.

UNIT I

Introduction to New Product Development: Introduction, Overview, Food Ingredients, Functional properties of ingredients, Consumer and market trends, Consumer survey questionnaire. Reasons for innovation in food industry, Ideation and evaluation of ideas, Strategies and tactics, Preliminary market analysis, Guidelines for detailed study of market, product, and process. Preliminary processing evaluation

Learning Objectives

At the end of the unit, students will be able to

1. Acquire knowledge on basic of food ingredients and their characteristics
2. Understand the market scenario, consumer preferences and other prerequisites for new food product development

UNIT II

Innovations in Product Development: Definition and need for product development, Factors affecting food product development – corporate factors, market factors, technological pressures, government issues and legislations, Classes and characteristics of new food products, Line Extensions and Repositioning of existing products, Reformulations, New Packaging, Ethics in food product development

Learning Objectives

At the end of the unit, students will be able to

1. Acquire knowledge on innovation and factors affecting the food product development
2. Understand the concept of formulations, repositioning and ethics involved in product development.

UNIT III

Food Product Development Process: Stages/ Phases of new product development – Idea generation, screening, feasibility studies, consumer research, financial review, product design and formulation. Process Development – recipe development and scale-up, consumer trials, market testing

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Learning Objectives

At the end of the unit, students will be able to

1. Acquire knowledge on new food product development process
2. Understand the concept of scale up, pilot trials and market testing etc

UNIT IV

Quality Assessment of New Developed Products: Sensory evaluation, Shelf life testing, Packaging and labelling Protocols, Certifications and licensing process of new product, Costing/ Pricing and economic evaluation of the product, Product Launch, Product life cycle

Learning Objectives

At the end of the unit, students will be able to

1. Acquire insights on testing process, packaging and pricing for new product development.
2. Gain knowledge on product launch in market and its life cycle.

UNIT V

Sensory Evaluation of Foods: History, Definition of sensory evaluation, Terms related to sensory evaluation, Scope and objectives of sensory evaluation. Characteristic and importance of
sensory evaluation. Types of scales in sensory evaluation, difference test, descriptive test. Instrumentation test for sensory attributes. Computer aided sensory evaluation.

Learning Objectives

At the end of the unit, students will be able to

1. Gain insights on basics of sensory evaluation, types of scales and methods
2. Understand the concepts of computer aided sensory evaluation and instruments involved.

Textbooks

1. Moskowitz, H. R., Saguy, I. S., & Straus, T. (2009). *An integrated approach to new food product development*. CRC Press.
2. Fuller, G. W. (2004). *New food product development: from concept to marketplace*. CRC Press.
3. Stone, H., Bleibaum, R., & Thomas, H. A. (2020). *Sensory evaluation practices*. Academic press.

References

1. Brody, A. L., & Lord, J. B. (Eds.). (2007). *Developing new food products for a changing marketplace*. CRC Press.
2. Lyon, D. H., Francombe, M. A., & Hasdell, T. A. (2012). *Guidelines for sensory analysis in food product development and quality control*. Springer Science & Business Media.

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B. Tech-FOOD ENGINEERING

	PROFESSIONAL ELECTIVE– 5	L	T	P	C
		3	0	0	3
ENTREPRENEURSHIP IN FOOD INDUSTRIES					

Course Objectives

To enable the students to understand

- Fundamentals on entrepreneurship environment and framework
- The entrepreneurship strategies and business plan for scale-up
- How to form the foundations of food organizations.

Course Outcomes

On completion of the course, the students will be able to

- Understand the concepts of entrepreneurship.
- Get practical and subjective knowledge on entrepreneurship development.
- Create a new food organization
- Evaluate the business and marketing plan for a food organization

UNIT I

Entrepreneurship Framework: Entrepreneurship and the future, Entrepreneurship - Definition, contents, dimensions of entrepreneurship, Paradoxes of entrepreneurship. Resources and capabilities - Identifying attributes of strategic resources, Resource types, Psychological approach, Sociological approach.

Learning Objectives

At the end of the unit, students will be able to

1. Brief understanding on entrepreneurship framework.
2. Acquire knowledge on resources and capabilities of entrepreneurship.
3. Understand the concept of various approaches of entrepreneurship.

UNIT II

Entrepreneurship Environment: Schematic of the new venture's environment, Processes of business environment analysis, Political and governmental analysis, Stakeholder analysis, Macroeconomic analysis, Technological analysis, Socio demographic analysis, Ecological analysis, Competitive analysis, Competitor analysis.

Learning Objectives

At the end of the unit, students will be able to

1. Brief understanding on the processes of business environment analysis.
2. Acquire knowledge on various analysis of business for political and governmental analysis, stakeholder analysis.
3. Evaluating the various analyzing methods involved during entrepreneurship development.

UNIT III

Entrepreneurial Strategies: Entrepreneurship and strategy, Business models and strategy, Entry wedges, Resource-based strategies, Isolating mechanisms and first mover advantages, Information rules strategies,

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Strategy and industry environments, Crafting and evaluating strategy. The business plan - Elements of the business plan, Format and presentation, Facilities and aggregate planning, Guidelines to commercial food commodity selection equipment survey, Capital and production costing

Learning Objectives

At the end of the unit, students will be able to

1. Brief understanding on entrepreneurial strategies.
2. Acquire knowledge on developing the business plans.
3. Understand the economic analysis during business plan.

UNIT IV

Marketing the New Venture: The marketing and entrepreneurship interface, Marketing concept and orientation, case study. Foundations of new venture finance - Determining financial needs, Sources of financing, new venture valuation, securing investors and structuring the deal, approaching investors, Structuring the deal negotiation skills.

Learning Objectives

At the end of the unit, students will be able to

1. Brief understanding on marketing the new developed food venture.
2. Acquire knowledge on creating the foundations of new developed food venture.
3. Understand the manageability of new investors in venture.

UNIT V

Creating the Organization: The Top management team, Building an enduring organization, Organization's boundaries, Networking and Alliances, Traditional organizational structure, Intrapreneurship, and corporate venturing.

Learning Objectives

At the end of the unit, students will be able to

1. Brief understanding on creating the whole organization.
2. Acquire knowledge regarding organization structure for food business development.
3. Understand the manageability of networking and cooperative of vendors.

Textbooks

1. Bridge, S., & O'Neill, K. (2012). *Understanding enterprise: Entrepreneurship and small business*. Macmillan International Higher Education.
2. Timmons, J. A., Spinelli, S., & Tan, Y. (2004). *New venture creation: Entrepreneurship for the 21st century* (Vol. 6). New York: McGraw-Hill/Irwin.

References

1. Dollinger, M. (2008). *Entrepreneurship*. Marsh Publications.
2. Phillips, R., & Waring, S. (2015). Food-based entrepreneurship. In *Growing livelihoods* (pp. 113-132). Routledge.

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	PROFESSIONAL ELECTIVE– 5	L	T	P	C
		3	0	0	3
FOOD SUPPLY CHAIN MANAGEMENT					

Course Objectives

- Fundamentals on logistics and supply chain management
- To take up the logistics and supply chain activities in food industries
- The various methods of supply chain management

Course Outcomes

On completion of the course, the students will be able to

- Understand the concepts of supply chain management
- Get technical and IT exposure in LSCM
- Design logistics and supply chain management for food industries
- Handle supply chain in the corporate arena

UNIT I

Introduction: Logistics and supply chain management - Types of FSC, Scope, Significance and Drivers - Basic Model – Primary and secondary activities, Role and challenges of logistics and supply chain management in food industry.

Learning Objectives

At the end of the unit, students will be able to

1. Brief understanding on food supply chain and types of FSC
2. Acquire knowledge on types of Drivers in FSC
3. Understand the concept of primary & secondary activities in LSCM

UNIT II

Procurement and Warehousing: Demand and supply management, Forecasting techniques, Strategic planning for material sourcing, Outsourcing strategies, Warehouse strategies, Inventory models, and control techniques.

Learning Outcomes

At the end of the unit, students will be able to

1. Learn demand & supply management
2. Know the fore-casting techniques
3. Knowledge of strategic planning, outsourcing strategies, Warehouse strategies.
4. Importance of Inventory models, and control techniques.

UNIT III

Distribution and Transportation: Various sources of distribution channels, Distribution models, 3PL and 4PL, Distribution network planning, Modes of transportation, Design of trans-shipment.

Dr K. V. S. G. Murali Krishna	Dr P Srinivasa Rao	Dr. N. N. Misra	Dr. K. S. M. S. Raghava Rao	Dr. S. Kaleemullah
Chairperson (i/c)	Member	Member	Member	Member
Dr. Ramachandra Pradhan	**Dr. Jathindra K Sahu**	**Er. K. Sri Varsha**	**Shri. P. Ramakrishna**	**Mr. Jaddu Samuel**
Member	Member	Member	Member-Convener	Invitee

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Learning Outcomes

At the end of the unit, students will be able to

1. Learn various sources of distribution channels
2. Know the Distribution models, 3PL and 4PL.
3. Knowledge of Distribution network planning, Modes of transportation, Design of trans- shipment.

UNIT IV

Packaging and Information Technology: Applications of packaging in logistics, Types of packaging and packaging materials, Export & import packaging and labelling details, Containerization, Pervasiveness of IT in supply chain management – ERP, Bar-coding, RFID, GPS, E-Procurement.

Learning Outcomes

At the end of the unit, students will be able to

1. Basic knowledge of Applications of Packaging in logistics.
2. Importance of Containerization, Pervasiveness of IT in Supply Chain Management like ERP, Bar- coding, RFID, GPS, E-Procurement.
3. Explain the types of packaging and packaging materials

UNIT V

Global LSCM: Export and import procedure and documentation, Risk management in global logistics, Customer relationship management in LSCM. Performance analysis. Performance metrics in Supply Chain, Indian agencies - EIC, EIA, APEDA, MEPEDA. Rapid alert system.

Learning Outcomes

At the end of the unit, students will be able to

1. Explain the Export and import procedure and Documentation.
2. Importance of Risk management in global logistics.
3. Understand the Performance metrics in Supply Chain, Indian agencies- EIC, EIA, APEDA, MEPEDA. Rapid alert system.

Textbooks

1. Christopher, M. (2016). *Logistics & supply chain management*. Pearson Uk.
2. Bourlakis, M. A., & Weightman, P. W. (Eds.). (2008). *Food supply chain management*. John Wiley & Sons.

References

1. Gattorna, J., & Jones, T. (Eds.). (1998). *Strategic supply chain alignment: best practice in supply chain management*. Gower Publishing, Ltd.

Dr K. V. S. G. Murali Krishna **Chairperson (i/c)**	**Dr P Srinivasa Rao** **Member**	**Dr. N. N. Misra** **Member**	**Dr. K. S. M. S. Raghava Rao** **Member**	**Dr. S. Kaleemullah** **Member**
Dr. Ramachandra Pradhan **Member**	**Dr. Jathindra K Sahu** **Member**	**Er. K. Sri Varsha** **Member**	**Shri. P. Ramakrishna** **Member-Convener**	**Mr. Jaddu Samuel** **Invitee**

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	PROFESSIONAL ELECTIVE– 5	L	T	P	C
		3	0	0	3
FOOD BUSINESS MANAGEMENT AND ECONOMICS					

Course Objectives

- To familiarize students with the principles of management science
- To impart knowledge on different types of management that are crucial in food businesses operation
- To make the students understand the economics involved and laws to be followed for running food businesses

Course Outcomes

On completion of the course, the students will

- Learn the glimpses of management, its nature, types and ethics.
- Gain knowledge on application of management principles to run a food business

UNIT I

Management: Definitions, Scope and importance, Managerial roles and functions, Management - Science or Art? Internal and external environment, Managing for competitive advantage - the challenges of management in cross - cultural environment, Corporate Social Responsibility, Managerial ethics.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics of management and its nature
2. Understand ethics, environment of managing and corporate social responsibility

UNIT II

Financial Management: Nature of capital budgeting, decisions-techniques of capital budgeting: pay back method, average rate of return and Time adjusted methods: IRR and NPV, profitability index, and excess present value index. Advanced problems and cases in capital budgeting. Statement of changes in working capital, funds flow and cash flow statement.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on principles of financial management
2. Understand the concepts of budgeting, profitability and examples of related case studies

UNIT III

Human Resource Management: Definition and functions of HRM, Significance of HRM, Evolution of HRM, Role of HRM to increase firm performance, Role and position of HR department, HRM at global perspective, changing dynamics of HRM in globalized scenario. Importance of recruitment and selection, Nature and significance of human resource development, human resource accounting practices and standards, problems, HR audit-process, HRIS Process and its significance.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics of human resource management and its functions
2. Understand the significance of human resource development and role of HR.

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UNIT IV

Marketing Management: Introduction to marketing: needs, demands, products, exchange, transactions, market, marketing, Evolution of marketing concepts, Indian marketing environment, role and functions of marketing department, Marketing mix and significance of 4Ps, product life cycle stages, skimming and penetration pricing strategies, Market segmentation and targeting - factors affecting effective segmentation, essentials of effective segmentation, Identification of market segments - marketing strategies. Positioning strategies, Need for international marketing, nature and significance of international trade, Balance of payments, nature, causes for disequilibrium in balance of payments, Trends in international business.

Learning Outcomes

By the end of the unit students will

1. Understand the concepts and principles of marketing management
2. Gain insights on product life cycle, international trade and payments

UNIT V

Economics and Company Laws: Introduction to economics - Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price and income elasticity. Company Act, 1956 - Nature and Types of companies, formation, memorandum of association, articles of association, kinds of shares, duties of directors, winding up.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics of economics, demand and supply and pricing
2. Understand the company laws act, its features and significance in food business management.

Textbooks

1. Baker, G. A. (2002). *Introduction to food and agribusiness management* (No. 630.68 B173i Ej. 1). Prentice Hall.
2. Aswathappa, K. E. M. A. L. (2005). *Human resource and personnel management*. Tata McGraw-Hill Education.
3. Jain, P. K. (1999). *Theory and problems in financial management*. Tata McGraw-Hill Education.

References

1. Joy-Matthews, J., Megginson, D., & Surtees, M. (2004). *Human resource development*. Kogan Page Publishers.
2. August, R., Mayer, D., & Bixby, M. B. (2013). *International business law: text, cases, and readings*. Pearson education.

Dr K. V. S. G. Murali Krishna	**Dr P Srinivasa Rao**	**Dr. N. N. Misra**	**Dr. K. S. M. S. Raghava Rao**	**Dr. S. Kaleemullah**
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LIST OF OPEN ELECTIVES

S. No.	Course Name	L-T-P	Credits
OPEN ELECTIVE - 1			
1	Food Material Science and Engineering	3-0-0	3
2	Biochemical Engineering	3-0-0	3
3	Food Thermodynamics	3-0-0	3
OPEN ELECTIVE - 2			
1	Membrane Technology in Food Engineering	3-0-0	3
2	Renewable Energy Systems	3-0-0	3
3	TQM in Food Industry	3-0-0	3
OPEN ELECTIVE - 3			
1	Food Sanitation, Management, and Hygiene	3-0-0	3
2	Energy Conservation and Audit	3-0-0	3
3	Food Waste Management	3-0-0	3
OPEN ELECTIVE - 4			
1	Food Refrigeration and Cold Chain	3-0-0	3
2	Food Plant Operations and Maintenance	3-0-0	3
3	ICT Applications in Food Processing	3-0-0	3
MOOC's programme will be notified by HOD at the beginning of the semester with a minimum of 12 weeks in duration to earn the 3 credits.			

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Dr. Ramachandra Pradhan **Member**	**Dr. Jathindra K Sahu** **Member**	**Er. K. Sri Varsha** **Member**	**Shri. P. Ramakrishna** **Member-Convener**	**Mr. Jaddu Samuel** **Invitee**

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		L	T	P	C
	OPEN ELECTIVE- 1	**3**	**0**	**0**	**3**
FOOD MATERIAL SCIENCE AND ENGINEERING					

Course Objectives

- To enable students, to understand the different food forms where their structure plays a crucial role
- To make the students understand the interaction of food constituents in maintaining the texture and structure of a food

Course Outcomes

The student would be able

- To understand the importance of glass transitions and their relation to stability
- To understand the theory of gelling and its effect on the texture of foods
- To understand the relationship between the structure and properties of foods

UNIT I

Glass Transitions in Foods: Basics of Theory of Glass Transitions, crystalline and amorphous polymers difference, Glass transition temperature, crystallite melting point, Crystal melting point, Key elements of the food polymer science approach, Fringed micelle structural model, The dynamics map. Effect of molecular weight on Tg Plasticizer, water as a plasticizer, Crystallization, gelation mechanism – Polymer crystallization kinetics theory, Importance in food systems

Learning outcomes

By the end of the unit, students will

1. Gain knowledge on basics of Glass transition and its importance in food systems
2. Understand the structure of food polymers and factors affecting glass transition temperature

UNIT II

Physical Chemistry of Food Gels and Gelling: Nature of the gel state, Mechanism of gel formation in food systems, point cross, linking extended junction zone formation, particle association, and spinodal decomposition, gel network types. Basic Theories of gelation, Flory -Stockmeyer theory, Percolation theory, diffusion-limited aggregation model, mechanical properties of cured gels, small deformation studies – differentiation between strong and weak gels - frequency dependence, strain dependence, and temperature dependence of viscos-elastic modulus – Large deformation studies, failure envelopes.

Learning outcomes

By the end of the unit, students will

1. Gain knowledge on basics of food gels and their mechanism of formation
2. Understand the characteristics of gels, related theories, and models

UNIT III

Structure of Food Gels and Emulsions**:** Foods as composite materials, Characteristics of composite materials, solid foams and sponges, Fibrous structures, Reinforcement by solid particles and fibers,

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Chairperson (i/c)	**Member**	**Member**	**Member**	**Member**
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Mixed dairy gels, filled dairy gels, Cellular structures of fruits and vegetables. General aspects of emulsions, Types of food emulsions, Oil in water, water in oil, water in oil in water. Measurement of particle size and size distributions in emulsions, Factors affecting. stability of emulsions, Structures of adsorbed layers on the surfaces of emulsion droplets Importance of interfacial layer – Protein stabilized emulsions and foams

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on different mixing, size reduction, and conveying equipment
2. Gain insights on design parameters, maintenance, and scale-up of those requirements

UNIT IV

Structure-Property Relationships in Foods: Structure-property relationships in foods, axes for food properties, Texture: To axes quantifying texture in solid foods food microstructure property relationships in food structure-formation of structure in processed foods modeling simple models for viscoelastic foods, structure property relationships in nutrition and health-gastronomical engineering

Learning outcomes

By the end of the unit, students will

1. Gain in-depth knowledge about food microstructure and gastronomy
2. Understand and derive various models based on viscosity and texture

UNIT V

Food Powders and Their Characteristics: Processing of food powders-powder properties and functionality, production of food powders-spray drying communition, processing food powders, coating principles and mechanism-micro encapsulation-fluidized bed coating & granulation of food powders, segregation-process and mechanism, caking-particle, breakage and degradation of ingredients and functionality

Learning outcomes

By the end of the unit, students will

1. Gain knowledge on food powders and their preparation methods and equipment used
2. Understand different properties of food powders, modification processes, and their functionality

Textbooks

1. Aguilera, J., & Lillford, P. (2008). *Food materials science*. New York: Springer.
2. Schwartzberg H.G., and Hartel R.W. (1992). *Physical Chemistry of Foods.* CRC Press

References

1. Bhandari, B. (2012). *Food materials science and engineering*. John Wiley & Sons.
2. Friberg, S., Larsson, K., & Sjoblom, J. (Eds.). (2003). *Food emulsions*. CRC Press

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		L	T	P	C
	OPEN ELECTIVE – 1	**3**	**0**	**0**	**3**
BIOCHEMICAL ENGINEERING					

Course Objectives

- This course deals with various biochemical reactions involved in food processing and enzyme technology.
- The objective of this course is to impart knowledge to students on mass and energy balance in the biological system; enzyme kinetics; design and scale-up in bioreactors; upstream and downstream processing techniques used in the food industry

Course Outcomes

The student will be able to:

- Understanding the kinetics of biochemical reactions is important in the food industry.
- Understand and monitor the activity of food enzymes.
- Get knowledge about design parameters for bioreactor scale-up.

UNIT I

Biochemical Engineering and Scope: Definition, necessity, value engineering, good manufacturing practices, standard operating procedures, good laboratory practices, History of Biochemical Engineering: Theory of scientists Pfizer, Alexander Fleming, Salman Waksman, Instrumentation and their control, physical and chemical parameters.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Importance of Biochemical Engineering & Its Scope
2. Understand the Concept of Theory of scientists Pfizer, Alexander Fleming, Salman Waksman
3. Acquire knowledge on Instrumentation and their control, physical and chemical parameter

UNIT II

Role of Biochemical Engineering in Development of Modern Fermenter: Scale-up, management of the cellular process, design, operation, and their problems. The basis for biochemical engineering in the fermentation industry: Unit operation, unit process, process design, chemical reaction kinetics, process variables, biochemical properties, process control.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Biochemical Engineering in The Development of Modern Fermenter such as management of the cellular process, design, operation, and their problems.
2. Acquire knowledge on Unit operation, Unit process, Chemical reaction kinetics, process variables, biochemical properties, process control.

UNIT III

Kinetics Pattern of Various Fermenters: Classification of kinetics pattern, as per different scientists, simple, simultaneous, consecutive, stepwise, complex reactions and their examples. Kinetics of microbial growth and death: Definition, fermentation kinetics rate of cell synthesis, product formation,

and effect of environment. Types of kinetics, Batch and continuous type, control measures.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on the use of the Classification of kinetics pattern.
2. Gain insights on the basics of Kinetics of microbial growth and death

UNIT IV

Simple Enzyme Kinetics: Simple kinetics model for enzyme-substrate interaction. Derive the equation of Michelin Menton for reaction rate, product formation, calculation of K_m and Vmax values. Complex enzyme kinetics**:** Oxidation-reduction form of enzymes, observed apparent rate constant, factors affecting the inhibition, competitive, noncompetitive inhibition, substrate interaction.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Simple Enzyme Kinetics
2. Gain insights on the basics of Complex enzyme kinetics.

UNIT V

Media & Air Sterilization and Product Development: Definition, thermal death time, media heat sterilization, advantages of continuous sterilization, Aeration, and agitation. Product formation for value-added products using bioconversions techniques: Production of single-cell protein, alcohol, raw material required for product formation, production of antibiotics, economic process, utilization of damaged grain through bioconversion, the present mode of utilization, and their nutritional value.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Media & Air Sterilization
2. Gain insights on the basics of Product formation for value-added products using bioconversions techniques

Textbooks

1. Clark, D. S., & Blanch, H. W. (1997). *Biochemical engineering*. CRC press.
2. Katoh, S., Horiuchi, J. I., & Yoshida, F. (2015). *Biochemical engineering: a textbook for engineers, chemists and biologists*. John Wiley & Sons

References

1. Rao, D. G. (2010). *Introduction to biochemical engineering*. Tata McGraw-Hill Education.
2. Dutta, R. (2008). *Fundamentals of biochemical engineering* (No. 660.63 D8F8). Springer.

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		L	T	P	C
	OPEN ELECTIVE- 1	**3**	**0**	**0**	**3**
FOOD THERMODYNAMICS					

Course Objectives

- To understand the importance of thermodynamics in the foodsystem.
- To apply the concept of statistical thermodynamics for various food system
- To develop an efficient system using the thermodynamic principle

Course Outcomes

On completion of the course, the student would be able to

- Identify the thermodynamic variables that will affect the food processing
- Estimate the effect of various thermodynamic properties on the food system
- Solve the problems related to food processing using thermodynamic principles
- A model food system based on thermodynamic properties
- Develop an efficient food processing method
- Predict the bottleneck using the thermodynamic principle

UNIT I

Fundamental Concepts and Calculation of Thermodynamic Quantities: Basic concepts: Definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, the concept of temperature, heat. Cp and Cv. Joule Thomson porous plug experiment. Calculation of thermodynamic quantities - Isothermal expansion, free expansion, and adiabatic reversible process.

Learning Outcomes

At The End of The Unit, Students Will

1. Gain Knowledge on Fundamental Concepts of Thermodynamic Quantities
2. Gain Insights on Thomson-Porus Plug Experiments and Calculation of Thermodynamic Quantities.

UNIT II

First And Second Law of Thermodynamics and Its Application**:** Steady flow energy equation and its application to the steam generator, condenser, nozzles, and air compressors. The second law of thermodynamics and its application to refrigerators, heat engines, and heat pumps. Concept of entropy and calculation of entropy changes.

Learning Outcomes

At The End of The Unit Students Will

1. Gain Knowledge on First Law of Thermodynamics and its application in Food Engineering
2. Gain Insights on Second Law of Thermodynamics and its application in Food Engineering
3. Acquire Knowledge on the Concept of entropy and calculation of entropy changes.

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Dr. Ramachandra Pradhan **Member**	**Dr. Jathindra K Sahu** **Member**	**Er. K. Sri Varsha** **Member**	**Shri. P. Ramakrishna** **Member-Convener**	**Mr. Jaddu Samuel** **Invitee**

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UNIT III

Thermodynamic Properties of Pure Fluids: Energy properties, Helmholtz and Gibbs free energy, fundamental property relations, Maxwell's equations - Clausius - Clapeyron equations. A differential equation for S, U, H. Gibbs- Helmholtz equation. **FUGACITY**- fugacity coefficient, activity, the effect of temperature and pressure on fugacity, determination of fugacity of real gases.

Learning Outcomes

At The End of The Unit Students Will

1. Gain knowledge of the thermodynamic properties of the pure fluid.
2. Acquire Knowledge of Maxwell's equations, Clausius, Clapeyron equations.
3. Gain Insights on Gibbs- Helmholtz equation & Fugacity.

UNIT IV

Properties Of Solutions: Partial molar properties, Concept of chemical potential, Fugacity in solutions- Lewis Randall rule, Raoult's law, Henry's law. Activity in solutions- activity coefficients, pressure and temperature effects, Gibbs- Duhem equations.

Learning Outcomes

At The End of The Unit Students Will

1. Gain knowledge on Partial molar properties, the concept of chemical potential.
2. Gain Insights on Fugacity in solutions & Activity in solutions

UNIT V

Psychrometry: Thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet-bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms. Psychrometric charts, psychrometric process – sensible heat exchange process, latent heat exchange process, adiabatic mixing, evaporative cooling – problems.

Learning Outcomes

At The End of The Unit Students Will

1. Gain knowledge on the Basic Definition of Psychrometric properties of air.
2. Gain Insight on psychrometric process & Its Problems.

Text Books

1. Narayanan, K. V. (2004). *A textbook of chemical engineering thermodynamics*. PHI Learning Pvt. Ltd.
2. Keszei, E. (2013). *Chemical thermodynamics: an introduction*. Springer Science & Business Media.

References

1. Nag, P. K. (2013). *Engineering thermodynamics*. Tata McGraw-Hill Education.
2. Choudhury, T. R. (1973). *Basic Engineering Thermodynamics*. Tata McGraw-Hill.
3. Borgnakke, C., & Sonntag, R. E. (2020). *Fundamentals of thermodynamics*. John Wiley & Sons

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		L	T	P	C
	OPEN ELECTIVE- 2	**3**	**0**	**0**	**3**

MEMBRANE TECHNOLOGY IN FOOD ENGINEERING

Course Objectives

- To enable students to understand different membrane processes
- To enable students to understand applications of different membrane processes in food industries
- To enable students to understand the techniques involved in the construction and operation of the processes.

Course Outcomes

On completion of the course, the students will

- Understand about membrane, its types, and functions
- Gain knowledge on different membrane processes and their working mechanisms
- Be made aware of the applications of membrane processes in food component separation.

UNIT I

Membrane Techniques: Introduction, Principle, and classification of Membrane characterization: Physical and chemical characteristics of the membrane, components of a membrane processing system Construction materials of membrane- cellulosic and non-cellulosic membrane, the configuration of membranes Techniques for membrane preparation Functionality and selection of membrane.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on basic concepts of membranes, types, characteristics, and their components.
2. Gain insights about materials, techniques of construction, and functionality testing of membranes.

UNIT II

Applications and Maintenance of Membrane: Applications of membranes for concentration and separation of food products. Factors affecting membrane fouling, flux enhancement, and fouling control. Membrane maintenance-Physical and chemical cleaning, mechanism, and efficiency of cleaning and sanitization.

Learning Outcomes

At the end of the unit, students will

1. Understand various factors affecting membrane
2. Gain insights about freezing process models, prediction of freezing time, and influence of other parameters

UNIT III

Ultrafiltration and Nanofiltration: Nano Filtration, Ultra Filtration, concept and Working principal Vs conventional filtration. Developments in the manufacture and utilization of food-grade lactose from UF permeate. Application in the food industry- fruit juices, soy sauce, vegetable oil. Application in the

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Member	**Member**	**Member**	**Member-Convener**	**Invitee**

food industry- fruit juices, soy sauce, vegetable oil. Reverse osmosis, and microfiltration: concept and working principle, Application in the food industry- fruit juices, milk. Whey processing soy sauce, vegetable oil.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on basic concepts of ultra and nanofiltration.
2. Gain insights into the application of membrane systems to different foods.

UNIT IV

Reverse Osmosis and Microfiltration: Reverse osmosis, and microfiltration: concept and working principle, Application in the food industry- fruit juices, milk. Whey processing soy sauce, vegetable oil. Use of membrane in preparation of-organic acids, biopolymers, vitamins, amino acids, low lactose powder, casein, etc.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on basic concentration processes through reverse osmosis and microfiltration
2. Gain insights on the processing of different food products.

UNIT V

Emerging Technologies in Membrane Technology: Osmo-distillation, Introduction, concept, and working various commercial applications and future trends. Membrane technology for food processing waste treatment- concept and working, membrane bioreactor and its application

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on advanced membrane concentration processes, Osmo-distillation.
2. Gain insights about wastewater treatment and applications in the food sector

Text Books

1. Khayet, M., & Matsuura, T. (2011). *Membrane distillation: principles and applications*. Elsevier.
2. Cui, Z. F., & Muralidhara, H. S. (2010). *Membrane technology: a practical guide to membrane technology and applications in food and bioprocessing*. Elsevier.
3. Baker, R. W. (2012). *Membrane technology and applications*. John Wiley & Sons.

References

1. Cheryan, M. (1998). *Ultrafiltration and microfiltration handbook*. CRC Press.
2. Porter, M. C. (1989). Handbook of industrial membrane technology. OSTI. GOV.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

		L	T	P	C
	OPEN ELECTIVE- 2	**3**	**0**	**0**	**3**
RENEWABLE ENERGY SYSTEMS					

Course Objectives

- This course deals with sources of renewable energy and their utilization in food industries.
- The objective of this course is to impart knowledge to students on sources and techniques for utilizing different renewable energies.

Course Outcomes

On completion of the course, the student would be able to

- Identify and utilize different renewable energy sources in food processing sectors.
- Understand the new developments in renewable energy studies.
- Categorize biomass quality and its usage in the biogas generation system

UNIT I

Introduction: Concerns of the current millennium, Renewable Energy Utilization, Desirability, Feasibility and the niches, Integrated Renewable, Energy Sources for Process heat availability.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Concerns of the current millennium, Renewable Energy Utilization, Desirability, Feasibility, and the niches.
2. Gain insights on the Integrated Renewable, Energy Sources for Process heat availability.

UNIT II

Solar Energy: Solar energy resources, Solar thermal and solar photovoltaic technology for electricity and process heat, Solar cell technologies for decentralized energy generation.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on solar energy resources, Solar thermal and solar photovoltaic technology for electricity and process heat.
2. Gain insights on the Solar cell technologies for decentralized energy generation.

UNIT III

Applications Of Solar Energy: Passive solar architectural and solar active system for refrigeration and cooling, Solar drying of fruits & vegetables, Hybrid solar dryer for industrial applications, Solar furnaces & concentrators.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on passive solar architectural and solar active systems for refrigeration and cooling, Solar drying of fruits & vegetables.
2. Gain insights on the Hybrid solar dryer for industrial applications, Solar furnaces & concentrators.

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UNIT IV

Wind and Turbine Energy**:** Overview of wind energy developments, Wind turbine technology, Its utilization for process heat and electricity generation, Bioenergy resource, Biomass conversion sources viz Gasification systems for process heat.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Overview of wind energy developments, Wind turbine technology, Its utilization for process heat and electricity generation.
2. Gain insights on the Bioenergy resource, Biomass conversion sources viz Gasification systems for process heat.

UNIT V

Other Renewable Sources: Biogas for electricity and other industrial energy, Ethanol fermentation, Liquid fuel from biomass and its process, chemistry & technologies, Complete combustion technology, Improved cook stoves & furnace technology, Pyrolysis, Syngas.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Biogas for electricity and other industrial energy, Ethanol fermentation, Liquid fuel from biomass, and its process.
2. Gain insights on the Complete combustion technology, Improved cookstoves & furnace technology, Pyrolysis, Syngas.

Textbooks

1. Jelley, N. (2017). *A dictionary of energy science*. Oxford University Press.
2. Goswami, D. Y., & Kreith, F. (2007). *Handbook of energy efficiency and renewable energy*. CRC Press

References

1. Board, N. (2000). *Modern Technology of Agro-Processing and Agricultural Waste Products*. National Institute of Industrial Research.
2. Dincer, I. (2000). Renewable energy and sustainable development: a crucial review. *Renewable and sustainable energy reviews*, *4*(2), 157-175

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		L	T	P	C
	OPEN ELECTIVE-2	**3**	**0**	**0**	**3**
TQM IN FOOD INDUSTRY					

Course Objectives

- This course deals with the Total Quality Management system which enables food industries to ensure the safety and quality of food products.
- The objective of this course is to impart knowledge to the students about the philosophy and core values of Total Quality Management and approaches to apply and evaluate best practices for the attainment of total quality in food industries.

Course Outcomes

On completion of the course, the student would be able to

- To learn about quality management in the food production chain.
- To learn about physical, chemical contaminants in foods
- To learn about the latest trends and techniques in food science
- To understand the significance of safe processing of foods.
- To understand the role of food standards and regulations in maintaining food quality.

UNIT I

Introduction to Quality Management**:** Definition, Scope, Significance, Objectives, Dimensions of quality in foods, Food quality evaluation techniques, Quality control Vs Quality assurance, Adulteration: Types of adulterants, Adulterant identification techniques, Quality assurance for raw materials, Processed and Finished goods.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Significance & Objective of Quality Management in Food Industry
2. Gain insights on the Adulteration & Its identification techniques
3. Concept of Quality control Vs Quality assurance.

UNIT II

Food Contamination: Contamination in Food: Physical, chemical (heavy metals, pesticide residues, antibiotics, veterinary drug residues, dioxins, environmental pollutants, radionuclides, solvent residues, chemicals) Natural toxins. Contaminants formed during processing – nitrosamines, acrylamide, etc. Natural food contaminants and contaminants from packaging materials.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Contamination in Food & Its Types
2. Gain insights on the Contaminants formed during the processing like nitrosamines, acrylamide.
3. Acquire Knowledge on contaminants from packaging materials

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UNIT III

Statistical Process Control: Seven tools of quality management mean & range chart, P chart and C chart, seven deadly wastages, PDCA cycle, Quality circle.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Seven tools of quality management mean & range chart
2. Gain insights on the P chart and C chart, seven deadly wastages, PDCA cycle, Quality circle.

UNIT IV

Quality Standards & Regulations: QMS, HACCP (ISO 22000), ISO 9000, IS0 14000, BIS, APEDA Six sigma certifications, AGMARK and Codex Alimentary Commission regulations, Quality audit, Internal audit. **Regulations**- Packaging and labeling regulations for food products, Regulations for food products export and imports.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Quality Standards like QMS, HACCP, ISO 9000, IS0 14000, BIS, APEDA Six sigma certifications, AGMARK and Codex.
2. Gain insights on the Quality Regulations like Packaging and labeling regulations for food products, Regulations for food products export and imports

UNIT V

New Interventions: Eco-friendly food processing system, green plant, Eco-friendly packaging methods, Challenges in quality management, and green processing system implementation.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on New Interventions like Eco-friendly food processing systems, Green - plants, Eco-friendly packaging methods.
2. Gain insights on the Challenges in quality management, and green processing system implementation.

Textbooks

1. Charantimath, P. M. (2011). *Total quality management*. Pearson Education India.
2. Agus, P., Ratna Setyowati, P., Arman, H., Masduki, A., Innocentius, B., Priyono Budi, S., & Otta Breman, S. (2020). The effect of implementation integrated management system ISO 9001, ISO 14001, ISO 22000 and ISO 45001 on Indonesian food industries performance. *Test Engineering and Management*, *82*(20), 14054-14069.
3. Sallis, E. (2014). *Total quality management in education*. Routledge.

References

1. Akinjaiyeju, O. (2009). Quality Control for the food industry. *A statistical Approach. Concept Pub., Ltd., Shomolu*, 229-274.
2. Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education.

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		L	T	P	C
	OPEN ELECTIVE -3	**3**	**0**	**0**	**3**
FOOD SANITATION, MANAGEMENT, AND HYGIENE					

Course Objectives

- To study the sanitation process done in food industries
- To study the Hygiene Parameters in food industries

Course Outcomes

By the end of the course, the students will be able to

- To understand the sanitation process carried out in food industries equipment
- To learn about the hygiene principles in food industries
- To Understand about sanitary aspects of waste disposal

UNIT I

General Principle of Food Hygiene**:** Hygiene in rural and urban areas in relation to food preparation, personal hygiene, and food handling habits. Place of sanitation in food plants. Sanitary aspects of building and equipment: Plant layout and design, Comparative studies on sanitary fabrication of different types of processing equipment.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on hygiene in rural and urban areas about food preparation, personal hygiene, and food handling habits.
2. Gain insights on the sanitary aspects of building and equipment.

UNIT II

Safe And Effective Insect and Pest Control: Extraneous materials in foods, Principles of Insects and pest control. Physical and chemical control. Effective control of micro-organisms: microorganisms important in food sanitation, micro-organisms as an indicator of sanitary quality. Physical and chemical methods.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on extraneous materials in foods, Principles of insects, pest control, physical and chemical control.
2. Gain insights on the microorganisms important in food sanitation, micro-organisms as indicators of sanitary quality. Physical and chemical methods.

UNIT III

Sanitary Aspects of Water Supply: Source of water, quality of water, water supply, and its uses in food industries. Purification and disinfection of water preventing contamination of potable water supply.

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Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on the source of water, quality of water, water supply, and its uses in food industries.
2. Gain insights on the purification and disinfection of water preventing contamination of potable water supply.

UNIT IV

Effective Detergency and Cleaning Practices: Importance of cleaning technology, physical and chemical factors in cleaning, classification, and formulation of detergents and sanitizers, cleaning practices.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on the importance of cleaning technology, physical and chemical factors in cleaning Technology.
2. Gain insights on physical and chemical factors in cleaning, classification, and formulation of detergents and sanitizers, cleaning practices.

UNIT V

Sanitary Aspects of Waste Disposal**:** Establishing and maintaining sanitary practices in food plants, the role of sanitation, general sanitary consideration, and sanitary evaluation of food plants.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Establishing and maintaining sanitary practices in food plants.
2. Gain insights on the role of sanitation, general sanitary consideration, and sanitary evaluation of food plants.

Textbooks

1. Roday, S. (1998). *Food hygiene and sanitation*. Tata McGraw-Hill Education.
2. Marriott, N. G., Gravani, R. B., & Schilling, M. W. (2006). *Principles of food sanitation* (Vol. 22). New York: Springer.
3. McLauchlin, J., Little, C., & Hobbs, B. C. (2007). *Hobbs' food poisoning and food hygiene*. CRC Press.

References

1. Mountney, G. J., Gould, W. A., & Weiser, H. H. (1988). *Practical food microbiology and technology*. Van Nostrand Reinhold.
2. Troller, J. A. (2012). *Sanitation in food processing*. Academic Press.

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		L	T	P	C
	OPEN ELECTIVE-3	**3**	**0**	**0**	**3**
ENERGY CONSERVATION AND AUDIT					

Course Objectives

- This course deals with energy conservation in the food processing system
- The objective of this course is to impart knowledge to students on saving energy in existing, emerging food processing technologies & converting waste into energy.

Course Outcomes

On completion of the course, the student would be able to

- Identify and utilize different energy conservation sources in food processing sectors.
- Understand the new developments in energy conservation in food processing systems & Facilities.
- Categorize conversion of waste into energy.

UNIT I

Fundamentals Of Engineering Analysis and Management: Fundamentals of Heat Transfer, Fluid Mechanics, and Thermodynamics in Food Processing, Fundamentals of Energy Auditing, Sustainability in the Food Industry.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on fundamentals of heat transfer, fluid mechanics, and thermodynamics in food processing.
2. Gain insights on the fundamentals of energy auditing, sustainability in the food industry.

UNIT II

Energy Conservation Technologies Applied to Food Processing Facilities: Energy Conservation in Steam Generation and Consumption System, in Compressed Air System, in Power and Electrical Systems, in Heat Exchangers, Waste-Heat Recovery and Thermal Energy Storage in Food Processing Facilities, novel Thermodynamic Cycles Applied to the Food Industry for Improved Energy Efficiency **Learning Outcomes**

At the end of the unit, students will

1. Gain knowledge on energy conservation in steam generation and consumption system, in compressed air system, in power and electrical systems, in heat exchangers.
2. Gain insights on the novel thermodynamic cycles applied to the food industry for improved energy efficiency.

UNIT III

Energy Saving Opportunities in Existing Food Processing Facilities: Energy Consumption pattern, Energy Conservation in Grains and Oilseeds Milling Facilities, in Sugar and Confectionery Processing Facilities, in Fruit and Vegetable Processing Facilities, in Dairy Processing Facilities in Meat Processing Facilities, in Bakery Processing Facilities

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Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on energy consumption pattern
2. Gain insights on the energy conservation in different food processing commodities

UNIT IV

Energy Conservation in Emerging Food Processing Systems: Membrane Processing of Foods, Energy Efficiency, and Conservation in Food Irradiation, in Pulsed Electric Fields Treatment, in High-Pressure Food Processing, in Microwave Heating, in Supercritical Fluid Processing.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on membrane processing of foods
2. Gain insights on energy conservation in different emerging food processing systems

UNIT V

Conversion of Food Processing Wastes into Energy**:** Food Processing Wastes and Utilizations, Anaerobic Digestion of Food Processing Wastes, Fermentation of Food Processing Wastes into Transportation Alcohols, Bio-diesel Production from Waste Oils and Fats, Thermochemical Conversion of Food Processing Wastes for Energy Utilization.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on food processing wastes and utilization, Anaerobic digestion of food processing wastes, fermentation of food processing wastes into transportation alcohols
2. Gain insights on thermochemical conversion of food processing wastes for energy utilization.

Textbooks

1. Wang, L. (2008). *Energy efficiency and management in food processing facilities*. CRC press.
2. Klemes, J., Smith, R., & Kim, J. K. (Eds.). (2008). *Handbook of water and energy management in food processing*. Elsevier.

References

1. Mattsson, B., & Sonesson, U. (Eds.). (2003). *Environmentally-friendly food processing* (Vol. 91). Woodhead publishing.

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		L	T	P	C
	OPEN ELECTIVE-3	**3**	**0**	**0**	**3**
FOOD WASTE MANAGEMENT					

Course Objectives

- This course deals with understanding various types of by-products and waste produced from the food industry, their management, and minimization.
- The objective of this course is to impart knowledge to the students about waste minimization, utilization, and development of various techniques to get the best out of food industry waste.

Course Outcomes

The student will be able to

- Gain knowledge about the nature of the wastes obtained from different food processing industries.
- Understand the properties of different food industry wastes.
- Understand common processes which allow different food waste to be converted into valuable products

UNIT I

Waste Management: Food industry wastes, Food waste treatment, ISO 14001 standards, Necessity of food waste utilization, Environmental legislation, Treatment according to established standards and directives, Environmental best practice technologies for waste minimization.

Learning outcomes

At the end of this unit, students able to

1. Understand the waste management & environmental legislation.
2. Learn about the environmental best practice technologies for waste minimization.

UNIT II

Operations in Wastewater Treatment: Advanced wastewater treatment practices, Removal and recovery of solids in process water and Reuse water within the processing plant, Water stream segregation of dissolved and particulate solids, Use of efficient membranes.

Learning outcomes

At the end of this unit, students able to

1. Understand the advanced wastewater treatment practices, removal, and recovery of solids in process water.
2. Learn about the water stream segregation of dissolved and particulate solids.

UNIT III

Alternative Techniques to Reduce Food Waste: Use of chlorine for water treatment, Zero-discharge system, Zero-emission system, Anaerobic digestion of organic residues and wastes, Effluent treatment: BOD and COD treatment and disposal of effluents.

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Learning outcomes

After completing this unit, students will be able to

1. Understand the zero discharge system, zero-emission system.
2. Learn about the effluent treatment: BOD and COD treatment and disposal of effluents.

UNIT IV

Co-Product Recovery Techniques: Enzymatic extraction and fermentation for the recovery of food processing products, Supercritical fluid extraction and other technologies for extraction of high-value food processing co-products, Membrane and filtration technologies, recovery of nutraceuticals, micronutrients, functional ingredients, Natural dyes.

Learning outcomes

At the end of this unit, students able to

1. Understand the enzymatic extraction and fermentation for the recovery of food processing products.
2. Learn about the recovery of nutraceuticals, micronutrients, functional ingredients, Natural dyes.

UNIT V

Waste Management and Co-Product Recovery: Meat, cereal, dairy, fish, fruit and vegetable, vegetable oil, plantation crops processing, waste management of food packaging. Gas production from solid food processing.

Learning outcomes

At the end of this unit, students able to

1. Understand the Meat, cereal, dairy, fish, fruit and vegetable, vegetable oil, plantation crops processing.
2. Learn about Gas production from solid food processing.

Textbooks

1. Waldron, K. W. (Ed.). (2009). *Handbook of waste management and co-product recovery in food processing*. Elsevier.
2. Oreopoulou, V., & Russ, W. (Eds.). (2007). *Utilization of by-products and treatment of waste in the food industry.* Springer.

References

1. Arvanitoyannis, I. S. (2010). *Waste management for the food industries*. Academic Press.
2. Chandrasekaran, M. (Ed.). (2012). *Valorization of food processing by-products*. CRC press.
3. Wang, L. K., Hung, Y. T., Lo, H. H., & Yapijakis, C. (2005). *Waste treatment in the food processing industry*. CRC press.

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		L	T	P	C
	OPEN ELECTIVE-4	**3**	**0**	**0**	**3**
FOOD REFRIGERATION AND COLD CHAIN					

Course Objectives

- To enable the students to understand the various concepts behind the refrigeration of food
- To enable students to know about food freezing and the equipment involved.
- To enable students to understand various aspects of cold storage.

Course Outcomes:

The students will be able to

- Understand refrigeration of food and its operational components.
- Gain knowledge of various forms of food refrigeration in plants, stores, and logistics.
- Learn advanced food freezing concepts and techniques.
- Study food safety aspects of chilled foods and frozen foods.
- Comprehend cold chain management in the food distribution sector.
- Evaluate the cold storage and packaging of frozen perishable products.

UNIT I

Principles of Refrigeration**:** Definition, background with the second law of thermodynamics, Ton of refrigeration, refrigeration cycles, unit of refrigerating capacity, coefficient of performance. Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on principles of refrigeration
2. Gain insights on the expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization

UNIT II

Vapour Refrigeration: Vapour compression system, Modifications in reverse Carnot cycle with vapor as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure enthalpy diagram, superheating, subcooling; effect of suction vapor, superheat, and liquid subcooling on actual vapor compression cycle. Vapor-absorption refrigeration system Process, calculations, maximum coefficient of performance of a heat-operated refrigerating machine; water/lithium bromide & ammonia/water absorption cooling.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on vapour compression system
2. Gain insights on the vapour-absorption refrigeration system

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UNIT III

Refrigerants: Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical; azeotrope refrigerants. Components of a Refrigeration system: Compressor, Condenser, Evaporator, Expansion valves piping, and different controls.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on common refrigerants and their properties like classification, nomenclature, desirable properties of refrigerants
2. Gain insights on the components of a refrigeration system

UNIT IV

Cold Storage**:** Cold store, design of cold storage for different categories of food resources, size, and shape, construction and material, insulation, vapor barriers, floors, frost- heave, interior finish and fitting, evaporators, automated cold stores, security of operations.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on Cold store, design of cold storage for different categories of food resources
2. Gain insights on the automated cold stores, security of operations

UNIT V

Cold Chain Management and Supply Chain System: Important Factors to consider, logistic supply, Protocols for Domestic, Sea, and Airfreight- Traceability and barcode, Product Temperature and Moisture monitoring- Refrigeration systems and Refrigerant types during field chilling, transportation via land, air, and sea. Grocery stores and display cases, home refrigerators - Cooling chain summary - Storage and packaging.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on cold chain management supply chain System like logistic supply- protocols for domestic, sea, and airfreight- traceability and barcode – product temperature and moisture monitoring
2. Gain insights on grocery stores and display cases, home refrigerators - cooling chain summary Storage, and packaging.

Textbooks

1. Dellino, C. (Ed.). (1997). *Cold and chilled storage technology*. Springer Science & Business Media.
2. Arora, C. P. (2000). *Refrigeration and air conditioning*. Tata McGraw-Hill Education.

References

1. Sun, D. W. (2005). *Handbook of frozen food processing and packaging*. CRC press.
2. Florkowski, W. J., Banks, N., Shewfelt, R. L., & Prussia, S. E. (Eds.). (2021). *Postharvest handling: a systems approach*. Academic press.
3. Brown, M. (Ed.). (2008). *Chilled foods: a comprehensive guide*. Elsevier.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

		L	T	P	C
	OPEN ELECTIVE-4	**3**	**0**	**0**	**3**

FOOD PLANT OPERATIONS AND MAINTENANCE

Course Objectives

- To learn about the operations carried out in food plant
- To learn about the Food Plant Maintenance

Course Outcomes

On completion of the course, the student would be able to

- To understand the principles of operations to be followed in food plant
- To understand the Types of Maintenance involved in food Plant Operation

UNIT I

Overview on Plant Operation & Design: Introduction to Plant Operation, plant Operation design specifics, General design considerations: Food processing unit operations, Prevention of contamination, Sanitation, Deterioration, Seasonal production. Feasibility study of Plant Operation, Preliminary screening of ideas, Comparative rating of product ideas.

Learning outcomes

At the end of this unit, students able to

1. Learning about the design considerations for food processing plant operations
2. Understanding the feasibility work done for plant operations.

UNIT II

Product Design and Process Selection: Product Design, Process technology, and its choices Plant Layout, Classification of layout, Job design, and work organization. The Operations Challenges: challenges, Globalization, Corporate social responsibility, Environmental responsibility, Technology, Knowledge management.

Learning outcomes

At the end of this unit, students able to

1. To know about the product design and work organization
2. To learn about the challenges faced in the operations

UNIT III

Plant Maintenance: Objectives and importance of maintenance, Primary and secondary functions, and responsibility of maintenance department. types of maintenance – corrective or breakdown maintenance, scheduled maintenance, preventive maintenance, and predictive maintenance. Types and applications of tools used for maintenance. Guidelines for good maintenance & safety precautions; Lubrication & lubricants; Workplace improvement through '5S'

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Learning outcomes

1. At the end of this unit, students able to
2. To know about the Objectives and importance of maintenance,
3. To learn about types of maintenance.

UNIT IV

Periodic and Preventive Maintenance: Periodic inspection-concept and need. Degreasing, cleaning, and repairing schemes. Overhauling of mechanical components, Overhauling of electrical motor, Common troubles, and remedies of Electric motor, Repair complexities, and their use.

Definition need, steps, and advantages of preventive maintenance, Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets. Program and schedule of preventive maintenance of mechanical and electrical pieces of equipment. Advantages of Preventive Maintenance, Repair cycle-concept, and importance.

Learning outcomes

At the end of this unit, students able to

1. To know about the objectives and importance of overhauling
2. To learn about periodic and preventive maintenance

UNIT V

Hygiene Operations of Food Equipment; Basic principles for hygiene Operations of food equipment, design of auxiliary systems of pumps, tanks, valves, pipes; external design of processing equipment and auxiliary systems; CIP (Clean-In-Peace) system design and its types. Illumination and ventilation, painting and color-coding, Fly and insect control.

Learning outcomes

At the end of this unit, students able to

1. To understand the design of auxiliary equipment in food plant operations
2. To understand the design of the CIP system Operation.

Textbooks

1. Chary, S. N. (2017). *Production and operations management*. McGraw Hill Education.
2. Newcomer, J. L. (1981). *Preventive maintenance manual for dairy industry*. Venus Trading Company.

References

1. Hill, T. (2005). Operations management. Operational Research Society Ltd.
2. King, E. (1965). Industrial Hygiene and Toxicology. *British Journal of Industrial Medicine*, *22*(2), 162.
3. Forsythe, S. (Ed.). (2012). *Food hygiene, microbiology and HACCP*. Springer Science & Business Media.

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Dr. Ramachandra Pradhan	**Dr. Jathindra K Sahu**	**Er. K. Sri Varsha**	**Shri. P. Ramakrishna**	**Mr. Jaddu Samuel**
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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

		L	T	P	C
	OPEN ELECTIVE-4	**3**	**0**	**0**	**3**
ICT APPLICATIONS IN FOOD PROCESSING					

Course Objectives

- To familiarize the students with concepts of basic computerization and information technology
- To inculcate knowledge about computer applications and industrial technologies that rely on information technology in food processing

Course Outcomes

On completion of the course, the student would be able to

- Understand the basics and importance of computerization and information technology in the food sector
- Gain knowledge on computer applications that play a key role in food process control or food quality or food industry automation
- Know about various tools and software that are used in food applications

UNIT I

Introduction: Importance of computerization in the food industry, operating environments and information systems for various types of food industries, Supervisory control and data acquisition (SCADA); SCADA systems hardware, firmware, software and protocols, landlines, local area network systems, modems. Use of SCADA systems in food processing industries

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge of basic computer applications and information systems
2. Understand the basics of SCADA and its importance in food industries

UNIT II

Spreadsheet Applications: Data interpretation and solving problems, preparation of charts, use of macros to solve engineering problems, use of add-ins, use of solver; Web hosting and webpage design; file transfer protocol (FTP), on-line food process control from the centralized server system in the processing plant.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on the use of spreadsheet applications
2. Gain insights on basics of web designing and online control of food processes

UNIT III

MATLAB n Food Industry: Computing with MATLAB, script files, and editor/debugger, problem- solving methodologies, user-defined functions, programming using MATLAB; debugging MATLAB programs, applications to simulations; Plotting and model building in MATLAB, XY plotting functions,

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subplots and overlay plots, special plot types, interactive plotting in MATLAB, function discovery, regression, the basic fitting interface, three-dimensional plots. Applications of MATLAB in image processing of foods.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge of basics and components of MATLAB
2. Gain insights on the usage of MATLAB in various food applications

UNIT IV

Introduction To Toolboxes Useful to Food Industry: curve fitting toolbox, fuzzy logic toolbox, neural network toolbox, image processing toolbox, statistical toolbox; Introduction to computational fluid dynamics (CFD), governing equations of fluid dynamics; Models of flow, substantial derivative, the divergence of velocity, continuity, momentum and energy equations; Physical boundary conditions, discretization; Introduction to CFD software, GAMBIT, and FLUENT software. Applications of CFD in the food industry

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on different toolboxes used in food applications
2. Gain insights on CFD, its importance in food processing, and various software used for CFD modeling

UNIT V

Lab View; LabVIEW environment, Components of a LabVIEW application: Creating a VI, data flow execution, debugging techniques, additional help, context help, tips for working in LabVIEW; LabVIEW typical programs: Loops, while loop, for loop, types of functions, searching the functions palette, decision making, and file I/O, case structure, select (if statement), file I/O; LabVIEW results: Displaying data on front panel, controls, and indicators, graphs, and charts, arrays, loop timing, signal processing, textual math, math script.

Learning Outcomes

At the end of the unit, students will

1. Gain knowledge on LabVIEW software and its usage
2. Gain insights on applications of LabVIEW software in food applications

Textbooks

1. Singh, R. P. (1996). *Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical, And Process Analysis*. Elsevier.
2. Nagar, S. (2017). *Introduction to MATLAB: For Engineers and Scientists*. Berkeley, CA: Apress.

References

1. Chapman, N. P., & Chapman, J. (2006). *Web design: a complete introduction*. John Wiley & Sons.
2. Elliott, C., Vijayakumar, V., Zink, W., & Hansen, R. (2007). National instruments LabVIEW: a programming environment for laboratory automation and measurement. *JALA: Journal of the Association for Laboratory Automation*, *12*(1), 17-24.

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SCHOOL OF FOOD TECHNOLOGY
B. Tech-FOOD ENGINEERING

HONORS PROGRAM

S. No.	Course Name	L-T-P	Credits
	POOL- 1		
1	Bakery and Confectionery Technology	3-1-0	4
2	Fermentation Technology	3-1-0	4
3	Fats and Oil Technology	3-1-0	4
	POOL- 2		
1	Beverage Technology	3-1-0	4
2	Food Nanotechnology	3-1-0	4
3	Enzyme Technology	3-1-0	4
	POOL- 3		
1	Specialty Foods: Neutraceuticals and Functional Foods	3-1-0	4
2	Food Rheology and Microstructures	3-1-0	4
3	Food Additives and Preservatives	3-1-0	4
	POOL- 4		
1	Food Fortification and Technology	3-1-0	4
2	Traditional Foods	3-1-0	4
3	Future Foods: Design and Formulation of Foods	3-1-0	4
MOOC's programme will be notified by HOD at the beginning of the semester with minimum 8/12 weeks in duration to earn the 2 credits.			

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SCHOOL OF FOOD TECHNOLOGY
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	HONORS PROGRAM: POOL – 1	L	T	P	C
		4	0	0	4
BAKERY AND CONFECTIONERY TECHNOLOGY					

Course Objectives

- To study about the functions of raw materials in bakery and confectionary
- To study about different manufacturing chocolates and equipment used

Course Outcomes

By the end of the course the students will be able to

- To understand the functioning of raw materials, present in bakery and confectionary
- To learn about the manufacturing steps of chocolates

UNIT I

Current status, growth rate, and economic importance of Bakery and Confectionary Industry in India. Raw materials for bakery and confectionery products- Essential and optional. FSSAI Specification of raw materials.

Learning Outcomes

At the end of unit, students will be able to

1. Knowing the importance of bakery and confections in India
2. Understanding about the basic raw materials used in bakery and confectionary

UNIT II

Bakery Products: Ingredients, assessing quality of ingredients & processes for breads, bread rolls, sweet yeast dough products, biscuits, cookies & crackers, cake specialties, pies and pastries, doughnuts; rusks; other baked products. Product quality characteristics, faults and corrective measures for above bakery products. Assessing quality of products.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the quality assessment of the breads, cookies and other products
2. Understand the measures taken in the bakery products

UNIT III

Dough Rheology, Bakery machinery and equipment: Weighing Equipment- Manual scale, Automatic weigh, liquid measuring. Mixing blenders, Horizontal and vertical planetary, continuous mixers. Make up equipment- Divider, Rounder, Proofer, moulder. Baking equipment – different ovens, slicer.

Learning Outcomes

At the end of unit, students will be able to

1. Brief knowledge on the dough rheology
2. Learning about the processing controls machines of different mixers used in bakery

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UNIT IV

Confectionery and Chocolate Products: Chocolate, fondant, caramels, fudge, hard-boiled candies, toffees, fruit drops, chewing and bubble gums, cocoa products and other confections: - ingredients, equipment & processes, packaging, storage and quality testing, product quality parameters, faults, causes and corrective measures.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the different chocolate manufacturing products
2. Knowing about quality measures to taken for manufactured chocolate

UNIT V

Flour Confectionery: Flour Specification - Types of dough – Developed dough, short dough, semi- sweet, enzyme modified dough and batters- importance of the consistency of the dough. Indian flour confections manufacture – Flour specification–ingredients–manufacturing process – types of chemically aerated goods.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the types of dough in baker confections
2. To know about the Indian flour confection manufactures

Textbooks

1. Matz, S. A. (1992). *Bakery technology and engineering*. Pan-Tech Intl.
2. Pyler, E. J., & Gorton, L. A. (2008). *Baking science & technology: volume I: fundamentals & ingredients*. Sosland Pub.
3. Minifie, B. (2012). *Chocolate, cocoa and confectionery: science and technology*. Springer Science & Business Media.

References

1. Beckett, S. T. (Ed.). (2011). *Industrial chocolate manufacture and use*. John Wiley & Sons.
2. Faridi, H., & Faubion, J. M. (2012). *Dough rheology and baked product texture*. Springer Science & Business Media.
3. Minifie, B. (2012). *Chocolate, cocoa and confectionery: science and technology*. Springer Science & Business Media.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	HONORS PROGRAM: POOL – 1	L	T	P	C
		4	0	0	4

FERMENTATION TECHNOLOGY

Course Objectives

- To study about the industrial fermentation and media for fermentation
- To study about the importance of fermentation in daily applicant foods

Course Outcomes

By the end of the course the students will be able to

- To understand about the microbial usage for fermentation
- To learn about the fermentation process in regular foods

UNIT I

Industrial Fermentation: Fundamentals involved in the production of industrial Microbial products such as details of the fermenters/Bioreactors, types of fermenters, Types of fermentation – solid state and submerged; Design and working of batch, fed-batch and continuous fermenters; Scale up of Bioreactors; Sterilization methods.

Learning Outcomes

At the end of unit, students will be able to

1. Understand about the importance of fermentation and production of microbes
2. Learning about the types and design of fermenters

UNIT II

Media for Fermentation: Importance of media components for production of industrial products by fermentation; use of different sources of carbon, nitrogen, minerals and activators for commercial fermentation; importance of pH, temperature and aeration in fermentation; optimization of fermentation media. Enzyme kinetics: Michaelis-Menten Constant, Competitive, Non-competitive inhibitions, Lineweaver- Burke Plot, Regulation of enzymes. Growth Kinetics: Modeling and optimization techniques.

Learning Outcomes

At the end of unit, students will be able to

1. Brief knowledge about the production of fermentation and suitable environmental factors
2. Learning about the enzymatic kinetics in fermentation

UNIT III

Downstream Processing: Importance, need for downstream processing, unit operations for downstream processing (Cell Harvesting and Disruption, Filtration, Centrifugation, Extraction, Adsorption, Chromatography, Electrophoresis, Membrane separation & drying) and their importance.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the importance and need of downstream processing
2. Understand about the unit operations carried for downstream processing

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

UNIT IV

Food Products: Processes for preparing milk based fermented products including Cheese, Yoghurt (curd) and other Traditional Indian Products like Idli, Dosa, Dhokla, Shrikhand, etc., Soya based products like Soya sauce, Natto, etc., control of quality in such products. Other products for food industry applications: Fermentative production of Organic acids like (Citric Acid, Lactic Acid, Acetic Acid), Amino Acids (Glutamic acid, Lysine), Vitamins, Antibiotics (Erythromycin, Penicillin), Oligosaccharides (GOS, FOS) and Polysaccharides (Dextran, Xanthan) etc.; flavor components and industrial enzyme production by micro-organisms; process descriptions and key controls for optimal production.

Learning Outcomes

At the end of unit, students will be able to

1. Brief understanding about fermentation process in milk and traditional food products
2. Learning about the acids used for fermentation production

UNIT V

Alcoholic Beverages: Production of Alcoholic Beverages based on fruit juices (wines), cereals (whisky, beer, vodka etc.), sugar cane (rum) etc. Process description, quality of raw materials, fermentation process controls etc. Ethanol production by fermentation using black strap molasses, starchy substances and cellulose substrates like waste sulphate liquor and purification methods for production of absolute ethyl alcohol.

Learning Outcomes

At the end of unit, students will be able to

1. Acquire knowledge about usage of fermentation process in brewery and fruit juice processing
2. Brief learning about the production of biofuels through fermentation

Textbooks

1. Patel, A. H. (1984). *Industrial Microbiology*. Macmillan India.
2. Bailey, J. E., & Ollis, D. F. (2018). *Biochemical engineering fundamentals*. McGraw-Hill.
3. Belter, P. A., Cussler, E. L., & Hu, W. (1987). *Bioseparations: downstream processing for biotechnology*. Wiley-Blackwell.

References

1. Peppler, H. J. (Ed.). (1977). *Microbial Technology*. RE Krieger Publishing Company.
2. Vine, R. P. (2012). *Commercial winemaking: Processing and controls*. Springer Science & Business Media.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	HONORS PROGRAM: POOL - 1	L	T	P	C
		4	0	0	4

FAT AND OIL PROCESSING TECHNOLOGY

Course Objectives

- To understand the physical and chemical properties of fats and oils
- To study the extraction and refining processes of various oils and fat.
- To learn the packaging, quality standards of fats and oils

Course Outcomes

By the end of the course the students will be able to

- Enumerate the importance of fats and oils
- Describe the manufacturing process of oils and fats
- Apply knowledge on manufacture of designer fats
- Appraise the quality attributes of oils and fats
- Design suitable packaging materials

UNIT I

Physical and Chemical Properties Fats and oils – formation – functions of oil in human body - fatty acids – double bonds and their position in oil – Geneva type classification - sources of vegetable oils – production status-oil content – coconut, palm, peanut, rice bran, sesame, mustard and sunflower seeds oil – physical and chemical properties of fats and oils - chemical reactions of oil – hydrolysis – hydrogenation, oxidation and polymerization.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the physical and chemical properties of fats and oils
2. Understanding about the classifications of fats and oils

UNIT II

Extraction Methods Oil Extraction Methods –mechanical expression – ghani, power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process – steps involved, batch and continuous-continuous solvent extraction process for rice bran, soy bean and sunflower-oil extraction process for groundnut and cotton seed-production of special oils – palm oil, virgin coconut oil – extraction process.

Learning Outcomes At the end of unit, students will be able to

1. Learning about the mechanical extraction methods of oils
2. Learning about the solvent extraction methods of oils

UNIT III

Refining of Oils Refining of oils – Objectives – characterization - degumming – Zeneath process – deacidification process – continuous acid refining-bleaching of oil –decolourising agents-

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deodorization and winterization processes- Hydrogenation of Fats – Vanaspati and Margarine – Ghee and butter.

Learning Outcomes

At the end of unit, students will be able to

1. Understanding about the importance of refining process in fats and oils
2. Learning about the deodorization, winterization and hydrogenation process of fats and oils

UNIT IV

Packaging of Edible Oils Packaging of Edible Oils – requirements – types – tinplate, semi rigid, glass, Polyethylene Terephthalate, Poly Vinyl Chloride, flexible pouches – packaging for Vanaspati and ghee changes during storage of oil –rancidity – causes – atmospheric oxidation and enzyme action – free fatty acid – color-non edible oils – castor oil, linseed oil, vegetable waxes – production and processing.

Learning Outcomes

At the end of unit, students will be able to

1. Acquire knowledge about the packaging material used for fats and oils
2. Learning about changes occurred in fats and oils during storage

UNIT V

Industrial Applications and Quality Standards Industrial applications of Fats and Oils – quality regulations - manufacture of soap, candle, paints and varnishes - ISI and AGMARK standards – site selection for oil extraction plant- safety aspects- HACCP standards in oil industries.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the regulations of fats and oils
2. Understanding about the standards to be followed for fats and oils

Textbooks

1. Lawson, H. W. (1995). *Food oils and fats: technology, utilization and nutrition*. Springer Science & Business Media.
2. Gunstone, F. (2009). *Oils and fats in the food industry*. John Wiley & Sons.
3. Rajah, K. K. (Ed.). (2002). *Fats in food technology* (Vol. 10). CRC Press.

References

1. Gunstone, F. (Ed.). (2011). *Vegetable oils in food technology: composition, properties and uses*. John Wiley & Sons.
2. Al Kurki, J., Hill, N. C. A. T., Ruffin, L., Lyons, B., Interns, N. C. A. T., Rudolf, M., & Biofuels, P. (2008). *Oilseed processing for small-scale producers*. ATTRA–National Sustainable Agriculture Information Service: A division of National Centre for Appropriate Technology (NCAT) United States Department of Agriculture's Rural Business–Cooperative Service, 16.
3. Hamm, W., Hamilton, R. J., & Calliauw, G. (Eds.). (2013). *Edible oil processing* (p. 342). Hoboken, NJ, USA: Wiley-Blackwell.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	HONORS PROGRAM: POOL -2	L	T	P	C
		4	0	0	4
BEVERAGE TECHNOLOGY					

Course Objectives

- To study about the manufacturing steps of carbonated and non-carbonated beverages
- To study the hygiene conditions of beverages and its standards in foods safety

Course Outcomes

By the end of the course the students will be able to

- To understand the process of carbonated and non-carbonated beverages
- To learning about the importance of hygiene and standards in food industries

UNIT I

Beverage-definition-ingredients- water, carbon dioxide, bulk and intense sweeteners, water miscible and water dispersible flavoring agents, colors–natural and artificial, Micro and nano emulsions of flavors and colors in beverages, preservatives, emulsifiers and stabilizers.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the basic ingredients and flavor used in beverages
2. Understanding about the emulsions and preservatives used in beverages

UNIT II

Technology for Alcoholic Beverages: Raw materials Malt, hops, adjuncts, water, yeast quality and handling. Beer manufacturing process malting, preparation of sweet wort, brewing, fermentation, pasteurization and packaging. Beer defects and Spoilage. Wine-fermentation-types–red and white. Wine defects and spoilage. Equipment and machinery for Wine, Beer, Whiskey, Brandy, and Rum. Cereal Fermentation. Packaging and storage of different beverages.

Learning Outcomes

At the end of unit, students will be able to

1. Understanding the processing steps of beer manufacture
2. Learning about the equipment used in brewery products and their packaging conditions

UNIT III

Equipment and machinery for carbonated beverages, water treatment, syrup preparation, filling system, packaging containers and closures, handling of empty containers and cleaning, carbonation, filling, inspection and quality control.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the equipment used in the carbonated beverages
2. Acquire knowledge on the sanitation of the beverage equipment and quality control

UNIT IV

Technology for Non-carbonated Beverages: Raw materials quality and handling. Coffee bean preparation-processing-brewing-decaffeination- instant coffee-tea types-black, green and oolong- fruit

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juices, nectars, squash, RTS beverages, isotonic Beverages. Flash pasteurization, canning and aseptic Packaging of beverages. Equipment and machinery used.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the manufacturing steps of the non-carbonated beverages
2. Understanding the packaging methods for storing of non-carbonated beverages

UNIT V

Effective application of quality controls-sanitation and hygiene in beverage industry-quality of water used in beverages-threshold limits of various ingredients according to FSSAI, EFSA and FDA- absolute requirements of soluble solids and titratable acidity in beverages. Water: RO, Mineral water specifications.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the hygiene conditions in beverage industries and quality controls
2. Understanding the standards of beverages and water specifications

Textbooks

1. Ashurst, P. R. (2016). *Chemistry and technology of soft drinks and fruit juices*. John Wiley & Sons.
2. Steen, D., & Ashurst, P. R. (Eds.). (2008). *Carbonated soft drinks: formulation and manufacture*. John Wiley & Sons.
3. Manay, N. S. O. (2001). *Food: facts and principles*. New Age International.
4. Hui, Y. H., Meunier-Goddik, L., Josephsen, J., Nip, W. K., & Stanfield, P. S. (Eds.). (2004). *Handbook of food and beverage fermentation technology* (Vol. 134). CRC Press.

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1. Chakraverty, A., Mujumdar, A. S., & Ramaswamy, H. S. (Eds.). (2003). *Handbook of postharvest technology: cereals, fruits, vegetables, tea, and spices* (Vol. 93). CRC press.
2. Hutkins, R. W. (2008). *Microbiology and technology of fermented foods*. John Wiley & Sons.
3. Boulton, C., & Quain, D. (2008). *Brewing yeast and fermentation*. John Wiley & Sons.

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KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	HONORS PROGRAM: POOL - 2	L	T	P	C
		4	0	0	4
FOOD NANOTECHNOLOGY					

Course Objectives

- To study about the importance of nano materials in food applications
- To study about the design and manufacture of nano materials used in food industries

Courses Outcomes

By the end of the course the students will be able to

- To learn about the nano materials usage carried out in food applicants
- To learn about the design considerations for the nano materials

UNIT I

Introduction: Definition of nanotechnology, potential applications related to food, functional materials in food nanotechnology, Nano-nutraceuticals and Nano functional foods, nanotechnology and risk assessment-regulatory approaches to nanotechnology in food industries.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the importance and application of nanotechnology in food applicants
2. Understanding about the nanotechnology approaches in food industries

UNIT II

Nanomaterials and Manufacture: Nanomaterial's technology- Nano powder production-Nano particles manufacture nanotechnology devices- analytical methods for nanotechnology.

Learning Outcomes

At the end of unit, students will be able to

1. Understanding about the nano powder production and its manufacturing methods
2. Brief leaning about the analytical methods of nanotechnology

UNIT III

Nanoparticles: Nano filters, nanotubes, Nano-clay, Nano-films, Nano-membranes, Nano-emulsions, nanocomposite and Nano laminates, nanoscale food additives – Nano-lycopene.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the design of nano products
2. Acquiring knowledge about the nano laminates and nano additives used

UNIT IV

Nanoscale Delivery Systems for Food Functionalization: Liposomes- Nano cochleates- hydrogels based nanoparticles-dendrimers-lipid nanoparticles-polymeric Nano particles-anno crystalline

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particles- delivery systems–mode of action.

Learning Outcomes

At the end of unit, students will be able to

1. Understanding about the nano delivery systems used in food functionalization
2. Learning about the polymeric nano particles used in food applications

UNIT V

Nanotech for Food Industries: Nanotechnology in food industry-Food quality monitoring-Nano- sensors nanotechnology in food microbiology-bacterial identification antimicrobial packaging- improved food storage-green packaging-tracking-tracing and brand products-nanotechnology research in food industry

Learning Outcomes

At the end of unit, students will be able to

1. Acquiring knowledge about nano sensors used in food microbiology
2. Understanding about the applications of nano particles in food packaging applications

Textbooks

1. Pandua W., (2012). *Nanotech research methods for foods and bio-products*, Wiley publications Ltd.
2. Fulekar M. H., (2010). *Nanotechnology-Implications and applications*, International Publishing House Ltd.

References

1. Andrews, D., Scholes, G., & Wiederrecht, G. (2010). *Comprehensive nanoscience and technology*. Academic Press.
2. Padua, G. W., & Wang, Q. (2012). *Nanotechnology research methods for food and bioproducts*. John Wiley & Sons.
3. Marcel. (2002). *Instrumentation to nanotechnology*, Taylor and Francis Ltd.

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		4	0	0	4

ENZYME TECHNOLOGY

Course Objectives

- To study about the importance of enzyme in food processing
- To know about the usage of enzymes in different food sectors

Course Outcomes

By the end of the course the students will be able to

- To understand the functioning of enzymes in food processing
- To learn about the types, selection of enzymes for different food processing

UNIT I

Enzymes: Introduction, classification, properties, characterization, Enzyme kinetics- enzyme concentration, substrate concentration, environment conditions and enzyme immobilization Enzymes in food industry: commercialization of enzyme processes, alternative method to use the enzymes, types of reaction Sources of enzymes, legal and safety implications

Learning Outcomes

At the end of unit, students will be able to

1. To know about the properties of enzymes and its kinetics
2. Brief knowledge on the usage of enzymes in food applications

UNIT II

Enzymes in Milk Production: Enzymes in milk preservation, lactose hydrolysis, Use of enzymes for determining milk quality enzymes in cheese manufacturing: Endogenous microbial enzymes, exogenous enzymes, Coagulant technology, and enzymes in cheese preservation.

Learning Outcomes

At the end of unit, students will be able to

1. Understand about usage of enzymes in milk preservation and maintain quality attributes
2. Knowledge about the usage of enzyme in cheese manufacturing

UNIT III

Enzymes in Beverage: Application of enzymes in tea and cocoa processing Application of enzymes in alcoholic beverages as beer, whisky, wine and ciders. Role of the enzymes in fruit juice production, factors affecting the enzymatic activity. Enzymatic clarification of apple and guava juices, factors affecting the clarity of fruit juices.

Learning Outcomes

At the end of unit, students will be able to

1. Brief understand about the enzyme usage in processing units of tea, cocoa and brewery
2. Understand the concept of enzyme clarification in fruit juices

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Chairperson (i/c)	Member	Member	Member	Member

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UNIT IV

Enzymes in Baking Industry: Introduction, Enzymes for baking industry, Use of the proteinases, lipases and pentosans in baking industry, Starch degrading enzymes: sources, analysis and application of starch degrading enzymes Hemicellulose: sources, analysis and application

Learning Outcomes

At the end of unit, students will be able to

1. Acquire knowledge in usage of enzymes in bakery industries
2. Understand about the starch and hemicellulose degrading enzymes

UNIT V

Enzymes in the Processing of Fats and Oils: specificity, stability and application of lipases and related enzymes Role of enzymes in hydrolysis of triglycerides, interesterification and randomization.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the usage of enzymes in fat and oil industries
2. Acquire knowledge on the enzyme hydrolysis for fatty acids

Textbooks

1. Whitehurst, R. J., & Van Oort, M. (Eds.). (2010). *Enzymes in food technology* (Vol. 388). Singapore: Wiley-Blackwell.
2. Khan, M. Y., & Khan, F. (2015). *Principles of Enzyme Technology*. PHI Learning Pvt. Ltd..

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1. Brakmann, S., Johnsson, K., Flickinger, M. C., & Drew, S. W. (1999). Encyclopedia of Bioprocess Technology. *Synthesis*. Wiley-VCH.
2. Reed, G. (1966). *Enzymes in Food Processing (1966)* (Vol. 3). Elsevier.
3. Poutanen, K. (1997). Enzymes: An important tool in the improvement of the quality of cereal foods. *Trends in Food Science & Technology*, *8*(9), 300-306.

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		4	0	0	4

SPECIALTY FOODS: NUTRACEUTICALS AND FUNCTIONAL FOODS

Course Objectives

- To study about the importance of nutraceuticals and functional foods
- To study about the different nutraceuticals, present in different foods

Course Outcomes

By the end of this course students will be able to

- To understand about the importance of nutraceuticals and functional foods
- To learn about different nutraceutical presence in foods

UNIT I

Introduction, definition, Modification in the definition of neutraceuticals. Classification of nutraceuticals, Neutraceutical's market scenario, formulation considerations. Challenges for Neutraceuticals.

Learning Outcomes

At the end of unit, students will be able to

1. Acquire brief knowledge in the nutraceutical foods
2. Learning about the classification and challenges faced in market

UNIT II

Nutraceutical's value of spices and seasoning – Turmeric, Mustard, Chilli, Cumin, Fenugreek, Black Cumin, Fennel, Asafoetidia, Garlic, Ginger, Onion, Clove, Cardamom Etc., Neutraceuticals from Fruits and Vegetables- Mango, Apple, Grapes, Bel, Banana, Broccoli, Tomato, Bitter Melon, Bitter Orange.

Learning Outcomes

At the end of unit, students will be able to

1. Understanding about the importance of spices and seasonings
2. To gain knowledge on nutraceuticals taken from fruits and vegetables

UNIT III

Omega -3 fatty acids from fish- Typical properties, structural formula, functional category. CLA- typical properties, structural formula, functional category. Application in Neutraceuticals. Calcium, chromium, copper, iodine, iron, magnesium, Zn- mechanism of action, bioavailability, uses and deficiency, dietary sources.

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Learning Outcomes

At the end of unit, students will be able to

1. Learning of nutraceutical composition taken from fish by-products
2. Understanding the importance of minerals in diet and their deficiency

UNIT IV

Definition, classification – Type of classification (Probiotics, prebiotics and synbiotics: Taxonomy and important features of probiotic microorganisms. Health effects of probiotics including mechanism of action. Probiotics in various foods: fermented milk products, non-milk products etc. Prebiotics. Definition, chemistry, sources, metabolism and bioavailability, effect of processing, physiological effects, effects on human health and potential applications in risk reduction of diseases

Learning Outcomes

At the end of unit, students will be able to

1. Learning about probiotics and prebiotics in foods and its classification
2. The presence of probiotics and prebiotics in foods and its health usage

UNIT V

Phytosterol, Fatty Acids, Carotenoids, Anthocyanins, Amino Acids, Water Soluble Vitamins, Free radical biology and antioxidant activity of nutraceuticals.

Learning Outcomes

At the end of unit, students will be able to

1. Acquire knowledge on the functional foods
2. Learning about the antioxidant properties of foods

Textbooks

1. Wildman, R. E., Wildman, R., & Wallace, T. C. (2016). *Handbook of nutraceuticals and functional foods*. CRC press.
2. Press, C. R. C. (2002). *Handbook of nutraceuticals and functional foods*. CRC Press.
3. Gibney, M. J., Lanham-New, S. A., Cassidy, A., & Vorster, H. H. (Eds.). (2013). *Introduction to human nutrition*. John Wiley & Sons.
4. Joshi, S. A. (1995). *Nutrition and dietetics*. McGraw-Hill Education.

References

1. Srilakshmi, B. (2007). *Dietetics*. New Age International.
2. Howe, P. S. (1980). *Basic nutrition in health and disease including selection and care of food*. Saunders.
3. Anderson, L. (1982). *Nutrition in health and disease*. Lippincott.

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	HONORS PROGRAM: POOL - 3	L	T	P	C
		4	0	0	4
FOOD RHEOLOGY AND MICROSTRUCTURES					

Course Objectives

- To study about the rheological principles in foods
- To study about the microstructures of foods

Course Outcomes

By the end of this course students will be able to

- To learn about the rheological properties in liquid, semi-solid and solid foods
- To understand about the microstructure of foods

UNIT I

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.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. To learn about the rheology in food studies
2. Understand about the different stress in the rheology of foods

UNIT II

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 behavior; Viscosity of food dispersions – dilute and semi dilute systems, concentration effects.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. Learning about the rheological studies of fluids
2. Understanding about the dispersions and dilute foods

UNIT III

Rheology of semi-solid and solid food; Rheological characterization of foods in terms of stress-strain relationship; rheology and flow characteristics of food powders, 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.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. Brief learning about the semi-solids and solid foods
2. To understand about the relaxation models for viscoelastic food

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UNIT IV

Examining Food Microstructures: History of food microstructure studies, light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. To learn about the importance of microstructures
2. Understand about the image analysis in foods

UNIT V

Food Structure: Traditional food structure and texture improvement, approaches to food structure, extrusion and spinning, structured fat products, structure and stability, gels, gelation mechanisms, mixed gels, the microstructure of gels, structure-property relations in gels.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. To learn about the traditional and texture improvement in foods
2. Understand about the microstructures and structure property of gels

Textbooks

1. McKenna, B. M., & Lyng, J. G. (2003). *Introduction to food rheology and its measurement*. Texture in food, *1*, 130-60.
2. Fischer, P., & Windhab, E. J. (2011). *Rheology of food materials*. Current Opinion in Colloid & Interface Science, *16*(1), 36-40.
3. Aguilera J. M., (2001). *Rheology and Texture in Food Quality*, AVI Publications.
4. Aguilera, J. M., & Stanley, D. W. (1999). *Microstructural principles of food processing and engineering*. Springer Science & Business Media.

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1. Bechtel, D. B. (1983). *New frontiers in food microstructure*. American Association of cereal chemists.
2. Steffe, J. F. (1996). *Rheological methods in food process engineering*. Freeman press.

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	HONORS PROGRAM: POOL - 3	L	T	P	C
		4	0	0	4
FOOD ADDITIVES AND PRESERVATIVES					

Course Objectives

- This course deals with the role of food additives in food processing and preservation
- The objective of this course is to enable the students to identify, characterize and differentiate various types of food additives used for the preservation of food

Course Outcomes

By the end of the course the students will be able to

- Understand the basic concepts of food additives, their characteristics and application
- Understand the role of different food additives in improving physical and sensory characteristics of foods
- Gain knowledge about regulations and functioning of monitoring agencies involved in ensuring the safer use of additives in foods

UNIT I

Introduction to food additives – role/functions of food additives in food processing - classification: Intentional and Unintentional food additives. Toxicology and safety evaluation of food additives - beneficial effects and harmful effects of food additives – categories of food additives under generally recognized as safe (GRAS) - tolerance levels and toxic levels in foods – ADI and LD50 values of food additives; naturally occurring food additives – applications in food processing.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the role and functions of food additives
2. Gain knowledge on Toxicology and safety evaluation of food additives
3. Gain knowledge about categories of food additives under GRAS

UNIT II

Naturally occurring Food Additives: Classification, Role in Food Processing, Health Implications. Food colors: Natural and artificial - pigments, dyes and lakes -their sources, importance and utilization- safe doses and toxic effects. Nutritional and non-nutritional sweeteners -definition, types (natural and synthetic) - functions, role, permitted levels and toxic effects.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand about role of naturally occurring food additives in food processing
2. Gain knowledge about food colors
3. Gain knowledge on nutritional and non-nutritional sweeteners

UNIT III

Stabilizers, Thickeners and Flavoring agents – definition – properties, applications and permitted

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levels in processed foods. Leavening agents – definition, types of leavening agents – natural and chemical leavening agents. Flavor and taste enhancers - definition, types, sources, mechanism of action and application in processed foods - permitted levels and toxic effects. Fat substitutes- definition, types, functions, sources, production of fat substitutes. Emulsifiers - definition, classification, properties, mechanism of action and applications surface activity in O/W and W/O systems, permitted levels and toxic effects.

Learning Outcomes

At the end of the unit, students will be able to

1. Gain knowledge about stabilizers, thickeners and flavoring agents
2. Understand about applications of stabilizers, thickeners, and flavoring agents in food industry
3. Gain knowledge about fat substitutes and emulsifiers

UNIT IV

Food preservatives and their chemical action – class I and class II preservatives-chemical action on foods - safe doses/permitted levels of usage in food and toxic effects; role and mode of action of salts –types of salts-properties and role in food processing - permitted levels of usage and toxic effects.

Learning Outcomes

At the end of the unit, students will be able to

1. Gain knowledge about class 1 and class 2 preservatives
2. Understand about role of preservatives and chemical action of foods
3. Gain knowledge about permitted levels of usage in foods

UNIT V

Anti-oxidants and Chelating agents-definition, types of antioxidants (natural and synthetic)- functions, mechanism of action in food products, permitted levels and toxic effects. Chelating agents-definition of chelation-types of chelators-synergism with anti-oxidants. Humectants and anti-caking agents- definition, functions, their mechanism of action in food products, permitted levels and toxic effects. Flour bleaching, maturing agents and firming agents-definition, types, functions, their mechanism of action in food products, permitted levels and toxic effects.

Learning Outcomes

At the end of the unit, students will be able to

1. Gain knowledge about antioxidants and types of antioxidants
2. Gain knowledge about functions of antioxidants and mechanism of action in food products
3. Gain knowledge about bleaching agents, humectants and chelating agents

Textbooks

1. Branen, A. L., Davidson, P. M., Salminen, S., & Thorngate, J. (Eds.). (2001). *Food additives*. CRC Press.
2. Burdock, G. A. (2014). *Encyclopedia of food & color additives*. CRC press.

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References

1. Damodaran, S., Parkin, K. L., & Fennema, O. R. (Eds.). (2007). *Fennema's food chemistry*. CRC press.
2. Mahindru, S. N. (2008). *Food additives: characteristics, detection and estimation* (pp. 4435- 36). New Delhi-India. APH Publishing Corporation.
3. Deshpande, S. S. (2002). *Handbook of food toxicology*. CRC Press.

Dr K. V. S. G. Murali Krishna **Chairperson (i/c)**	**Dr P Srinivasa Rao** **Member**	**Dr. N. N. Mishra** **Member**	**Dr. K. S. M. S. Raghava Rao** **Member**	**Dr. S. Kaleemullah** **Member**
Dr. Ramachandra Pradhan **Member**	**Dr. Jathindra K Sahu** **Member**	**Er. K. Sri Varsha** **Member**	**Shri. P. Ramakrishna** **Member-Convener**	**Mr. Jaddu Samuel** **Invitee**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	HONORS PROGRAM: POOL - 4	L	T	P	C
		4	0	0	4
FOOD FORTIFICATION					

Course Objectives

- To study about the importance of fortification and its need
- To study about the fortification of different products

Course Outcomes

By the end of the course the students will be able to

- To learn about the fortification uses and health benefits
- To understand about the different fortified foods

UNIT I

Food Fortification: Past Experience, Current Status, And Potential for Globalization, Prevalence, Causes and Consequences of Micronutrient Deficiencies. The Gap Between Need and Action, Developing National Strategies to Prevent and Control Micronutrient Deficiency: The Role of Food Fortification.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the importance of food fortification
2. Understanding the requirement of fortification in modern foods

UNIT II

Fortification Vehicles: Wheat and maize flour fortification, salt fortification, fortification of condiments and sauces, fortification of bouillon cubes, fornication of fats and cooking Oils, fortification of milk and dairy Products.

Learning Outcomes

At the end of unit, students will be able to

1. Understanding about the fortification carried out in flours and sauces
2. Learning about the fortification of fats and dairy products

UNIT III

Characteristics of nutrients used in cereal fortification: Types and levels of micronutrients to be added, fortification of bread, pasta, noodles, biscuits, and breakfast cereals.

Learning Outcomes

At the end of unit, students will be able to

1. Brief learning about the nutrients used in cereal fortification
2. Acquire knowledge about the fortification of bakery products

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UNIT IV

Technology of fortifying candies - Product formulation, Factors to be considered in selecting fortificants, Nutrient bioavailability and its interactions, Packaging, storage, shelf life and cost.

Learning Outcomes

At the end of unit, students will be able to

1. Brief understanding about the fortified candies
2. Learning about the packaging storage and shelf life of fortified candies

UNIT V

Efficacy and Safety fortification of: Iron, Zinc, Iodine, Folic Acid, Vitamin A, Vitamin B12, Vitamin D, and calcium.

Learning Outcomes

At the end of unit, students will be able to

1. Learn about the vitamins used for the food fortification
2. Understanding about the minerals used for food fortification

Textbooks

1. Mannar, M. V., & Hurrell, R. F. (Eds.). (2018). *Food fortification in a globalized world*. Academic Press.
2. Preedy, V. R., Srirajaskanthan, R., & Patel, V. B. (2013). Handbook of food fortification and health. *From Concepts to Public Health Applications*, 2013.
3. Rychlik, M. (Ed.). (2011). *Fortified foods with vitamins: analytical concepts to assure better and safer products*. John Wiley & Sons.

References

1. Lendy, A. F. (1857). *Elements of Fortification: Field and Permanent*. JW Parker and Son.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	HONORS PROGRAM: POOL - 4	L	T	P	C
		4	0	0	4
TRADITIONAL FOODS					

Course Objectives

- To study about the processing methods of sweets, bakery products, beverages and fermented foods
- To study about the preservation methods of sweets, bakery products, beverages and fermented foods

Course Outcomes

By the end of the course the students will be able to

- To learn about the processing methods of sweets, bakery products, beverages and fermented foods
- To learn about the preservation methods of sweets, bakery products, beverages and fermented foods

UNIT I

Processing & Preservation methods of Sweets & Desserts: kulfi, falooda, kheer, khurchan, khoa/mawa, rabri, jalebi, imarti, gulabjamun, peda, petha, rewdi, gajak, milk cake, balushahi, bal mithai, singoni, ras-malayi, gulqand, ghevar, rasgolla, chamcham, son halwa, son papri, several varieties of halwa, laddu, barfi & rasgolla.

Learning Outcomes

At the end of unit, students will be able to

1. Understand about the processing steps carried out for sweets and dessert
2. Learning about the preservatives used for maintaining the quality of sweets and deserts

UNIT II

Processing & Preservation methods of Snacks: Gujiya, kachauri, samosa, mirchi bada, kofta, potato chips, banana-chips, mathri, bhujiya, fried dhals, bhujia, shakarpara, pakora, vada.

Learning Outcomes

At the end of unit, students will be able to

1. Acquiring knowledge about the preparation of snack foods
2. Brief understanding about the quality factors of snack foods

UNIT III

Processing & Preservation methods of Fermented Foods: Idli, dosa, Vada, khamman dhokla, dahi (Curd), Srikhand.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the processing steps of fermented foods
2. Understanding about the preservative techniques used in fermented foods

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UNIT IV

Processing & Preservation methods of Baked Products: Biscuits, Toast, Candies, Cookies, Breads, Roti, Naan, Tandoori Roti, Parantha, Kulcha, Kuri, Bhatura.

Learning Outcomes

At the end of unit, students will be able to

1. Learning about the making of bakery products
2. Brief learning about the preservatives used in bakery manufacturing

UNIT V

Processing & Preservation methods of Preserves & Beverages: Murabba, sharbat, pana, aam papad, sharbat, coconut water, tea, milk (khas, rose), Alcoholic Beverages (palm wine, fenny, bhang & Indian beer)

Learning Outcomes

At the end of unit, students will be able to

1. Understanding about the beverages processing steps
2. Learning about the preservatives used for beverages storage

Textbooks

1. Steinkraus, K. (2018). *Handbook of Indigenous Fermented Foods, revised and expanded*. CRC Press.
2. De, S. (1980). *Outlines of dairy technology*. Oxford University Press.

References

1. Aneja, R. P., Mathur, B. N., Chandan, R. C., & Banerjee, A. K. (2002). *Technology of indian milk products: handbook on process technology modernization for professionals, entrepreneurs and scientists*. Dairy India Yearbook.
2. Srinivasan, K. (2010). Traditional Indian functional foods. *Functional Foods of the East, Nutraceutical Science and Technology. Series*, *10*, 51-76.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	HONORS PROGRAM: POOL – 4	L	T	P	C
		4	0	0	4
FUTURE FOODS: DESIGN AND FORMULATION OF FOOD					

Course Objectives

- To study about the nutritional value in foods and its requirements
- To study about the therapeutic diets
- To study about the anti-nutritional food presence in foods

Course Outcomes

After learning the course, the students should be able to:

- Know the nutritional value of different food groups
- Identify the nutritional requirements of infants, preschool-going children, and athletes
- Design therapeutic diets for diseases like diabetes, and CHD
- Identify anti-nutritional factors present in different foods with their properties and ill effects

UNIT I

Nutritional Concept in Food Design: Nutrients and their function, food classification and their Nutritive value and anti-nutritional factors present in cereals, pulses, oilseeds, fruits, vegetables, fish, meat, and eggs, the effect of processing on the nutritive value of foods. Concept of different food groups, recommended dietary allowances (RDA) for Indians.

Learning Outcomes

At the unit, students will be able to

1. Understand the concept of Nutrients and their Food classification
2. Acquire the knowledge on Anti-Nutritional factors on food commodities
3. Concept of RDA for different Food Groups

UNIT II

Infant Foods & Snack food Formulation: Formulation of weaning foods, Protein-energy malnutrition, Formulating diet for preschool-going (2-5 years) children. Production and formulation of Indian traditional sweets and snack food products, steps for quality improvement, and value addition.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the concept of formulation of weaning foods
2. Acquire the knowledge on Formulation diets Pre-School Children's
3. Know the Production & Formulation of Indian Sweets and Snacks
4. Concept of Quality Improvements and Value addition while designing food

UNIT III

Introduction to plant-based meat. Raw materials used in plant-based meat and associated plant processing technologies, development of plant-based meat products and associated texturization technologies, plant-based meat regulations, value chain & white space opportunity analyses.

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Learning Outcomes

At the end of the unit, students will be able to

1. Understand the importance of plant-based meat
2. Learning about the raw materials used for plant-based meat and manufacturing process

UNIT IV

Functional Foods: Concepts for functional foods design, prebiotics & probiotics, nutraceuticals, designer foods. Anti-Nutritional Factors in Foods: Trypsin inhibitors, Phytins, Tannins, Oxalates, Goitrogens, Aflatoxins, Process induced toxins. Fermented Foods: Preparation and maintenance of microbial cultures for food fermentation, Nutritional significance of traditional fermented foods.

Learning Outcomes

At the end of the unit, students will be able to

1. Know the about Functional Foods & Nutraceutical
2. Understand the Prebiotics & Probiotics
3. Get the knowledge Anti-Nutritional Factors in Foods
4. Details Description about Fermented Foods

UNIT V

Recent trends in food formulation; Antioxidant-rich food products; concepts for formulation of foods for drought and disaster afflicted; defense services, sportsmen, space food. Formulation of Space Foods.

Learning Outcomes

At the end of the unit, students will be able to

1. Know the about formulation of foods for drought and disaster afflicted defense services, sportsmen, space food
2. Understand the Anti-Oxidant rich food Products
3. Concept of Space Foods

Textbooks

1. Nathanial, S., Bhatia, C., & Tiara, B. K. (2021). *Food Formulation: Novel Ingredients and Processing Techniques*, 1-4. John Wiley & Sons.
2. Fryer, P., Norton, I. T., & Norton, J. E. (Eds.). (2013). *Formulation engineering of foods*. John Wiley & Sons.

References

1. Mudambi, S. R. (2007). *Fundamentals of foods, nutrition and diet therapy*. New Age International.
2. Steinkraus, K. (2018). *Handbook of Indigenous Fermented Foods, revised and expanded*. CRC Press.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

MINOR PROGRAM
GENERAL TRACK

S. No.	Course Name	L-T-P	Credits
1	Food Processing Operations-I	3-1-0	4
2	Food Processing Operations-II	3-1-0	4
3	Current Trends in Food Packaging	3-1-0	4
4	Food Plant Design & Economics	3-1-0	4

MINOR PROGRAM
SPECIALIZED TRACKS

S. No.	Course Name	L-T-P	Credits
TRACK 1 - FOOD SCIENCE			
1	Food Nutrition	3-1-0	4
2	Food Preservation Technology	3-1-0	4
3	Food Biochemistry	3-1-0	4
4	Industrial Microbiology	3-1-0	4
TRACK 2 - FOOD TECHNOLOGY			
1	Process Technology for Convenience and RTE Foods	3-1-0	4
2	Flavor Technology	3-1-0	4
3	Brewing Technology	3-1-0	4
4	Advances in Milling Technology	3-1-0	4
TRACK 3 - FOOD PLANT OPERATIONS			
1	Effluent Treatment in Food Processing	3-1-0	4
2	Food Plant Maintenance	3-1-0	4
3	Energy Management in Food Industries	3-1-0	4
4	Food Plant Utilities and Services	3-1-0	4
TRACK 4 - FOOD SAFETY AND QUALITY			
1	Emerging Technologies in Food Safety and Quality	3-1-0	4
2	Food Licensing and Registration System	3-1-0	4
3	Food Quality and Safety Standards	3-1-0	4
4	Traceability and Recall in Food System	3-1-0	4
TRACK 5 – IT APPLICATIONS IN FOOD PROCESSING			
1	Computer Applications in Food Processing	3-1-0	4
2	Robotics and Computer Controlled Machines	3-1-0	4
3	IT in Food Processing	3-1-0	4
4	Computations in Food Engineering	3-1-0	4
MOOC's programme will be notified by HOD at the beginning of the semester with minimum 8/12 weeks in duration to earn the 2 credits.			

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B. Tech-FOOD ENGINEERING

		L	T	P	C
	GENERAL TRACK	**3**	**1**	**0**	**4**
FOOD PROCESSING OPERATIONS-I					

Course Objectives

- To study theory, principles, and applications of food processing operations

Course Outcomes

The students will be able to understand

- Types of equipment and Working principles of each piece of equipment- Animations &Videos.
- Selection of equipment, Applications, Design/Sizing of equipment- conventional and software aids.
- Equipment Suppliers - Web references. Assignments on equipment.

UNIT I

Fluid Flow: Review of Theory: Bernoulli's equation, Hagen-Poiseuille equation, Friction factor and Reynolds number, Types of fluids. Pipes & pipe fittings: Frictional losses, Types and selection. Pumps: Types, selection, Pump characteristics & calculations of power, Net suction positive head, efficiency, Power calculations for both Newtonian and Non-Newtonian fluids. Compressors & Blowers: Types & selection.

Learning Outcomes

Students will be able to understand

1. Fluid flow and its application in food industry
2. Types, selection, pump characteristics & calculations

UNIT II

Heat Transfer: Review of Theory on Conduction, Convection & Radiation: Fourier's law, conduction through flat walls and cylindrical pipes. Newton's law of cooling, natural, forced convection, Stefan-Boltzmann law, Kirchhoff's law, black body, radiation between two bodies and surroundings. Heat Exchangers: counter current and co-current flows, LMTD concept, dimensional analysis and correlation for heat transfer coefficients, types, selection, design and applications of heat exchangers, unsteady state heat transfer in jacketed kettles, Scale up. Ovens & Furnaces: Types, selection and design. Sterilizers: Mechanism, factors affecting spoilage of different types of food products, Survival curves, thermal death curves (D, Z, Fo values), analysis of thermal resistance data, process time evaluation and thermal process design.

Learning Outcomes

Students will be able to understand

1. Heat Transfer: Review of theory on conduction, convection & radiation
2. Heat exchangers and its applications
3. Selection and design of sterilizers

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B. Tech-FOOD ENGINEERING

UNIT III

Size reduction: Review of Theory, Mechanisms of grinding, grinding laws, properties of materials, factors affecting grinding. Equipment: Types and selection, calculation of crushing strength, work index and power. Advances: Cryogenic grinding. Screening: Review of Theory: Average particle size, distribution, standard sieves. Equipment: Types and selection of screens, calculation of screen effectiveness. Grading: Review of Theory. Equipment: Types of graders and their working principle, Destoner, Air classifier, Paddy Separators, Indent cylinder, magnetic, cyclone and color separator. Grading efficiency & Selection of graders.

Learning Outcomes

Students will be able to understand

1. Mechanisms of grinding, grinding laws
2. Calculation of screen effectiveness
3. Types of graders and their working principle.

UNIT IV

Filtration: Review of Theory: filter cake resistance, cake thickness, constant rate filter, constant pressure filter, filter aid, Equipment: Plate & frame filters, leaf filters, rotary vacuum filters and calculation of cake resistances and area of filtration. Selection and Applications. Advances: Membrane filtration and Reverse osmosis. Sedimentation: Review of Theory: Stokes law, settling velocity. Design of thickeners: Estimation of minimum area for continuous sedimentation based on batch sedimentation data. Sizing of settling tables/tanks. Applications in food industry. Centrifugation: Review of Basics: Centrifugal force, 'g' factor. Equipment: Basket, tubular bowl, disc bowl, decanters and their Selection. Calculations of neutral zone in separation of liquids for tubular bowl centrifuges and Sigma for various types of centrifuges. Scale up and advances.

Learning Outcomes

Students will be able to understand

1. Calculation of cake resistances and area of filtration
2. Sizing of settling tables/tanks. Applications in food industry.
3. Various types of centrifuges. Scale up and advances

UNIT V

Mixing: Review of Theory: Characteristics of mixtures, mixing index, mixing time. Equipment: Types of mixing equipment for solids (powder and particle) and pastes, liquids and gases, power required for mixing, selection of mixers and applications. Extrusion: Basics: Principles of extrusion, chemical and nutritional changes during extrusion, Equipment: Types, selection and application of extruders, calculations of power requirement. Frying, Baking and Roasting: Theory: Heat and mass transfer mechanisms. Equipment: Types, selection and applications, calculation of energy. Coating: Theory & Principles. Methods: Enrobing, dusting and pan coating; soft, hard & chocolate coating. Coating Applications.

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

Learning Outcomes

Students will be able to understand

1. Types of mixing equipment for solids equipment
2. Selection and applications in food processing.
3. Selection and application of extruders, calculations of power requirement

Textbooks

1. Rao, D. G. (2009). *Fundamentals of food engineering*. PHI Learning Pvt. Ltd..
2. Sahay, K. M., & Singh, K. K. (2004). *Unit operations of agricultural processing*. Vikas Publishing House.
3. Singh, R. P., & Heldman, D. R. (2001). *Introduction to food engineering*. Gulf Professional Publishing.
4. Berk, Z. (2018). *Food process engineering and technology*. Academic press.

References

1. Smith, P. G. (2003). *Introduction to food process engineering*. Chemical engineer, (742), 56-56.
2. Toledo, R. T., Singh, R. K., & Kong, F. (2007). *Fundamentals of food process engineering* (Vol. 297). New York: Springer.
3. McCabe, W. L., Smith, J. C., & Harriott, P. (1993). *Unit operations of chemical engineering* (Vol. 5, p. 154). New York: McGraw-hill.

Dr K. V. S. G. Murali Krishna Kaleemullah	**Dr P Srinivasa Rao**	**Dr. N. N. Mishra**	**Dr. K. S. M. S. Raghava Rao**	**Dr. S.**
Chairperson (i/c)	**Member**	**Member**	**Member**	**Member**
Dr. Ramachandra Pradhan	**Dr. Jathindra K Sahu**	**Er. K. Sri Varsha**	**Shri. P. Ramakrishna**	**Mr. Jaddu Samuel**
Member	**Member**	**Member**	**Member-Convener**	**Invitee**

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

	GENERAL TRACK	L	T	P	C
		3	1	0	4
FOOD PROCESSING OPERATIONS-II					

Course Objectives

- To study theory, principles, and applications of food processing operations.

Course Outcomes

Students will be able to understand

- Types of equipment. Working Principle of each equipment- Animations & Videos. Selection of equipment. Applications. Design/Sizing of equipment- conventional and software aids. Scale up.
- Advances. Industrial visits to show the equipment in operation. Equipment Suppliers - Web references. Assignments on equipment.

UNIT I

Humidification: Theory and Principles: Properties of dry air, water-vapor. Psychrometric chart and its use. Equipment: Types, selection and applications of humidifiers and dehumidifiers. Refrigeration: Basic concepts: Selection of a Refrigerant, Components of a Refrigeration System, Joule Thomson effect, various refrigerants, Effect of temperature on food spoilage, Sources of refrigeration, load of refrigeration. Equipment: Types, Selection and Application of refrigeration and cryogenic equipment.

Learning Outcomes

Students will be able to

1. Gain insights on selection and applications of humidifiers and dehumidifiers
2. Know application of refrigeration and cryogenic equipment.

UNIT II

Evaporation: Review of Theory: Heat Transfer to boiling liquids. Types of Evaporators-Tubular Type, Short-Tube Evaporator, Long-Tube Vertical Rising Film, Long- Tube Vertical Falling Film, Forced Circulation, Scraped Surface Thin Film, Plate Evaporators. Effect of Boiling point elevation and Hydrostatic Head. Evaporators in the food industry and their selection. Multiple effect Evaporation-Types, Selection. Vapor recompression systems, optimum number of effects. Advances - Centritherm Evaporator. Trends in multi effect evaporation. Drying: Review of Theory: Principles of drying, EMC- RH data, Bound & Unbound moisture, Critical moisture, Drying curve, Constant rate & Falling rate. Types of Dryers: Tray dryer, Rotary Dryers, Vacuum shelf dryers, Drum dryer, Spray dryers, Fluid bed dryers, Pneumatic dryers Equipment: Selection and Applications in food processing. Recent Developments in drying Technology.

Learning Outcomes

Students will be able to

1. Know evaporators and its applications in food industry
2. Understand types of distillations and distillation columns

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B. Tech-FOOD ENGINEERING

UNIT III

Mass Transfer**:** Principle and theory of diffusion, Fick's law, role of diffusion in mass transfer, Theories of mass transfer, Applications of mass transfer in food processing. Gas absorption: Review of theory and principles: Concept of ideal stages, material balance and operating line, Concept of equilibrium, calculation of ideal stages using stage to stage calculation and graphical methods. HTU, NTU and design of packed columns. Equipment.Types and applications. Distillation: Review of theory and principles: Raoult's law, Henry's law, Charles law, Newton's of law partial pressure, Ideal gas equation, calculation of VLE forideal mixtures, Relative volatility. Concept of ideal stages- calculation of number of stages, McCabe-Thiele method, Ponchon & Savarit method, various types of distillations and distillation columns, viz batch, steam, flash, azeotropic and continuous distillations. Types of distillations and applications in food processing.

Learning Outcomes

Students will be able to

1. Learn HTU, NTU and design of packed columns. Equipment
2. Understand types of distillations and applications in food processing.

UNIT IV

Extraction: Solid-liquid extraction: Theory and Principle: leaching, different types of leaching processes and various equipment used in food processing. Stage to stage calculations and graphical methods to estimate number of stages and other parameters. Application of leaching in food processing. Liquid-liquid extraction: Theory and Principle: counter current and co-current extractions, batch and continuous extractions, Stage to stage calculations and graphical methods to estimate number of stages and other parameters and applications to the food industry. Advances- Super critical fluid extraction: Basic principles, super critical extraction systems and its applications. Crystallization: Theory and principles: Crystallization kinetics-nucleation and crystal growth, Dissolution, solubility curves. Equipment: Types, selection and applications of crystallization. Calculations of energy and yield.

Learning Outcomes

Students will be able to

1. Learn various equipment used in food processing
2. Understand liquid-liquid extraction
3. Learn principles of crystallization kinetics-nucleation

UNIT V

Material handling and Storage: Properties of materials. Angle of repose, Angle of surcharge, Angle of rupture, loaded area, Types, selection and design of Materials Handling Equipment: Conveyors-Belt, Slat, Roller, Chain, Chutes, Vibratory, Screw, bucket elevators; Trucks; Pallets; Bulk Handling; and pneumatic conveyors, transportation of solids. Storage: Theory and Principles: Internal angle of friction, External angle of friction. Methods of storage: Silos, Bins, Hoppers. Design of silos: Calculation of lateral pressure and vertical pressures: Rankine's Theory, Janssen's Theory and Airy Theory. Washing and Peeling: Types of washing: Bubble washers, Jet washers, Spiral washers, Float washers, Brush washers. Selection of equipment's for washing and peeling. Types of peeling: Flash peeling, Steam peeling, Knife peeling, Abrasion peeling, Lye peeling and Flame peeling

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SCHOOL OF FOOD TECHNOLOGY

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Learning Outcomes

Students will be able to

1. Learn the concepts of supercritical fluid extraction
2. Understand crystallization kinetics-nucleation and crystal growth

Textbooks

1. Ibarz, A., & Barbosa-Cánovas, G. V. (2002). *Unit operations in food engineering*. CRC press.
2. Rao, D. G. (2009). *Fundamentals of food engineering*. PHI Learning Pvt. Ltd..
3. Earle, R. L. (2013). *Unit operations in food processing*. Elsevier.
4. Singh, R. P., & Heldman, D. R. (2001). *Introduction to food engineering*. Gulf Professional Publishing.

References

1. Geankoplis, C. J., Hersel, A. A., & Lepek, D. H. (2018). *Transport processes and separation process principles* (Vol. 4). Boston, MA, USA: Prentice hall.
2. Ibarz, A., & Barbosa-Canovas, G. V. (2014). *Introduction to food process engineering*. CRC Press.
3. Toledo, R. T., Singh, R. K., & Kong, F. (2007). *Fundamentals of food process engineering* (Vol. 297). New York: Springer.
4. Berk, Z. (2018). *Food process engineering and technology*. Academic press.

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		L	T	P	C
	GENERAL TRACK	**3**	**1**	**0**	**4**
CURRENT TRENDS IN FOOD PACKAGING					

Course Objectives

- To familiarize with novel, recent advances and innovative food packaging.
- Skills to select and design packaging for foods

Course Outcomes

Students will be able to understand

- Functions of Food Packaging
- Antimicrobial agents, constructing an antimicrobial packaging system
- Non- Migrating Bioactive Polymers (NMBP) in Food Packaging
- Green Plastics for Food Packaging
- Intelligent Packaging, storage and distribution

UNIT I

Introduction: Importance and Functions of Food Packaging, Type of packaging materials; Selection of packaging material for different foods: Cereals, Meat, Poultry, Fish, Milk, Vegetables, Fruits, Spices and Carbonated Beverages. Selective properties of packaging film; Tests on packaging materials - Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates; Methods of packaging and packaging equipment

Learning Outcomes

Students will be able to understand

1. Functions of Food Packaging
2. Selection of packaging material for different foods

UNIT II

Antimicrobial food packaging: Antimicrobial agents, constructing an antimicrobial packaging system, Factors affecting the effectiveness of antimicrobial packaging. Non- Migrating Bioactive Polymers (NMBP) in Food Packaging: Advantages of NMBP, Inherently Bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds

Learning Outcomes

Students will be able to understand

1. Antimicrobial agents, constructing an antimicrobial packaging system
2. Non- Migrating Bioactive Polymers (NMBP) in Food Packaging

UNIT III

Time-Temperature Indicators (TTIs): Defining and classifying TTIs, Requirements for TTIs, The development of TTIs, Maximizing the effectiveness of TTIs, Using TTIs to monitor shelf-life during distribution. The use of freshness indicators in packaging: Compounds indicating the quality of packaged food products, Freshness indicators, Pathogen indicators other methods for spoilage detection.

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Learning Outcomes
Students will be able to understand

1. Time-Temperature Indicators (TTIs)
2. Freshness indicators in packaging

UNIT IV

Developments in Modified Atmosphere Packaging (MAP): Novel MAP gases, testing novel MAP applications, applying high 02 MAP. MAP, product safety and nutritional quality; Reducing pathogen risks in MAP-prepared produce; Active and Intelligent Packaging Techniques: Active packaging techniques, Active packaging in practice: Fish, meat; Active packaging and colour control: the case study of meat, fruit and vegetables; intelligent packaging techniques, Legislative issues relating to active and intelligent packaging.

Learning Outcomes
Students will be able to understand

1. Novel MAP gases, testing novel MAP applications
2. Active packaging techniques

UNIT V

Green Plastics for Food Packaging: The problem of plastic packaging waste, the range of biopolymers, developing novel biodegradable materials. Integrated Intelligent Packaging, storage and distribution: The supply chain for perishable foods, role of packaging in the supply chain, creating integrated packaging, storage and distribution: alarm systems and TTIs.

Learning Outcomes
Students will be able to understand

1. Green Plastics for Food Packaging
2. Intelligent Packaging, storage and distribution

Textbooks

1. Brody, A. L., Strupinsky, E. P., & Kline, L. R. (2001). *Active packaging for food applications*. CRC press.
2. Paine, F. A., & Paine, H. Y. (2012). *A handbook of food packaging*. Springer Science & Business Media.
3. Ahvenainen, R. (Ed.). (2003). *Novel food packaging techniques*. Elsevier.
4. Coles, R., McDowell, D., & Kirwan, M. J. (Eds.). (2003). *Food packaging technology* (Vol. 5). CRC press.

References

1. Beswick, R., & Dunn, D. J. (2002). *Plastics in Packaging: Western Europe and North America*. iSmithers Rapra Publishing.
2. Stewart, G. F., & Amerine, M. A. (2012). *Introduction to food science and technology*. Elsevier.

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	GENERAL TRACK	L	T	P	C
		3	1	0	4
FOOD PLANT DESIGN & ECONOMICS					

Course Objectives

- To teach various aspects of plant design and its feasibility.

Course Outcomes

Students will be able to understand

- Software's for designing a layout.
- Students are assigned to prepare a project report on establishment of a food industry on selected food product as a part of credit course during third and fourth semesters.

UNIT I

Introduction: Important and special features of food processing plants. Plant location: Site selection criteria, factors influencing plant location, location analysis and techniques, General design considerations for location of food plants. Basics of layouts: Basic concepts of plant layout, types of layout and its applicability, factors influencing plant layout, understanding of equipment layout.

Learning Outcomes

Students will be able to understand

1. Important and special features of food processing plants
2. The layout of plant and equipment

UNIT II

Process Design: Selection of process, flow sheet-Basic flowchart, Food processing steps flowchart, Process equipment flowchart, material & energy balance, selection of equipment, process schedule, GANTT chart, PERT and CPM methods in brief, equipment design& design of auxiliary equipment.

Learning Outcomes

Students will be able to understand

1. Process schedule, GANTT chart, PERT and CPM methods
2. Food processing steps flowchart

UNIT III

Layout: Broad classification of food layouts and their peculiarities. Typical layouts for important products- Rice/Wheat milling, IQF, Beverages, Bakery, Breweries, Extraction plants, Confectionery, Abattoirs, Instant coffee and Tea, Dairy. Other aspects- Boiler Act, Factories Act, Pollution Act, Labour Act and other relevant Acts, Effluent treatment, Waste disposal.

Learning Outcomes

Students will be able to understand

1. Classification of food layouts and their peculiarities
2. Effluent treatment, Waste disposal.

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UNIT IV

Case Study-Project cost: Cost of land, building, equipment and utilities. Fixed capital cost, working capital cost, pre-operative expenses, total capital investment. Cost of manufacture & Profitability: Raw material cost, packaging material cost, manpower cost, utilities, administrative expenses, maintenance cost, depreciation cost, interest, taxes, estimation of total manufacturing cost, profitability, breakeven analysis and payback period.

Learning Outcomes

Students will be able to understand

1. Cost calculation of fixed capital
2. Cost calculation of Working capital
3. Cost of manufacture & Profitability

UNIT V

Plant maintenance: Role of maintenance staff and plant operator's, Types of maintenance-Preventive and condition based maintenance; Guidelines for good maintenance & safety precautions; Lubrication & lubricants; Work place improvement through '5S', Six sigma concept. Sanitation: Hygiene and sanitation requirement in food processing; CIP methods- single use, multi-use, Compact Systems and Foam-Cleaning Systems, sanitizing & disinfestation, pest control in food processing; storage and service areas.

Learning Outcomes

Students will be able to understand

1. Role of maintenance staff and plant operator's
2. Work place improvement through '5S', Six sigma concept
3. Hygiene and sanitation requirement in food processing

Textbooks

1. López-Gómez, A., & Barbosa-Cánovas, G. V. (2005). *Food plant design*. CRC Press.
2. Maroulis, Z. B., & Saravacos, G. D. (2007). *Food plant economics*. CRC Press.
3. Baker, G. A. (2002). *Introduction to food and agribusiness management* (No. 630.68 B173i Ej. 1). Prentice Hall.

References

1. Potter, Norman N., and Joseph H. Hotchkiss. *Food science*. Springer Science & Business Media, 2012.
2. Scott, R. (2018). *Basic concepts of industrial hygiene*. Routledge.
3. Peters, M. S., Timmerhaus, K. D., & West, R. E. (2003). *Plant design and economics for chemical engineers* (Vol. 4). New York: McGraw-Hill.

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		L	T	P	C
	SPECIALIZED TRACK - 1	**3**	**1**	**0**	**4**
FOOD NUTRITION					

Course Objectives

- To familiarize students with the classification of foods and nutrients, and their metabolism in the human body
- To apply knowledge on the legal aspects of formulating and labelling functional foods and dietary supplements.
- To develop a food product of high nutritive value

Course Outcomes

Students will be able to

- Gain knowledge on nutrition and its importance in daily life
- Having knowledge on recommended dietary allowances, acceptable daily intake of nutrients.
- Able to know about functions and properties of different nutrients

UNIT I

Basic concept of nutrition- characteristics, functions, digestion and assimilation of food, metabolism, Digestion, Absorption, and Transport of Foods and Nutrients. Importance of nutrition and dietetics - Assessment of nutritional status –balanced diet – Recommended dietary intake – Acceptable dietary intake – Malnutrition and its problems – Nutrient supplementation & fortification - Nutritional labeling and its importance.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about concepts of nutrition
2. Understand the digestion, absorption and transport of nutrients
3. Get knowledge on assessment of nutritional status
4. Gain knowledge about malnutrition and its problems

UNIT II

Carbohydrates- Definition, Structure, Properties, Functions, Classification, Dietary Sources, Chemical Reactions, Deficiencies and Excess, Recommended Dietary Allowances.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about the functions and properties of carbohydrates
2. Understand the classification and dietary sources for carbohydrates
3. Get knowledge on RDA values for carbohydrates

UNIT III

Proteins and amino acids- Definition, Structure, Properties, Functions, Classification, Dietary Sources, Chemical Reactions, Protein efficiency ratio – Net protein utilization and their determinations – Deficiencies and Excess, Recommended Dietary Allowances.

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Learning Outcomes

At the end of the unit, students will be able to

1. Know about the functions and properties of proteins and amino acids
2. Understand the classification and dietary sources for proteins and amino acids
3. Get knowledge on RDA values for proteins

UNIT IV

Lipids, fats and oils- Definition, Structure, Properties, Functions, Classification, Dietary Sources, Chemical Reactions, Deficiencies and Excess, Recommended Dietary Allowances

Learning Outcomes

At the end of the unit, students will be able to

1. Know about the functions and properties of lipids, fats and oils
2. Understand the classification and dietary sources for fats and oils
3. Get knowledge on RDA values for lipids

UNIT V

Vitamins and minerals- Minerals, fat-soluble vitamins, water-soluble vitamins- ascorbic acid and vitamin B complex; energy metabolism, special nutrition needs during pregnancy, lactation, infancy, for children, adolescents and aged; nutrition and public health; introduction to therapeutic nutrition, diet in disease conditions: jaundice, coronary heart disease, obesity, anemia, renal problems, GI tract problems; inborn errors of metabolism, diabetes: Neutraceuticals.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about vitamin sources and functions of vitamins
2. Understand energy metabolism and special nutrition
3. Get knowledge diet in disease condition

Textbooks

1. Agrawal, A., & Udipi, S. A. (2014). *Textbook of Human Nutrition*. Jaypee Brothers Medical Publishers (p) Limited.
2. Bamji MS, Krishnaswamy K, and Brahmam GNV. 2009. Textbook of Human Nutrition. Third Edition. Oxford and IBH Publishing Co. Pvt. Ltd
3. Potter NN, and Hotchkiss JH. 2007. Food Science. 5th Edition. CBS Publishers and Distributors.

References

1. Swaminathan, M. (1977). *Hand book of food and nutrition.* CRC Press
2. Eastwood, M. A. (2013). *Principles of human nutrition*. Springer.
3. Watson, R. R. (Ed.). (2008). *Functional foods and nutraceuticals in cancer prevention*. John Wiley & Sons.

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		L	T	P	C
	SPECIALIZED TRACK - 1	**3**	**1**	**0**	**4**
FOOD PRESERVATION TECHNOLOGY					

Course Objectives

- This course deals technology used in food preservation.
- To provide students with the knowledge of basic food preservation principles and processing methods to control food spoilage and deterioration.
- To introduce the basics of various food processing and preservation technologies.

Course Outcomes

The students will be able to

- Understand fundamental principles of food spoilage.
- Gain knowledge about different preservation techniques.
- Understand the impact of various preservatives on safety and quality parameters of food products

UNIT I

Introduction: Scope of food processing, Historical developments, Principles of food preservation, Preservation by physical methods and chemical methods.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about principles of food processing
2. Get knowledge on physical and chemical methods of preservation

UNIT II

Food preservation by low temperature- Freezing and Refrigeration: Introduction to refrigeration, cool storage and freezing, definition, principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, introduction to thawing, changes during thawing and its effect on food.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about preservation by low temperature methods
2. Get knowledge on preservation by freezing and different types of freezing

UNIT III

Food preservation by high temperature - Thermal Processing-

Commercial heat preservation methods: Sterilization, Commercial Sterilization, Pasteurization, and blanching.

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Learning Objectives

At the end of the unit, students will be able to

1. Gain knowledge on preservation using high temperature
2. Get knowledge on commercial heat preservation methods

UNIT IV

Food preservation by moisture control drying and dehydration - Definition, drying as a means of preservation, differences between sun drying and dehydration (i.e. mechanical drying), heat and mass transfer, factors affecting rate of drying, normal drying curve, names of types of driers used in the food industry, Evaporation – Definition, factors affecting evaporation, names of evaporators used in food industry.

Learning Outcomes

At the end of the unit, students will be able to

1. Gain knowledge on preservation by drying and dehydration
2. Get knowledge on evaporation and factors affecting evaporators

UNIT V

Food preservation by irradiation- Introduction, units of radiation, kinds of ionizing radiations used in food irradiation, mechanism of action, uses of radiation processing in the food industry, concept of cold sterilization.

Learning outcome

At the end of the unit, students will be able to

1. Gain knowledge on preservation by irradiation
2. Get knowledge on uses of irradiation in food industry

Textbooks

1. Fellows, P. J. (2009). *Food processing technology: principles and practice*. Elsevier.
2. Potter, N. N., & Hotchkiss, J. H. (2012). *Food science*. Springer Science & Business Media.

References

1. Barbosa-Cánovas, G. V. (2003). *Handling and preservation of fruits and vegetables by combined methods for rural areas: technical manual* (No. 149). Food & Agriculture Org.,
2. Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education.

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		L	T	P	C
	SPECIALIZED TRACK - 1	**3**	**1**	**0**	**4**
FOOD BIOCHEMISTRY					

Course Objectives

- Develop the ability to have knowledge on chemical composition of food and role of Food Biochemistry in food production, storage.

Course Outcomes

Students will be able to

- Explain properties and reaction of carbohydrates, lipids and proteins during storage and processing of food
- Having knowledge on important sources of vitamins and minerals in the food and how these factors affect the quality aspects of food.

UNIT I

Introduction to biochemistry: usefulness of cells and organisms in biochemical studies; Water and its effect on dissolved bio-molecules; Nomenclature, Classification and specificity of enzymes and cofactors, iso-enzymes, Regulatory enzymes. Enzyme Kinetics: Factors affecting the rate of enzyme catalyzed reaction.

Learning Outcomes

At the end of unit, students will be able to

1. Explain the Water and its effect on dissolved bio-molecules
2. Know the classification of enzymes and its importance in food production

UNIT II

Regulation and control of enzyme action, enzyme inhibition and kinetics of enzyme inhibition, enzyme purification; elements of bioenergetics, Application of enzymes in food processing: Endogenous enzymes and their role in modification of foods, enzymes added to foods during processing, sources, conversions and specific applications.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the kinetics and application of enzymes in food processing
2. Know the importance of enzymes in food modification and value addition

UNIT III

Metabolic Pathways: Carbohydrates, glycolysis, TCA cycle, oxidative phosphorylation, biosynthesis of starch. Lipid metabolism, fatty acid oxidation, biosynthesis of fatty acids, phospholipids, cholesterol, Amino acid oxidation, protein biosynthesis; clinical problems associated with excess and deficiency of proteins.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the metabolic pathways
2. Understand the biosynthesis of macro and micro molecules

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UNIT IV

Nucleic acids; Hormones; Elements of immunology. Biochemistry of Foods: Post harvest and Postmortem biochemical changes in foods: Changes in composition, color, texture, flavor and its implications on quality of foods.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the biochemistry of foods and biochemical changes in food
2. Explains how these biomolecules will affect the quality of food

UNIT V

Molecular Biology & Biotechnology Replication of DNA (E. coli), transcription & translation, Recombinant DNA technology, plasmid, cosmid, Phage vector, Genomic and cDNA Library, Southern Northern, and western blotting.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the transcription and translation process
2. Understand the importance of molecular biology and biotechnology in food

Textbooks

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of biochemistry: life at the molecular level*. John Wiley & Sons.

References

1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). (2015). *Biochemistry and molecular biology of plants*. John wiley & sons.
2. Berg, J. M., Deis, F. H., Gerber, N. C., Gumport, R., & Koeppe, R. E. (2011). *Biochemistry student companion*. Macmillan.
3. Manay, N. S. O. (2001). *Food: facts and principles*. New Age International.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

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SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

		L	T	P	C
	SPECIALIZED TRACK - 1	**3**	**1**	**0**	**4**
INDUSTRIAL MICROBIOLOGY					

Course Objectives

- To introduce fermentation technology and its application in food industry
- To familiarize students with industrially important microorganisms and their application in food industry

Course Outcomes

Students will be able to

- Know about Industrial fermentation techniques
- Know about different industrially important micro organisms
- Know about different growth regulators (Hormones)
- Know about different products produced by Industrial fermentation process

UNIT I

History of industrial microbiology; Primary and secondary metabolites produced by the microorganisms; Screening of microorganisms; Preservation of microorganisms; Organizations involved in microbiological work; Fermentation media, Industrial sterilization.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the significance of industrial microbiology
2. Know various Organizations involved in microbiological work

UNIT II

Basic concepts: Historical development of bioprocess technology, Kinetics of microbial growth and product formation. Phases of cell growth in batch cultures, Simple unstructured kinetic models for microbial growth, Monod model, Growth of filamentous organisms. Growth associated (primary) and non-growth associated (secondary) product formation kinetics.

Learning Outcomes

At the end of unit, students will be able to

1. Explain the Kinetics of microbial growth
2. Enumerate bioprocess technology

UNIT III

Fermentation process: Basic design and construction of fermenter and ancillaries, main parameters to be monitored and controlled in fermentation processes. Types of fermentation and fermenters and its applications. Industrially important secondary metabolites.

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Learning Outcomes

At the end of unit, students will be able to

1. Understand the Basic design and construction of fermenter
2. Know various Types of fermentation
3. Explain Industrially important s e c o n d a r y metabolites

UNIT IV

Downstream processing operations; Immobilized enzyme technology: enzyme immobilization, industrial processes, utilization and regeneration of cofactors. Immobilized enzyme kinetics. and microorganisms involved in Probiotics: Importance, r ole in fermented foods, organisms involved, beneficial effects; Bacteriocins; Nisin: Production of microbial enzymes

Learning Outcomes

At the end of unit, students will be able to

1. Understand the description of downstream processing operations
2. Know the immobilization technology for enzymes

UNIT V

Industrial production of important products; Production of pectic enzymes, Industrial production of Glucose transforming enzymes; Organisms involved, production, purification and immobilization of Glucose isomerase and Oxidase. Industrial scale production of Bakers' yeast and Brewer's yeast; Microbial oil production and Bio pesticides.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the Industrial production of important products
2. Acquire knowledge on industrial applications of various enzymes

Textbooks

1. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology: concepts and applications*, 221-241. John Wliey & Sons.
2. Frazier, W. C., & Westhoff, D. C. (1998). *Food microbiology* 4th ed. International Edition McGraw Hill, Singapore, 440-441.

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1. Banwart, G. (2012). *Basic food microbiology*. Springer Science & Business Media.
2. Jay, J. M., Loessner, M. J., & Golden, D. A. (2008). *Modern food microbiology*. Springer Science & Business Media.
3. Prescott, S. C., & Dunn, C. G. (2018). Industrial Microbiology. Mc Graw-Hill Book Company.
4. Patel, A. H. (2003). Industrial Microbiology McMillan (India) Ltd. *New Delhi*, 18-19.

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		L	T	P	C
	SPECIALIZED TRACK - 2	**3**	**1**	**0**	**4**

PROCESS TECHNOLOGY FOR CONVENIENCE AND RTE FOODS

Course Objectives

- To enable the students to understand the various aspects of convenience and RTE foods
- To enable the students to understand manufacturing technology of convenience and RTE foods

Course Outcomes

Students will be able to

- Gain knowledge about processed food and technology
- Having knowledge on extruded snack foods
- Get knowledge about ready to eat snacks

UNIT I

Overview of grain-based snacks: whole grains – roasted, toasted, puffed, popped and flakes Coated grains-salted, spiced and sweetened Flour based snack– batter and dough based products; savory and farsans; formulated chips and wafers, papads.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about grain based snacks.
2. Understand about flour based snacks.
3. Get knowledge on processing of wafers and chips.

UNIT II

Technology for fruit and vegetable based snacks: chips, wafers, papads etc. Technology for coated nuts – salted, spiced and sweetened products- chikkis, Sing bhujia Technology of ready to eat fruits and vegetable based food products like, sauces, fruit bars, glazed candy etc. Technology of ready to eat canned value added fruits/vegetables and mixes and ready to serve beverages etc.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about technology for fruit and vegetable based snacks
2. Get knowledge about technology for coated nuts
3. Get knowledge on technology for ready to eat canned foods

UNIT III

Technology of ready- to- eat baked food products, drying, toasting roasting and flaking, coating, chipping Extruded snack foods: Formulation and processing technology, colouring, flavouring and packaging

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Learning Outcomes

At the end of the unit, students will be able to

1. Know about technology for ready to eat baked food products.
2. Get knowledge about extruded snack foods
3. Gain knowledge about formulation and processing of extruded foods

UNIT IV

Technology for ready-to-cook food products- different puddings and curried vegetables etc. Technology for ready-to-cook and ready to eat meat and meat food products. Technology for preparation of instant cooked rice, carrot and other cereals based food products

Learning Outcomes

At the end of the unit, students will be able to

1. Know about technology of ready to eat cook products
2. Get knowledge about RTE meat and meat products
3. Gain knowledge about instant cooked cereal and vegetable based products.

UNIT V

Technology of ready to eat instant premixes based on cereals, pulses etc. Technology for RTE puffed snack- sand puffing, hot air puffing, explosion puffing, gun puffing etc. Technology for preparation of traditional Indian dairy products

Learning Outcomes

At the end of the unit, students will be able to

1. Know about technology of instant premixes
2. Get knowledge about technology for RTE puffed snacks
3. Gain knowledge about technology of traditional dairy products.

Textbooks

1. Lal, G., & Siddappa, G. S. (1959). *Preservation of fruits and vegetables* (No. 664.828 L35). Bombay Popular Prakashan.
2. Patil, J. V., & Chavan, U. D. (2013). *Industrial processing of fruits and vegetables*. Daya Publishing House, A division of Astral International Pvt. Limited.
3. Manley, D. (Ed.). (2011). *Manley's technology of biscuits, crackers and cookies*. Elsevier.

References

1. Lusas, E. W., & Rooney, L. W. (Eds.). (2001). *Snack foods processing*. CRC Press.
2. Harper, J. M. (1994). *The technology of extrusion cooking*. N. Frame (Ed.). Glasgow: Blackie Academic & Professional.
3. Matz, S. A. (2012). *Snack food technology*. Springer Science & Business Media.

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	SPECIALIZED TRACK - 2	L	T	P	C
		3	1	0	4
FLAVOUR TECHNOLOGY					

Course Objectives

- To enable the student to understand basics of foods flavors
- To enable the student to understand chemistry & technology of natural flavors

Course Outcomes

On completion of the course, the student would be able

- To understand the basics of flavor
- To understand the correlation between appearance and taste
- To develop methods for stabilization of natural flavor
- To develop aroma chemicals
- To develop techniques for analysis of aroma chemicals

UNIT I

Basics of flavors and colors olfactory perception of flavor and taste – Theories of olfaction - Molecular structure and activity relationships of taste – Sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Classification of flavors – Natural, Nature identical, and synthetic – Flavor potentiators. Methodology of sensory evaluation and determination of threshold levels as specified by BIS.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about olfactory perception of flavor and taste
2. Understand the molecular structure and activity relationships of taste.
3. Get knowledge on the classification of flavors & flavor potentiators
4. Concept of methodology of sensory & specified standards of BIS.

UNIT II

Extraction techniques Essential oils and oleoresins –Types of Extraction Solid-Liquid Extraction – Solvent Extraction-Supercritical fluid extraction - Continuous and semi-continuous methods- Effect of types of solvents used. Solid-phase microextraction of aroma components – E-nose technology.

Learning Outcomes

At the end of the unit, students will be able to

1. Acquire knowledge on types of extraction of essential oils and oleoresins
2. Understand the concept of supercritical fluid extraction & E-nose technology.
3. Description of solid-phase microextraction of aroma components

UNIT III

Technology of natural flavours Classification – Alliaceous flavors – Bittering agents, Coffee and Cocoa,

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Fruit flavors. Evolution of flavors during processing – enzymatic development, the effect of roasting, cooking frying on flavor developments. Flavor changes during the processing, preservation, packaging, and storage of foods. Roles as sulfur compounds, fatty acids, amino acids, terpenoids, lactic acid ethanol in food flavors.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the concept of Coffee and Cocoa, Fruit flavors. Evolution of flavors during processing – enzymatic development.
2. Acquire the knowledge on alliaceous flavors – Bittering agents, Coffee and Cocoa, Fruit flavors
3. Explanation of Flavor changes during the processing, preservation, packaging, and storage of foods.

UNIT- IV

Spices and herbs as food flavorings: Processing of basil, mint, saffron, cloves, tamarind, ginger, cardamom, chill, pepper, etc. for essential oils, extracts, and/or oleoresins. Liquid and dry flavor production - Staling of flavors. Microbial and cell suspensions in the synthesis of flavors.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the concept of Processing basil, mint, saffron, cloves, tamarind, ginger, cardamom, chill, pepper for essential oils
2. Acquire knowledge on Liquid and dry flavor Production &Staling of flavors.
3. Understand the concept of Microbial and cell suspensions in the synthesis of flavors.

UNIT V

Total component and headspace analysis of flavour- Total Component analysis– Basics and methods – Recent developments. Headspace analysis – static and dynamic methods – basic principles – method and developments.

Learning Outcomes

At the end of the unit, students will be able to

1. Understand the concept of Total component analysis
2. Acquire knowledge about the. Headspace analysis – static and dynamic methods

Textbooks

1. Reineccius, G. (2005). *Flavor chemistry and technology*. CRC press.
2. Socaciu, C. (2007). *Food colorants: chemical and functional properties*. CRC Press.
3. Damodaran, S., Parkin, K. L., & Fennema, O. R. (Eds.). (2007). *Fennema's food chemistry*. CRC press.

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1. Rowe, D. J. (2005). *Chemistry and technology of flavors and fragrances*, 56. Blackwell.
2. Marsili, R. T. (1997). *Flavor, fragrance, and odor analysis*, 203-227. Marcel Dekker.
3. Paredes-López, O., & Delgado-Vargas, F. (2003). *Natural colorants for food and nutraceutical uses*. CRC Press LLC.
4. Hendry, G. A. F., & Houghton, J. D. (Eds.). (1996). *Natural food colorants*. Springer Science & Business Media.

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		L	T	P	C
	SPECIALIZED TRACK – 2	**3**	**1**	**0**	**4**
BREWING TECHNOLOGY					

Course Objectives

- To enable the student to understand basics of malting and brewing
- To enable the student to understand different methods of beer production

Course Outcomes

Students will be able to

- Having knowledge on brewing and equipment's used for brewing
- Gain knowledge about energy management in brewing industry

UNIT I

Introduction of brewing, history of brewing; Raw materials: barley, hops, water, yeast; Adjuncts for beer production: Maize, rice, millet, wheat, sugar etc.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about basics of brewing process
2. Get knowledge about raw materials used for brewing

UNIT II

Malt production, role of enzymes for malting; Barley storage, steeping, germination, kilning, cooling, storage; Malt from other cereals, caramel malt, roasted malt, smoked malt, malt extract; Malt quality evaluation.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about production and role of enzymes in malting process
2. Get knowledge about quality evaluation of malt.

UNIT III

Wort production, malt milling, Mashing, Mashing vessels; Wort boiling, clarification, cooling and aeration Enzyme properties, starch degradation, b-glucan degradation; Conversion of fatty matter, Biological acidification.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about enzyme properties
2. Get knowledge about wort production and malt milling

UNIT IV

Beer production methods, fermentation technology, changes during fermentation; Filtration procedure and equipment, beer stabilization conditions and durations, beer carbonation process; Packaging equipment and

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packaging materials, storage conditions and distribution process. Brewing Equipment's. Grain mill, kettles, siphons, carboys, fermentation equipment, wort chillers, pumps beer bottles, cans, labels, bottle caps, sanitation equipments.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about methods of beer production.
2. Get knowledge about equipment used in brewing process
3. Gain knowledge about packaging equipment and packaging materials.

UNIT V

Preventive Production of beer against technology, ling phenomenon of beer, possible measures against staling reactions, oxidation. Recent advances: Immobilized Cell Technology in Beer Production, immobilized yeast cell technology. Energy management in the brewery and malting; waste water treatment Automation and plant planning.

Learning outcome

At the end of the unit, students will be able to

1. Know about recent advances in beer production
2. Get knowledge about energy management in brewery and malting
3. Know about preventive production of beer

Textbooks

1. Briggs, D. E., Brookes, P. A., Stevens, R. B. C. A., & Boulton, C. A. (2004). *Brewing: science and practice* (Vol. 108). Woodhead Publishing.
2. Esslinger, H. M. (Ed.). (2009). *Handbook of brewing: processes, technology, markets*. John Wiley & Sons.

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1. Bamforth, C. W. (2016). *Brewing materials and processes* (Vol. 253). California: Academic Press.
2. Parker, D. K. (2012). Beer: Production, sensory characteristics and sensory analysis. In *Alcoholic beverages* (pp. 133-158). Woodhead Publishing.

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		L	T	P	C
	SPECIALIZED TRACK – 2	**3**	**1**	**0**	**4**

ADVANCES IN MILLING TECHNOLOGY

Course Objectives

- To study about advanced milling techniques for cereals
- To study about milling of pulses and oilseeds

Course Outcomes

The student will be able to

- Know about Paddy Processing and Rice milling equipment which will help them for developing entrepreneurial skills.
- Recommend a better equipment for processing the raw materials
- Acquainted with traditional and modern oil milling methods

UNIT I

Rice milling - Rice milling flow chart - Modern Rice Milling equipments– paddy milling – Dehusking of paddy - Engelberg Huller, Under runner disc shellers, rubberroll sheller and Centrifugal dehusker- Paddy Separators – Satake and Schule Designs – Rice Polishers - Cone polishers and other types - Bran and Brokens separators - Rice mill yields and loss due to brokens at different stages of milling – milling efficiency.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about types of equipment used for rice milling
2. Understand the different types of separators
3. Get knowledge on the efficiency of milling.

UNIT II

Wheat milling - flow chart for wheat milling – milling process - equipments used in wheat milling – parboiling of wheat – bulgur wheat – wheat flour milling - products and by products of wheat.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about equipment's used in milling of wheat
2. Get knowledge about products and byproducts of wheat milling

UNIT III

Processing of maize - milling methods - Pre-cleaning - cleaning equipment – degermination and dehusking - Dry milling of maize – wet milling – flow chart -Products of milling – Flour – Semolina - Brewers' grits etc and their applications – Bran and Fibre separation - Gluten and Starch Separation - Equipment used - Starch conversion into other value added products – Acid Hydrolysis - Enzyme Hydrolysis - Isomerization processes- Processing for Dextrose - Malto dextrin and other products -

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Extraction and refining of corn oil in brief.

Learning Outcomes

At the end of the unit, students will be able to

1. Know about milling methods of maize
2. Get knowledge about equipment's used for milling of corn
3. Gain knowledge about extraction and refining of corn oil

UNIT IV

Milling of pulses and oilseeds - Unit operations of pulse milling – domestic and commercial scale pulse milling methods –Dry and wet milling, CFTRI, CIAE, Jadavpur methods - Process flow chart –Pulse milling machineries - dehusking in Pulse Pearler - splitting of pulses in Pulse splitter - Mini dhal mill - working principle - advantages and disadvantages –pulse milling efficiency - Grinding of split pulses - pulse flour products - their applications and equipments used. Traditional milling equipment's for oilseed processing- Ghani – Improvement over conventional method of expression – Mechanical expression devices – hydraulic press – screw press

Learning Outcomes

At the end of the unit, students will be able to

1. Know about milling methods of pulses and oil seeds
2. Get knowledge about equipment's used for milling of pulses and oil seed

UNIT V

Modern milling techniques: Advances in Milling like Turbo milling & Extractive milling of wheat – dehusking of millets – Lye peeling of rice. New value added products like agglomerated wheat flour, fortified rice, diabetic rice, cured rice, brown rice. New trends in processing of pulses & oilseeds like preparation of protein concentrates and isolates and their use in high protein foods

Learning Outcomes

At the end of the unit, students will be able to

1. Know about modern milling methods
2. Get knowledge about technology for new value added products.

Textbooks

1. Sahay, K. M., & Singh, K. K. (2004). *Unit operations of agricultural processing*. Vikas Publishing House.
2. Chakraverty, A., & Singh, R. P. (2014). *Postharvest technology and food process engineering*. CRC Press.

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1. Matz, S. A. (1991). *Chemistry and technology of cereals as food and feed*. Springer Science & Business Media.
2. Kulp, K. (Ed.). (2000). *Handbook of Cereal Science and Technology, revised and expanded*. Marcel Dekker.

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	SPECIALIZED TRACK – 3	**3**	**1**	**0**	**4**

EFFLUENT TREATMENT IN FOOD PROCESSING

Course Objectives

- To learn about waste water treatment
- To learn to analyze different types of food industry wastes, their special characteristics and how they can be utilized effectively.
- To apply the chemical and biological treatments methods while treating the waste water from industry

Course Outcomes

By the end of the course the students will be able to

- To impart knowledge on the biological treatment processes used in waste water treatment industry.
- To impart knowledge on the various advances in waste water treatment process across the industries.
- To impart knowledge on various chemical treatment methods used in waste water treatment industry.

UNIT I

Waste water treatment an overview Introduction, Terminology, Summary of Significant Regulations. Health and Environment Concerns in Waste Water Management, Waste Water Characteristics, Waste Water Treatment Methods, Waste Water Reclamation and Reuse waste Water Constituents, Physical Characteristics, Inorganic, Non- metallic Constituents, Metallic, Organic Constituents, Biological Characteristics.

Learning Outcomes

At the end of this unit, students able to

1. Learn about the wastewater characteristics and need for waste water treatment
2. Understand about the waste water treatment methods, waste water reclamation and reuse waste water constituents.

UNIT II

Process analysis and selection components of waste water, components of waste water, statistical analysis, analysis of waste water flow rate data reactors used in waste water treatment, Mass balance analysis, Blackboard, Ideal flow reactors – design & modeling blackboard, analysis of non – ideal flow in reactors, non- Ideal flow reactors – design & modeling, types of reactions, treatment processes, process selection.

Learning Outcomes

At the end of this unit, students able to

1. Learn about the statistical analysis, analysis of waste water flow rate data, reactors used in waste water treatment.
2. Understand about the Ideal flow reactors, design &modeling Blackboard, Analysis of non – ideal flow in reactors.

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UNIT III

Role of Unit Processes in waste water treatment chemical coagulation, Chemical precipitation for improved plant performance chemical oxidation, chemical neutralization, chemical storage, feeding, piping, control systems, scale control and stabilization.

Learning Outcomes

At the end of this unit, students able to

1. Learn about the various chemical treatment methods used in waste water treatment industry.
2. Understand the neutralization, chemical storage, feeding, piping, control systems, Chemical neutralization, scale control and stabilization.

UNIT IV

Biological Treatment**:** Overview of biological Treatment, Microbial metabolism, Bacterial growth and energetics, Aerobic biological oxidation, Anaerobic fermentation and oxidation, Trickling filters – Rotating biological contractors, Combined aerobic processes , Activated sludge film packing.

Learning Outcomes

At the end of this unit, students able to

1. Learn about the overview of biological treatment.
2. Understand about the trickling filters & activated sludge film packing.

UNIT V

Advanced waste water treatment technologies used in advanced treatment, Classification of technologies Removal of Colloids and suspended particles , Depth Filtration – Surface Filtration , Membrane Filtration Absorption ,Ion Exchange, Advanced oxidation process.

Learning Outcomes

At the end of this unit, students able to

1. Understand the technologies used in advanced treatment.
2. Understand the classification of technologies Removal of Colloids and suspended particles.

Textbooks

1. Tchbanoglous, G., Burton, F. L., & Stensel, H. D. (2003). *Wastewater engineering: treatment and reuse*. McGraw-Hill.
2. Gray, N. (2017). *Water technology*. CRC Press.

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1. Klemes, J., Smith, R., & Kim, J. K. (Eds.). (2008). *Handbook of water and energy management in food processing*. Elsevier

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	SPECIALIZED TRACK – 3	**3**	**1**	**0**	**4**

FOOD PLANT MAINTENANCE

Course Objectives

- To know about the role of maintenance in food plant
- To learn about the types of maintenance involved in the food industry
- To learn about the safety & welfare programs

Course Outcomes

On completion of the course, the student would be able to

- To understand the plant maintenance Program
- To understand the maintenance organization
- To understand the types of maintenance involved in food plant operation
- To understand HACCP; desirable safety features of some food processing equipment

UNIT I

Plant maintenance program; Introduction of course and its relevance, basic concepts of plant maintenance. Role of maintenance staff and plant operators; Guidelines for good maintenance & safety precautions; Lubrication & lubricants; Workplace improvement through '5S'. Types of maintenance – corrective or breakdown maintenance, scheduled maintenance, preventive maintenance, and predictive maintenance.

Learning Outcomes

At the end of this unit, students able to

1. Understand the basic concepts & role of plant maintenance
2. Learn about the lubrication & lubricants
3. Get concept of types of maintenance & workplace improvement through '5S

UNIT II

Periodic & preventive maintenance: Periodic inspection-concept and need. Overhauling of mechanical components, Overhauling of electrical motor, common troubles, and remedies of Electric motor, Repair complexities, and their use. Definition need, steps, and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets. Program and schedule of preventive maintenance of mechanical and electrical pieces of equipment. Advantages of Preventive Maintenance, Repair cycle-concept, and importance.

Learning Outcomes

At the end of this unit, students able to

1. Understand the Basic Periodic Maintenance
2. Learn about Preventive Maintenance

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UNIT III

Maintenance organization, development of the optimum organization. Planned overhaul and PERT planning, engineering and general stores, workshop facilities in relation to the size and types of dairy plants.

Learning Outcomes

At the end of this unit, students able to

1. Understand the Maintenance organization, development of the optimum organization
2. Learn about the Planned overhaul and PERT planning, engineering

UNIT IV

Care and maintenance of materials**:** Care and maintenance of Stainless Steel Surfaces, insulations, rubber and gasket materials, properties, grade, and their selection, maintenance of engineering control systems.

Learning Outcomes

At the end of this unit, students able to

1. Understand the Care and maintenance of S.S.
2. Learn About the maintenance of engineering control systems.

UNIT V

Safety & welfare programs the objective of safety, health & environment; Cost of safety; Accident investigation report; Safety promotional activity; Environmental pollution and its control. Indian Factories Act on safety; HACCP; Desirable safety features of some food processing equipment; Personal protective equipment; Safety from the adulteration of food.

Learning Outcomes

At the end of this unit, students able to

1. Understand the objective of safety, health & environment; cost of safety; accident investigation report, Indian Factories Act on safety
2. Learn about the HACCP; desirable safety features of some food processing equipment.

Textbooks

1. Brumbach, M. E., & Clade, J. A. (2013). *Industrial maintenance*. Cengage Learning.
2. Scott, R. (2018). *Basic concepts of industrial hygiene*. Routledge.
3. Shuler, C. F. (1989). *Safety design criteria for industrial plants* (Vol. 1). M. Cumo, & A. Naviglio (Eds.). CRC Press.

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1. Patty, F. A., & Brožek, J. (1949). industrial hygiene and o icology contributors to ek [et Al.]. Interscience Publishers.
2. Hayes, P. R., & Forsythe, S. J. (2013). *Food hygiene, microbiology and HACCP*. Springer Science & Business Media.

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ENERGY MANAGEMENT IN FOOD INDUSTRY

Course Objectives

- To learn about the minimal usage of energy in food industries
- To learn about the energy conservation in different processing techniques

Course Outcomes

By the end of the course, the students will be able to

- To understand the waste energy usage in food industries
- To understand the various processing techniques runs by waste energy

UNIT I

Fundamentals of energy auditing: procedures of energy audit, Measurements, Instrumentation, and Data Collection, Energy Audit in Food Processing Facilities. Minimal energy consumption in food industry associated with storage of foods in cooling, chilling and refrigerated.

Learning Outcomes

At the end of this unit, students able to

1. Learn about the energy auditing process and data collection
2. Understand about the minimal energy consumption in frozen conditions

UNIT II

Conversion of food processing wastes into energy: Fermentation of Food Processing Wastes into Transportation Alcohols, Biodiesel Production from Waste Oils and Fats: traditional biodiesel production, catalyst for biodiesel and its production; Thermochemical Conversion of Food Processing Wastes for Energy Utilization: combustion, pyrolysis, gasification and thermochemical liquefaction process.

Learning Outcomes

At the end of this unit, students able to

1. Gain knowledge about the production of alcohols, biodiesel production from waste
2. Understanding about the production of thermal energy from waste

UNIT III

Heat recovery in food industry: Introduction and recovery waste heat as source, uses of waste heat and quantifying, types of heat recovering equipment. Fouling of heat transfer equipment: Introduction to fouling mechanism, waterside and process - side fouling.

Learning Outcomes

At the end of this unit, students able to

1. Brief knowledge on recovery waste heat for source and its use
2. Learning about the fouling mechanism in heat transfer equipment

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UNIT IV

Energy management in slaughter house, poultry, cereal, sugar processing industries. Improving energy efficiency in sugar processing.

Learning Outcomes

At the end of this unit, students able to

1. Understand the energy management in different processing industries
2. Learn about the energy efficiency on sugar industries

UNIT V

Energy Efficiency and Conservation in Food Irradiation, Pulsed Electric Fields Treatment, High-Pressure Food Processing, Microwave Heating, Supercritical Fluid Processing.

Learning Outcomes

At the end of this unit, students able to

1. Understand the energy efficiency of different processing techniques

Textbooks

1. Wang, L. (2008). *Energy efficiency and management in food processing facilities*. CRC press.
2. Klemes, J., Smith, R., & Kim, J. K. (Eds.). (2008). *Handbook of water and energy management in food processing*. Elsevier.
3. Arvanitoyannis, I. S. (2010). *Waste management for the food industries*. Academic Press.

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1. Kosseva, M., & Webb, C. (Eds.). (2020). *Food industry wastes: assessment and recuperation of commodities*. Academic Press.
2. Waldron, K. W. (Ed.). (2009). *Handbook of waste management and co-product recovery in food processing*. Elsevier.
3. Wang, L. K., Hung, Y. T., Lo, H. H., & Yapijakis, C. (2005). *Waste treatment in the food processing industry*. CRC press.

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	SPECIALIZED TRACK – 3	**3**	**1**	**0**	**4**
FOOD PLANT UTILITIES AND SERVICES					

Course Objectives

- To learn about the usage of utilities in processing equipment
- To learn about the improving energy efficiencies

Course Outcomes

Students will be able

- To understand about the requirement of utilities in food industries
- To understand about the water purification and softening

UNIT I

Water supply system: Pumps of different types, operational aspects, water requirement for cleaning and processing, water quality, water purification and softening, different types of water requirements in food processing plants and its uses, water filtration, recirculation and wastage minimization.

Learning Outcomes

At the end of this unit, students able to

1. Understand about the types of pumps and usage of water for various purpose
2. Learn about the waste water usage

UNIT II

Steam uses in food industry, Steam generation system: Components of a boiler system, fuels used in boilers, energy analysis for a steam generation system, heat loss from boiler system, boiler design consideration. Steam distribution system: Components of steam distribution, heat loss and energy efficiency of a steam distribution system.

Learning Outcomes

At the end of this unit, students able to

1. Gain knowledge on types of boilers and steam generation systems
2. Understand about the steam distribution and its energy efficiency

UNIT III

Power and Electrical System: Types of electrical loads, electric loads, sources of energy losses in power and electrical systems, low power factor, improper motor load, poor control. Power management for demand control, power factor improvement, replacement with high efficiency motors, replacement with electronic adjustable motors

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Learning Outcomes

At the end of this unit, students able to

1. Learn about the different types of electrical loads
2. Understand about the minimal power controls and improving its efficiency

UNIT IV

Quantity and quality of waste heat in food processing facilities, waste heat utilization, heat exchangers for waste heat recovery, and heat pumps for waste heat recovery. Thermal energy storage system and materials, hot thermal energy storage, cooling energy storage.

Learning Outcomes

At the end of this unit, students able to

1. Know the usage of waste heat and its recovery from food equipment
2. Understanding about the hot and cooling energy storages

UNIT V

Estimation of utilities requirements: Lighting, ventilation, drainage, CIP system, dust removal, fire protection etc. Maintenance of facilities: Design and installation of piping system, codes for building, electricity, boiler room, plumbing and pipe coloring, maintenance of the service facilities.

Learning Outcomes

At the end of this unit, students able to

1. Gain knowledge on utilities required for the food plant
2. Brief knowledge on the maintenance of the facilities

Textbooks

1. Wang, L. (2008). *Energy efficiency and management in food processing facilities*. CRC press.
2. Casper, M. E. (1977). *Energy-saving techniques for the food industry*. OSTI.GOV.
3. Morris, C. E. (1994). The food engineer: essential or expendable? *Chilton's Food Engineering*, *66*(8), 71-77.

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1. Arvanitoyannis, I. S. (2010). *Waste management for the food industries*. Academic Press.

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	SPECIALIZED TRACK – 4	**3**	**1**	**0**	**4**
EMERGING TECHNOLOGIES IN FOOD SAFETY AND QUALITY					

Course Objectives

- To understand latest technologies used in food safety

Course Outcomes

By the end of the course, the students will

- Acquire knowledge on theoretical aspects of emerging technologies like GC, HPLC, Fluorimetry, PAGE, NIR, X ray diffraction, E sensors, e nose, e tongue and FTIR etc.

UNIT I

Basic Chromatographic Technique: Basic principles of chromatography. Paper Chromatography. Introduction, general principles, procedure, types of paper chromatography, applications. Thin layer chromatography. Introduction, principle, procedure, general application. Column liquid chromatography. Gas- liquid chromatography General procedure, qualitative analysis, separation and resolution, quantitative analysis- immuno affinity chromatography- trouble shooting components and interpretation.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. Basic principles of chromatography. Introduction to Paper Chromatography, general principles, procedure and its types, applications.
2. Introduction to Thin layer chromatography, principle, procedure, general application.
3. Quantitative analysis- immuno affinity chromotography- trouble shooting components and interpretation

UNIT II

HPLC Analysis of Food: HPLC (High performance l iquid chromatography). Introduction, principle of separation, components of an HPLC system. Pump, injector, column (column hardware and column packing materials in brief) detector and different types of detectors, Recorder, Application of HPLC- Minimum Response Performance level- operation quotient and performance quotient.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. Introduction to HPLC, principle of separation, components of an HPLC system. Pump, injector
2. Column (column hardware and column packing materials in brief) detector and different types of detectors, recorder

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3. Application of HPLC- minimum response performance level- operation quotient and performance quotient.

UNIT III

Gas Chromatography: Gas chromatography Introduction, sample preparation, principle of separations, components gas supply system, injection port, oven, column and stationary phases, types of columns, detectors different types of detectors, recorder, types of carrier gases used.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. Introduction to Gas chromatography, sample preparation, principle of separations, components gas supply system.
2. Injection port, oven, column and stationary phases, types of columns
3. Detector and different types, recorder, types of carrier gases used

UNIT IV

Spectrophotometric Techniques: Spectrophotometry introduction and principles. Ultra violet and visible absorption spectroscopy basis of absorption spectroscopy, deviations from Beer's law, procedural consideration, and calibration curves. Instrumentation and instrument design, application. Fluorimetry introduction, principle and techniques, instrumentation and application. Atomic spectrophotometry, Introduction, principles and techniques.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. Introduction and principles of Spectrophotometry
2. Ultra violet and visible absorption spectroscopy basis of absorption spectroscopy
3. Deviations from Beer's law, procedural consideration, and calibration curves.
4. Instrumentation and instrument design, application

UNIT V

Modern Analytical Instrumentation: Radiotracer techniques radioactive counters, solid, gas and liquid scintillation. Measurement of enzyme activity. Radio Immune Assay Electrophoresis, definition, types of electrophoretic methods, free solution electrophoresis, paper or agar gel electrophoresis, PAGE. Principles and applications of NIR, X ray diffraction analysis in food systems. E sensors, e nose, e tongue – instrumentation, application and working principles. Noninvasive non-destructive methods of analysis- MS- FTIR analysis in food.

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Learning Outcomes

At the end of unit, students will be able to understand the following

1. Radiotracer techniques radioactive counters, solid, gas and liquid scintillation.
2. Measurement of enzyme activity.
3. Principles and applications of NIR, X ray diffraction analysis in food systems.
4. E sensors, e nose, e tongue – instrumentation, application and working principles.
5. Noninvasive non-destructive methods of analysis- MS- FTIR analysis in food

Textbooks

1. Nielsen, S. S. (1989). *Introduction to the chemical analysis of foods* (No. 664.07 Su98c Ej. 1). Chapman & Hall.
2. Mahindru, S. N. (2008). *Food additives: characteristics, detection and estimation* (pp. 4435-36). New Delhi-India:: APH Publishing Corporation.

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1. Egan, H., Cox, H. E., & Pearson, D. (1981). *Pearson's chemical analysis of foods*. Churchill livingstone.
2. Sharma, B. K. (1981). *Instrumental methods of chemical analysis*. Krishna Prakashan Media.

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	SPECIALIZED TRACK – 4	**3**	**1**	**0**	**4**

FOOD LICENSING AND REGISTRATION SYSTEM

Course Objectives

- To understand the present FLRS system, which is a licensing platform to a central food safety compliance regulatory platform.
- To understand advanced integrated application for achieving interoperability with other applications, capable of higher user traffic and potential for future upgrades and functionalities.

Course Outcomes

Students will be able to understand

- The application and make the application process effective and simple to promote ease of doing business amongst the FBOs.
- Minimum physical documentation and to streamline business process flows for FBOs for online application.
- To enable the application to seed business-specific details such as CIN No., PAN No. and GST No. to ensure 360 degrees profiling and validation of FBOs. FoSCoS will also be integrated with the Government of India platforms of GST, PAN, MCA etc. for this purpose.

UNIT I

Introduction: Evolution, need and importance, FSSAI Registration, FSSAI License, License Vs. Registration, requirements and procedures, Exemption from Registration, categories of Registration and Eligibility.

Learning Outcomes

At the end of unit, students will be able to

1. Understand registration and licensing process
2. Understand the categories of registration

UNIT II

Documents required for Registration/License, Registration for small food business, and manufacturing, petty foods, diary units, vegetable oil, Neutraceuticals and Health supplements.

Learning Outcomes

At the end of unit, students will be able to

1. Know the process of Registration for small food business
2. Get the knowledge how proceed registration foe different industries

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UNIT III

Validity of FSSAI registration/ license, state and central license, license fee, food licensing & registration system, decoding of licensing number and each digit description, color codes for food business.

Learning Outcomes

At the end of unit, students will be able to

1. Understand validity of FSSAI registration/ license
2. Gain insights on color codes for food business.

UNIT IV

License for manufacturing, proprietary foods, mid-day meals, E commerce, exporter, importer and license kit. Respond to revertal application, modification of license/registration, renewal of license/registration, transfer of license, consequences of noncompliance and penalties

Learning Outcomes

At the end of unit, students will be able to

1. Get knowledge to usage of license kit
2. Modification of license/registration, renewal of license/registration
3. consequences of noncompliance and penalties

UNIT V

Food Testing Laboratories (Notified & Referral), Sampling, monitoring g, surveillance, sampling plan; attribute, variable, single, multiple and sequential, acceptable quality level and limiting quality; general principles for collection of sample and tools used in sampling

Learning Outcomes

At the end of unit, students will be able to

1. Get knowledge on food testing laboratory
2. Understand the sampling methods and tools

Textbooks

1. Crandall, P. G., & O'Bryan, C. A. (2015). Global food safety initiative: implementation and perspectives. In *Food safety* (pp. 3-8). Academic Press.
2. Havinga, T., & Verbruggen, P. (2017). The Global Food Safety Initiative and state actors: Paving the way for hybrid food safety governance. In *Hybridization of food governance*. Edward Elgar Publishing.

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1. https://foodlicensing.fssai.gov.in/

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FOOD QUALITY AND SAFETY STANDARDS					

Course Objectives

- To develop knowledge of basic food legislations both World and India wide
- To provide in depth insights on FSSAI and its role in country
- To incorporate knowledge on intellectual property rights

Course Outcomes

The students will gain

- Insights on international organizations and their laws
- Knowledge about FSSAI, different mandatory and voluntary standards for foods
- Understanding about intellectual property rights and their significance in food sector

UNIT I

Concepts and Trends in Food Legislation: Evolution of Food Regulations: History of food adulteration and evolution of standards. Food Regulations in India. Need for food laws and regulations, consumer protection. GATT, WTO, TBT, SPS, FAO: Overview of Organizational structure, Objectives and Functions.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on food adulteration and need for regulations
2. Understand basic organizational structure of WTO, FAO and etc

UNIT II

International Standards: ISO-Origin, Members, Governance, Committees, Procedure employed in development and issue of standards. ISO 9000 series, ISO 22000:2005, Comparison of ISO 9001:2008 vs. ISO 22000:2005 Codex Alimentarius: Origin & meaning, Membership, Procedure employed in development and issue of standards, Role of CAC and its committees, Codex guidelines in labelling. Pre-requisites: Role of GMP, GLP, GAP and GHP-implementation and maintenance in the food industry. HACCP- Terminology, Principles, Identification of CCPs, Application of HACCP system and the logic sequence involved.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on structure and regulations of ISO and CODEX
2. Understand the concepts, principles and applications of HACCP in food industries

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UNIT III

Indian Food Laws: Brief Review - PFA Act, FPO, MMPO and MPO. **FSSAI:** Food Safety and Standards Act-2006: Scope; Definitions; Food Safety Standards Rules, Food Safety Standards Regulations, Food Safety & Standards Authority of India – Organizational chart – Committees and Panels, Enforcement of the act, Powers of Food Safety Officer, Responsibilities of Food Business Operator, Food Analyst, Sampling and analysis, Offences and penalties – Adjudication and Food safety appellate tribunal, Food recall procedures, Product Approval, Licensing for food businesses, Packaging and Labelling Regulations. AGMARK: AGMARK Act & Rules: Scope, Definitions, Certification policy & Procedure, laboratory approvals, Action on noncompliance. BIS: Evolution of BIS, Scope, Definitions, Power & Functions of BIS, Licensing procedure, mandatory certification for foods, National Standards Body of India. APEDA, MPEDA, EIC and their role in exports. Legal Metrology Act for Packaged commodities**.**

Learning Outcomes

By the end of the unit students will

1. Gain deep insights about FSSAI and its role in food quality maintenance
2. Gain knowledge about AGMARK, BIS, APEDA, MPEDA and EIC

UNIT IV

Legislation in Europe, USA and rest of the world: EU- Evolution, Treaties, Members-Benefits; Risk Analysis, Farm to Fork management of Food Chain, Introduction to EU General Food law (EC 178/2002), EU Legislations (Meaning and nature of each type of legislation), EFSA, Approval Process for Food Additives; Nutritional Labeling (Claims allowed & requirements), Enforcement of Food Laws. Food legislation in UK: Food Safety Act 1990 (Imports & Exports, Safety, Traceability, Labeling, Product withdrawal & recall), National Control Plan for UK. US Food Regulations: Introduction to Food Regulation in the United States, CFR Title 21, Federal Meat Inspection Act (1906), Federal Food Drug and Cosmetic Act (1938), Fair Packaging and Labeling Act (1966), Food labelling. USFDA, USDA, FSIS-Inspection and Enforcement. Legislations in other countries: Other Regulatory bodies around the world: (FSANZ) Australia and New Zealand, CFIA, KFDA. Differences in food and nutritional labelling around the world.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge about legislations of Europian union and US
2. Understand food laws in other different countries

UNIT V

Intellectual Property & Rights: Concept of Intellectual Property, History and evolution of Intellectual Property Rights (IPR), Benefits, Need to protect IPR, Types of protection of IPR (Patents, Trademark, Industrial design, Trade secret, Copy right, Geographical indication, Industrial design and Traditional Knowledge), Distinction among various forms of IPR. International conventions; IPR laws in India: Various IPR laws currently in force in India. Registration procedures and rights of protection; Infringement and Remedies against infringement; Role of

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India in International IPR scenario.

Learning Outcomes

By the end of the unit students will

1. Gain knowledge on basics of Intellectual Property Rights
2. Understand international and Indian scenarios of IPR

Textbooks

1. Roberts, C. A. (2001). *The food safety information handbook*. Greenwood Publishing Group.
2. Hentges, D. L., Schmidt, R. H., & Rodrick, G. E. (2005). *Food safety handbook*, 425-442. John Wiley and Sons.

References

1. Fortin, N. D. (2016). *Food regulation: law, science, policy, and practice*. John Wiley & Sons

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	SPECIALIZED TRACK – 4	**3**	**1**	**0**	**4**

TRACEABILITY AND RECALL IN FOOD SYSTEM

Course Objectives

- Provide a background and overview of traceability legislation
- Detail the traceability requirements of Regulation 178/2002 for all foods and those for specific foods

Course Outcomes

The students will be able to

- Give details of the requirements for food business operators including supporting management systems
- Outline the role of competent authorities
- Show how product identification and management of information facilitates traceability

UNIT I

Introduction, benefits of traceability, traceability, legislation, international standards, private voluntary standards, external traceability and record keeping, retrieval of traceability information, products of animal origin, sprouts and seeds intended for sprouting, traceability requirements for imported seeds and sprouts

Learning Outcomes

At the end of unit, students will be able to

1. Know the traceability procedures
2. Understand the traceability requirements for foods

UNIT II

Food and feed business operation, traceability in food and feed supply chain, animal product, notification, withdrawal, and recall, competent authority notification, Standards for food business, design and application of traceability

Learning Outcomes

At the end of unit, students will be able to

1. Know the traceability in food and feed supply chain
2. Recall procedures for foods
3. Standards and design and application of traceability

UNIT III

Food Law Guidance for Authorised Officers, food safety and general food law, food incidents and hazards, responsibility of Food Authorities, guidance on the action by the food Authority, responsibility of enforcement officer, food safety and hygiene, general food regulation.

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Learning Outcomes

1. At the end of unit, students will be able to
2. Responsibilities and duties of Authorised Officers
3. General food regulation for Traceability/Recall in Food System

UNIT IV

Product units, identification codes and marks, management, animal Origin, identification mark, official guidance, traceability, International standard ISO 22005, codex Alimentarius Commission, CAC/GL 60-2006, Industry best practices, BRC global standard food safety, campden BRI guideline no. 60

Learning Outcomes

At the end of unit, students will be able to

1. Know the identification codes and marks, for Traceability/Recall in Food System
2. Understand the International standard ISO 22005

UNIT V

Traceability analysis- Restaurant (retailer), online butcher, game handling establishment, hunter, case study; shellfish(oyster), oyster supply chain flow diagram, traceability analysis- shellfish merchant, traceability analysis retailer, sprouted seed business, importer.

Learning Outcomes

At the end of unit, students will be able to

1. Understand the Traceability analysis for the case study of shellfish
2. Understand the Traceability analysis for the case study Retailer
3. Document the traceability analysis for different foods

Textbooks

1. Codex Alimentarius Commission. (2006). Principles for traceability/Product tracing as a tool within a food inspection and certification system. *CAC/GL*, *60*, 1-4.
2. Lem, A. (2014). Market access for seafood in a globalized world. International Institute of Fisheries, Economics and Trade.

References

1. Zhang, J., & Bhatt, T. (2014). A guidance document on the best practices in food traceability. *Comprehensive Reviews in Food Science and Food Safety*, *13*(5), 1074-1103.
2. Smith, D. (2019, April). British Retail Consortium (BRC) Global Standard for Food Safety Issue 8-Requirements for Housekeeping and Hygiene. In *IAFP European Symposium on Food Safety*. IAFP.
3. http://www.mygfsi.com/schemes-certification/benchmarking/gfsi-guidance-document.html
4. International Organization for Standardization. (2007). *Traceability in the Feed and Food Chain: General Principles and Basic Requirements for System Design and Implementation*. International Organization for Standardization. ISO.

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	SPECIALIZED TRACK – 5	**3**	**1**	**0**	**4**
COMPUTER APPLICATIONS IN FOOD PROCESSING					

Course Objectives

- Able to know about "The necessity of Software & their applications in Food Industries"

Course Outcomes

By the end of the course, the students will be able to

- know about the various steps which are related to computer and Software and their application in Food Industries

UNIT I

Introduction, Introduction to computer and related hardware used in food industry (Touch Screens, Hand Held Devices, Palm Tops, Barcode Printers and Scanners, RFID Tags, etc.), Introduction to various software's for their application in food technology (like SAP, just Food ERP, Food Works, SERVE, etc.) with relevant case studies.

Learning Outcomes:

At the end of unit, students will be able to understand the following

1. Various software's for their application in food technology
2. Touch Screens, Hand Held Devices, Palm Tops, Barcode Printers and Scanners, RFID Tags

UNIT II

Application of MS Excel (latest version) to solve the problems of Food, introduction to different menus and commands commonly used in solving problems, Use of Add-In Tools like Mega Stat, etc. for statistical data analysis, Statistical quality control in food processing, Chemical kinetics in food processing.

Learning Outcomes:

At the end of unit, students will be able to understand the following

1. Application of MS Excel to solve the problems of food
2. Statistical data analysis
3. Statistical quality control in food processing

UNIT III

Familiarization with the application of computer in some common food industries, (like milk plant, bakery, fruit and vegetable processing, etc.) starting from the receiving of raw material up to the storage and dispatch of finished product with relevant case studies.

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Learning Outcomes

At the end of unit, students will be able to understand the following

1. Familiarization with the application of computer in milk plant
2. Familiarization with the application of computer in vegetable processing

UNIT IV

Basic Introduction to CAD (Computer Aided Designing), CAM (Computer Aided Manufacturing), CIM (Computer Integrated Manufacturing) and CAE (Computer Aided/ Assisted Engineering) and application of different software's (like AutoCAD, Pro-E, Google Sketch up, etc.) in the same

Learning Outcomes:

At the end of unit, students will be able to understand the following

1. Computer Aided Designing
2. Computer Aided Manufacturing
3. Computer Aided/ Assisted Engineering

UNIT V

Basic Introduction to Application of computers in instrumentation and process control of food industry (PLC, SCADA, etc.), Inventory control and management in food industry using computer.

Learning Outcomes

At the end of unit, students will be able to understand the following

1. Application of computers in instrumentation and process control
2. SCADA in food industry
3. Application of computers in Inventory control and management

Textbooks

1. Singh, R. P. (1996). *Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical, And Process Analysis*. Elsevier.
2. Teixeira, A. A., & Shoemaker, C. F. (2012). *Computerized food processing operations*. Springer Science & Business Media.

References

1. Hubbard, M. R. (2012). *Statistical quality control for the food industry*. Springer Science & Business Media.
2. MS Excel Video Tutorials on http://www.youtube.com
3. MS Excel for Dummies.

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	SPECIALIZED TRACK – 5	**3**	**1**	**0**	**4**

ROBOTICS AND COMPUTER CONTROLLED MACHINES IN FOOD INDUSTRY

Course Objectives

- To introduce the need for robotics and automation in food industry
- Provide an overview of the sensors and gripper mechanisms for food sector.
- Understanding the various applications of automation in food industry.

Course Outcomes

The student will be able to

- Specify the characteristics of robots used in food industry.
- Identify the applications of sensors in food industry.
- Describe about the different types of gripper mechanisms
- Describe the use of sensor networks and quality control in food sector
- Discuss about the advanced methods for control of food process.
- Summarize the applications of automation and robotics in food industry.

UNIT I

Introduction Process Control Systems and Structure in the Food Industry, Process Control Methods, Robotics in the food industry, Automation, Specification for a food sector robot, future trends.

Learning Outcomes

At the end of unit, students will be able to

1. Understand process control systems and structure in the food industry
2. Know the importance of Robotics in the food industry

UNIT II

Sensors and Automation Sensors for automated food process control, Special Considerations, Measurement Methods, Device Integration, Applications - Machine Vision- Optical Sensors, SCADA in food industry.

Learning Outcomes

At the end of unit, students will be able to

1. Know the different sensors used in food process control
2. Understands SCADA in food industry and applications

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UNIT III

Gripper Technology Gripper Challenges in food industry, Gripping Physics, Pinching and enclosing grippers, Penetrating Grippers, Suction Grippers, Surface Effect Grippers –Selection of appropriate gripping mechanism.

Learning Outcomes

At the end of unit, students will be able to

1. Know the Gripper Challenges in food industry
2. Understand the different grippers, its working application in food industry
3. Select the grippers for food processing and monitoring

UNIT IV

Sensor Networks and Intelligent Quality Control Systems Wireless sensor networks, applications in agriculture and food production, future trends, intelligent control systems using fuzzy logic.

Learning Outcomes

At the end of unit, students will be able to

1. Know the wireless sensor network and intelligent control systems
2. Understand the application of sensors in food industry

UNIT V

Advanced Methods for control of food processes Introduction, Case Study of Bio conversion in a batch fed reactor, Design of PID Controller for fed batch process, Real time optimization. Case Study, Bulk sorting, Food chilling and processing, meat processing, poultry industry –sea food processing, confectionary

Learning Outcomes

At the end of unit, students will be able to

1. Design PID controller in food industry
2. Get application knowledge of robotics in food industry

Textbooks

1. Iqbal, J., Khan, Z. H., & Khalid, A. (2017). Prospects of robotics in food industry. *Food Science and Technology*, *37*, 159-165.
2. Ilyukhin, S. V., Haley, T. A., & Singh, R. K. (2001). A survey of automation practices in the food industry. *Food control*, *12*(5), 285-296.
3. Gunasekaran, S. (2009). Automation of food processing. *Food Engineering. EOLSS Publishers/UNESCO, Oxford*, 102-122.

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1. Piramuthu, S., & Zhou, W. (2016). *RFID and sensor network automation in the food industry: Ensuring quality and safety through supply chain visibility*. John Wiley & Sons.
2. Luo, Z. (Ed.). (2015). *Robotics, automation, and control in industrial and service settings*. IGI Global.
3. Love, J. (2007). *Process automation handbook: a guide to theory and practice* (Vol. 42). Newcastle: Springer.

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	SPECIALIZED TRACK - 5	**3**	**1**	**0**	**4**
COMPUTATION IN FOOD INDUSTRY					

Course Objectives

- To familiarize students with various computation processes, models that are employed in food industries.

Course Outcomes

Students will be able to understand

- Understand Modeling strategies, Static and dynamic modeling
- Classification for food odor pattern recognition
- Ultrasonic signal acquisition of grading foods
- Quality evaluation based on linear statistic

UNIT I

Introduction: Food quality, automated evaluation of food quality, food quality quantization and process control, typical problems in food quality evaluation e.g., beef quality evaluation; food odor measurement, continuous snack food frying quality.

Learning Outcomes

At the end of unit, students will be able to

1. Automated evaluation of food quality
2. Quality quantization of snack food industry

UNIT II

Data acquisition: Sampling elaboration with examples, concepts and systems for data acquisition such as: ultrasonic signal acquisition for beef grading, electronic nose data acquisition for food odor measurement, snack food frying data acquisition for quality process control, Image acquisition: elaboration with examples.

Learning Outcomes

At the end of unit, students will be able to

1. Know Image acquisition of snack and frying food
2. Know Ultrasonic signal acquisition for beef grading
3. Know Electronic nose data acquisition

UNIT III

Data analysis: Data preprocessing, Static data analysis, Dynamic data analysis, Image processing: Image segmentation, Image feature extraction etc. Modeling: Modeling strategies: Theoretical and empirical modeling, Static and dynamic modeling, Linear statistical modeling, ANN modeling etc.

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Learning Outcomes

At the end of unit, students will be able to

1. Understand Modeling strategies
2. Understand Static and dynamic modeling

UNIT IV

Prediction: Prediction and classification, Sample classification for beef grading, examples such as, based on linear statistical and ANN models, electronic nose data classification for food odor pattern recognition, Snack food classification for eating quality evaluation based on linear statistical and ANN models, One-step-ahead prediction

Learning Outcomes

At the end of unit, students will be able to

1. Understand linear statistical and ANN models
2. Know quality evaluation based on linear statistics

UNIT V

Control: Process control, Internal model control, Predictive control, Neuro-fuzzy PDC for snack food frying process, Systems integration: Food quality quantization systems integration, Food quality process control systems integration, Food quality quantization and process control systems development

Learning Outcomes

At the end of unit, students will be able to

1. Understand Food quality quantization and control
2. Predictive control, Neuro-fuzzy PDC for snack food frying process

Textbooks

1. Doebelin, E. O., & Manik, D. N. (2007). *Measurement systems: application and design*. Mc Graw Hill Education.
2. Golnaraghi, F., & Kuo, B. (2017). *Automatic control systems*. McGraw-Hill Education.

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1. Huang, Y., Whittaker, A. D., & Lacey, R. E. (2001). *Automation for food engineering: food quality quantization and process control*. CRC Press.
2. Bhuyan, M. (2006). *Measurement and control in food processing*. CRC Press.
3. Zude, M. (2008). *Optical monitoring of fresh and processed agricultural crops*. CRC press.

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	SPECIALIZED TRACK - 5	**3**	**1**	**0**	**4**
IT IN FOOD PROCESSING					

Course Objectives

- To learn about a few applications of the Internet of Things
- To distinguish between motionless and motion detectors as IoT applications
- To know about Micro Electro Mechanical Systems (MEMS) fundamentals in the design and fabrication process
- To understand about applications of IoT in smart grid
- To introduce the new concept of the Internet of Energy for various applications

Course Outcomes

On completion of the course, the student would be able to

- To get exposed to recent trends in few applications of IoT
- To understand about the usage of various types of motionless sensors
- To understand about the usage of various types of motion detectors
- To get exposed to various applications of IoT in the smart grid
- To get exposed to a future working environment with Energy internet

UNIT I

Sensors- Definitions, Terminology, Classification, Temperature sensors, Thermo-resistive, Resistance, temperature detectors, Silicon resistive thermistors, Semiconductor, Piezoelectric, Humidity and moisture sensors. Capacitive, Electrical conductivity, Thermal conductivity, time-domain reflectometer, Pressure and Force sensors: Piezoresistive, Capacitive, force, strain and tactile sensors, Strain gauge, Piezoelectric

Learning Outcomes

After completing this unit, students will be able to

1. To know about basic principles of sensors and their classification
2. To learn about various motion fewer sensors
3. To understand Piezoelectric sensor applications to detect temperature, pressure etc. & Capacitive sensors to detect temperature, force, and pressure, etc.
4. To know about concepts of tactile sensors, for a few applications

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UNIT II

Occupancy And Motion Detectors: Capacitive occupancy, Inductive and magnetic, potentiometric - Position, displacement, and level sensors, Potentiometric, Capacitive, Inductive, magnetic velocity and acceleration sensors, Capacitive, Piezoresistive, piezoelectric cables, Flow sensors, Electromagnetic, Acoustic sensors - Resistive microphones, Piezoelectric, Photoresistors.

Learning Outcomes

After completing this unit, students will be able to

1. To know about Capacitive occupancy & Motion detectors
2. To distinguish between Potentiometric, inductive and capacitive sensors for a few applications
3. To learn about a few Velocities and acceleration sensors & various flow sensor.

UNIT III

MEMS: Basic concepts of MEMS design, Beam/diaphragm mechanics, electrostatic actuation and fabrication, Process design of MEMS-based sensors and actuators, Touch sensor, Pressure sensor, RF MEMS switches, Electric and Magnetic field sensors

Learning Outcomes

After completing this unit, students will be able to

1. To understand the basic concept of MEMS
2. To know about electrostatic actuation & process design of MEMS-based sensors
3. To learn about the process design of MEMS-based actuators

UNIT IV

Artificial Intelligence: Introduction, Meaning of artificial intelligence and machine learning, Identify relevant data, Use of AI in the food industry, Innovation of food recipe & cloud kitchens, Efficient food delivery service, Challenges of AI in the food industry.

Learning Outcomes

After completing this unit, students will be able to

1. To get exposure Meaning of artificial intelligence and machine learning
2. To learn about the Use of AI in the food industry
3. To learn about the Challenges of AI in the food industry.
4. To learn about driving factors of IoT in the Distribution level

UNIT V

Machine Learning: General Overview of Ml and Dl Applications in Agriculture & Food Processing, Basics of Multivariate Data Analytics, Principal Component Analysis and Regression Applications in Agriculture & Food Processing, Applications of Classification and Clustering Methods in Agriculture and Food Processing.

Dr K. V. S. G. Murali Krishna **Chairperson (i/c)**	**Dr P Srinivasa Rao** **Member**	**Dr. N. N. Mishra** **Member**	**Dr. K. S. M. S. Raghava Rao** **Member**	**Dr. S. Kaleemullah** **Member**
Dr. Ramachandra Pradhan **Member**	**Dr. Jathindra K Sahu** **Member**	**Er. K. Sri Varsha** **Member**	**Shri. P. Ramakrishna** **Member-Convener**	**Mr. Jaddu Samuel** **Invitee**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

SCHOOL OF FOOD TECHNOLOGY

B. Tech-FOOD ENGINEERING

Learning Outcomes

After completing this Unit, students will be able to

1. To get exposed the General Overview of Ml and Dl Applications in Agriculture & Food Processing
2. To learn about the Principal Component Analysis and Regression Applications in Agriculture & Food Processing.
3. To know about Applications of Classification and Clustering Methods in Agriculture and Food Processing to learn about information sensing and processing issues

Textbooks

1. Wilson, J. S. (2004). *Sensor technology handbook*. Elsevier.
2. Tai-Ran, H. (2016). *MEMS and Microsystems design and manufacture*. Mc Graw Hill Education.

References

1. Buyya, R., & Dastjerdi, A. V. (Eds.). (2016). *Internet of Things: Principles and paradigms*. Elsevier.
2. Luo, P., Peng, D., Wang, Y., & Zheng, X. (2018, October). Review of solar energy harvesting for IoT applications. In *2018 IEEE Asia Pacific Conference on Circuits and Systems (APCCAS)* (pp. 512-515). IEEE.
3. Misra, N. N., Dixit, Y., Al-Mallahi, A., Bhullar, M. S., Upadhyay, R., & Martynenko, A. (2020). *IoT, big data and artificial intelligence in agriculture and food industry*. IEEE Internet of Things Journal. IEE

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MOOC COURSE

1. ONLINE PLATFORM- SWAYAM

S. No	COURSE NAME	DURATION	FACULTY	ORGANIZATION
1	Food Laws and Standards	16 Weeks	Dr. Mita Sinhamahapatra	Indira Gandhi National Open University
2	Technology of Fermented Cheese, Ice Cream by Products	16 Weeks	Prof. M.K. Salooja	Indira Gandhi National Open University
3	Functional Foods and Neutraceuticals	15 Weeks	Dr. Rocha Sharma	Rashtrasant Tukadoji Maharaj University, Nagpur
4	Food Microbiology and Food Safety	15 Weeks	Dr. Tejpai Dhewa	Central University of Haryana
5	Food Microbiology	12 Weeks	Dr. Niranjan Raj S	Karnataka State Open University, Mukthagangotri
6	Food Preservation Technology	12 Weeks	Dr. Girish K	Maharani's Science College for Women, Mysuru
7	Introduction of Poultry Farming	12 Weeks	Dr. P. Vijayakumar	Indira Gandhi National Open University
8	Food and Nutrition	12 Weeks	Dr. Asna Urooj	Department of Studies in Food Science and Nutrition, University of Mysore
9	Food Chemistry	12 Weeks	Dr. Chandra Nayaka, S	Department of Studies in Biotechnology, University of Mysore
10	Food Safety and Quality Control	8 Weeks	Dr. Vijaya Lakshmi	The English and Foreign Languages University

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Invitee

2. ONLINE PLATFORM- NPTEL

S.NO	COURSE NAME	DURATION	FACULTY	ORGANIZATION
1	Novel Technologies for Food Processing and Shelf-Life Extension	12 Weeks	Prof. Hari Niwas Mishra	IIT, Kharagpur
2	Thermal Processing of Foods	12 Weeks	Prof. Anandalakshmi	IIT Guwahati
3	Thermal Operations in Food Process Engineering: Theory and Applications	12 weeks	Prof Tridib Kumar Goswami	IIT, Kharagpur
4	Introduction to Industry 4.0 and Industrial Internet of Things, IIT Kharagpur	12 Weeks	Prof. Sudip Misra	IIT, Kharagpur
5	Instrumentation and Process Control	8 Weeks	Prof. Ashis Kumar Datta	IIT Kharagpur
6	Conductive and convection Heat Transfer	12 Weeks	Prof. Suman Chakraborty and Sankar Kumar	IIT Kharagpur
7	Fundamentals of Food Process Engineering	12 Weeks	Prof. Jayeeta Mitra	IIT Kharagpur
8	Food Engineering	12 Weeks	Dr. Shishir Sinha	IIT Roorkee

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3. ONLINE PLATFORM– EDX

S.NO	COURSE NAME	DURATION	FACULTY	ORGANIZATION
1	The Basics of Transport Phenomena	7 weeks	Robert Mudde, Peter Hamersma, Bijoy Bera	Delft University of Technology, The Netherlands
2	Advanced Transport Phenomena	6 weeks	Robert Mudde, Peter Hamersma, Bijoy Bera	Delft University of Technology, The Netherlands
3	Food Fermentation: The Science of Cooking with Microbes	14 weeks	Pia Sorensen, Roberto Kolter	Harvard University, USA
4	Nutrition and Health: Human Microbiome	6 weeks	Clara Belzer	Wageningen University & Research, Netherlands
5	Nutrition and Health: Food Safety	8 weeks	Ivonne Rietjens, Marcel Zwitering et al.	Wageningen University & Research, Netherlands
6	The Science of Beer	6 weeks	Sander Breevart, Florence Scherer, Nico van der Veen	Wageningen University & Research, Netherlands
7	Plant-Based Diets: Food for a Sustainable Future	7 weeks	Eva Everloo, Ella Stephens	Wageningen University & Research,Netherlands
8	Industrial Biotechnology	7 weeks	Isabel Arends, Sef Heijnen.	TU Delft, The Netherlands
9	Entrepreneurship for Engineers	8 weeks	Rainer Harms, Dap Hartmann, Thomas Lans	University of Twente + TU Delft + Wageningen University & Research
10	Big Data for Agri-Food: Principles and Tools	6 weeks	Ioannis Athanasiadis, Sjoukje Osinga.	Wageningen University & Research,Netherlands
12	Introduction to Computer Science and Programming Using Python	9 weeks	Jon Guttag, Eric Grimson, Ana Bell	MIT, USA

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4. ONLINE PLATFORM – COURSERA

S.NO	COURSE NAME	DURATION	FACULTY	ORGANIZATION
1	Introduction to Programming with MATLAB	35 hours	Akos Ledeczi, Mike Fitzpatrick	Vanderbilt University, USA
2	Mastering Programming with MATLAB	56 hours	Akos Ledeczi, Mike Fitzpatrick	Vanderbilt University, USA
3	Machine Learning	61 hours	Andrew Ng	Stanford University, USA
4	Introduction to Python Programming	28 hours	Brandon Krakowsky	University of Pennsylvania
5	Industrial Biotechnology	11 hours	Nicholas Turner, Nigel Scrutton, Nick Weise	Manchester University

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