

II  
YEAR

**B.Tech.**

# FOOD TECHNOLOGY

<b>I SEMESTER</b>	▶ 16CH102 - Materials Science and Technology
	▶ 16CS202 - Data Structures
	▶ 16EL102 - Soft Skill Laboratory
	▶ 16FT201 - Food Chemistry
	▶ 16FT202 - Food Microbiology
	▶ 16FT203 - Thermodynamics and Heat Engines
	▶ 16FT204 - Fundamentals of Fluid Mechanics

<b>II SEMESTER</b>	▶ 16EL103 - Professional Communications Laboratory
	▶ 16HS202 - Probability and Statistics
	▶ 16FT205 - Principles of Food Preservation
	▶ 16FT206 - Fundamentals of Heat and Mass Transfer
	▶ 16FT207 - Unit Operations
	▶ - Department Elective
	▶ - Department / Open Elective
	▶ - Employability and Life Skills Elective

**COURSE CONTENTS**

I SEM & II SEM



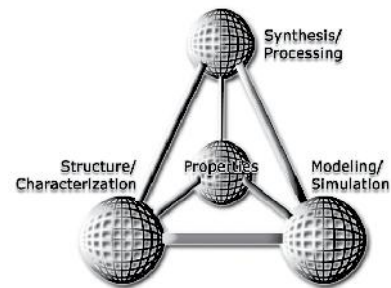
# 16CH102 MATERIALS SCIENCE AND TECHNOLOGY

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	15	-	8	60	-	10	-	-



## Course Description and Objectives:

This course will emphasize the structure-property relationships of engineering materials. The objective of this course is to provide knowledge in basic principles of material science and also to study structure of materials at all length scales.

## Course Outcomes:

The student will be able to:

- understand crystal structure of various materials and techniques used for structure determination.
- understand the influence of defects on the properties of materials.
- understand the fundamentals of equilibrium phase diagrams.
- gain knowledge on various fabrication techniques used for manufacturing common engineering materials.

## SKILLS:

- ✓ *Identify the type of material: ceramic, polymer, metal or composite.*
- ✓ *Select materials with suitable properties for a given application.*
- ✓ *Predict the type of fracture/failure in a material.*
- ✓ *Read and draw conclusion from binary phase diagrams.*
- ✓ *Suggest manufacturing methods for metals, ceramics and polymeric materials.*
- ✓ *Determine basic mechanical properties of materials using universal testing machine.*

**ACTIVITIES:**

- *Testing the type of failures.*
- *“Gee Whiz”:  
Wonder presentations.*
- *Analysis of load test results.*
- *Study of micro structures of materials.*
- *Segregation of the given materials.*
- *Identification of phases in the given phase diagram.*

**UNIT - I****L-9, T-3**

**BONDING IN SOLIDS** : Inter atomic forces and potential energy, Types of bonds: Primary and secondary, Variation in bonding character and resulting properties.

**CRYSTAL STRUCTURE** : Classification of crystal systems–SC, BCC, FCC & HCP crystal structures with examples, Atomic packing factor, Coordination number, Determination of miller indices of planes and directions of cubic and hexagonal crystals, Linear and planar densities, Separation between successive planes, Crystal structure determination: Bragg law, Powder method.

**UNIT - 2****L-10, T-3**

**CRYSTAL DEFECTS** : Point defects, Dislocations: Edge, Screw and mixed, Burgers vectors, Energy of dislocation, Motion of dislocation, Dislocation density. Grain boundary, Stacking faults and twin boundary.

**PHASE DIAGRAMS** : Gibb's phase rule and terms involved–Reduced phase rule, Tie line and lever rules, Two component systems–invariant reactions–Eutectic system and Iron-Carbon system.

**UNIT - 3****L-9, T-3**

**MATERIALS FABRICATION TECHNIQUES** : Fabrication of Metals: Forming operations, Casting, Fabrication of Ceramics: Particulate forming processes, Cementation. Forming techniques of Plastics: Compression, Transfer and injection molding, Extrusion, Blow molding.

**MECHANICAL PROPERTIES** : Stress-Strain relations of various solids–Elastic, Anelastic, Visco-elastic and plastic deformations in solids, Creep and fatigue, Fracture: Brittle and Ductile, Fracture toughness, Ductile to brittle transitions.

**UNIT - 4****L-8, T-3**

**ELECTRICAL & SEMICONDUCTING PROPERTIES** : Ohm's Law, Electrical conductivity, Electronic and Ionic conduction, Energy band structures in Solids, Classification of solids based on band models, Electron mobility, Electrical resistivity of metals, Intrinsic semiconduction, Extrinsic Semiconduction, The temperature dependence of carrier concentration, Factors that affect carrier mobility.

**UNIT - 5****L-8, T-3**

**DIELECTRIC AND MAGNETIC PROPERTIES** : Dielectric behavior, Capacitance, Polarization, Frequency Dependence of dielectric constant, Dielectric strength. Types of magnetism, Ferromagnetism-Domain theory-hysteresis behavior, Ferrimagnetism, Soft and hard magnets–application of magnetic materials.

**TEXT BOOKS:**

1. W. D. Callister, "Materials Science and Engineering: An Introduction," 8<sup>th</sup> edition, John Wiley & Sons Inc, 2009.
2. V. Raghavan, "Materials Science and Engineering: A First Course", 5<sup>th</sup> edition, Prentice Hall of India Learning Pvt. Ltd., 2013.

**REFERENCE BOOKS:**

1. L. H. VanVlack, Elements of Materials Science and Engineering, 6<sup>th</sup> edition, Addison Wesley, 1989.
2. W. F. Smith and J. Hashemi, "Foundations of Materials Science and Engineering", 4<sup>th</sup> edition, McGraw-Hill, 2005.
3. N. W. Dowling, "Mechanical Behavior of Materials", 3<sup>rd</sup> edition, Prentice Hall of India, 2006.
4. J. F. Shackelford, Introduction to Materials Science for Engineers, 6<sup>th</sup> edition, Prentice Hall of India, 2004.
5. P. Haasen and B. L. Mordike, Physical Metallurgy, 3<sup>rd</sup> edition, Cambridge University Press, 1996.

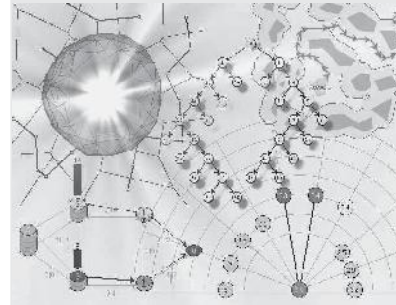
# 16CS202 DATA STRUCTURES

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	-	30	5	40	-	8	5	-



## Course Description and Objectives:

This course will emphasize the structure-property relationships of engineering materials. The objective of this course is to provide knowledge in basic principles of material science and also to study structure of materials at all length scales.

## Course Outcomes:

The student will be able to:

- apply advanced C programming techniques such as pointers, dynamic memory allocation, structures to develop solutions for particular problems.
- analyze characteristics of various data structures.
- differentiate between Graphs and Trees.
- understand the importance of sorting and applying it wherever useful.
- understand the usefulness of data structures in solving problems.

## SKILLS:

- ✓ *Identify the required data structures for various applications.*
- ✓ *Identify the sorting algorithm suitable for a given scenario.*
- ✓ *Implement array or linked list for a given problem.*
- ✓ *Analyse Pros & Cons of each of the data structure.*
- ✓ *Usage of trees and graphs.*

**ACTIVITIES:**

- *Design and implement a school management system.*
- *Design and implement a social networking site.*
- *Implement a project to find out the most common words in the articles.*
- *Design and implement a library book management system.*
- *Design and implement a cric buzz application.*

**UNIT - 1****L-9**

**SORTING AND SEARCHING:** Introduction - Data, Data type, Data structure, Primitive and Non-primitive - Data type, Data structure; Storage structures - Sequential and linked storage representations; Applications of structures, Hashing.

**SORTING:** Selection sort, Bubble sort, Insertion sort, Quick sort, Merge sort.

**SEARCHING:** Binary search and linear search.

**UNIT - 2****L-9**

**LINKED LISTS:** Introduction, Types of linked list - Singly linked list, Doubly linked list, Circular linked List; Operations - Insertion, Deletion, Traverse forward/reverse order; Multi lists, Applications of linked lists.

**UNIT - 3****L-9**

**STACKS AND QUEUES:** Stacks - Introduction, Array and linked representations, Implementation and their applications; Queues - Introduction, Array and linked representations, Implementation and their applications, Types - Linear, Circular and doubly ended queues; Applications.

**UNIT - 4****L-9**

**TREES:** Introduction, Properties, Binary Tree - Introduction, Properties, Array and linked representations; Tree traversals and their Implementation, Expression trees, BST definition and implementation; AVL Trees - Definition and implementation.

**UNIT - 5****L-9**

**GRAPHS:** Introduction, Properties, Modeling problems as graphs representations - Adjacency matrix, Adjacency list; Traversals - Breath first search and depth first search; Application of graphs.

**LABORATORY EXPERIMENTS****Course Outcomes:**

The student will be able to:

- understand the importance of structure, abstract data type and their basic usability in different applications through different programming languages.
- understand the linked implementation and its uses both in linear and non-linear data structure.
- understand various data structures such as stacks, queues, trees, graphs, etc. to solve various computing problems.
- decide a suitable data structure to solve a real world problem.

**LIST OF EXPERIMENTS** Total hours-30

1. Selection, Bubble, Insertion, Quick and Merge sorting algorithms.
2. Linear and Binary search algorithms.
3. Single linked list, doubly linked list, and circular linked list.
4. Stack using an array and linked list.
5. Queue using an array and linked list.
6. Tree using an array and linked list.
7. Check if given expression is fully parenthesis or not using stack.

8. Tree traversing techniques.
9. BST using an array and linked list.
10. Graph traversal techniques.

**TEXT BOOK:**

1. ReemaThareja, "Data Structures Using C", 2<sup>nd</sup> edition, Oxford University Press, 2014.

**REFERENCE BOOKS :**

1. F. G. Richard and A. B. Forouzan, "Data Structures: A Pseudocode Approach with C", 2<sup>nd</sup> edition, Cengage Learning, 2004.
2. Jean Paul Tremblay and Paul G. Sorenson, "An Introduction to Data Structures with Applications", 2<sup>nd</sup> edition, Tata Mc-Graw Hill, 2004.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2<sup>nd</sup> edition, Pearson Education, 2006.

## 16EL102 SOFT SKILLS LABORATORY

Hours Per Week :

L	T	P	C
-	-	2	1

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
-	-	30	-	-	-	-	-	-

### Course Description and Objectives:

The Soft Skills Laboratory course is aimed at training undergraduate students on employability skills. Designed to impart work related skills, the course will enable trainees to develop interpersonal communication, leadership, preparing resumé, group discussion and interview skills. It will give them the required competence and confidence to handle professional tasks.

### Course Outcomes:

The student will be able to :

- think critically on issues for informed decision making and know how to communicate effectively through choice of appropriate language and speech, while dealing with others at the workplace.
- identify and introspect on individual strengths and weaknesses.
- improve levels of self-awareness and self-worth for greater efficacy at workplace.

### SKILLS:

- ✓ *Communicate and understand the difference between soft skills and hard skills.*
- ✓ *Professionalism and employability skills.*
- ✓ *Plan career by drawing their SWOT, setting the goal, learn the importance of time and stress management.*
- ✓ *Vocabulary, situational english, group discussion, reading comprehension and listening comprehension which are essential for all competitive examinations.*
- ✓ *Prepare resumé and learn how to face interview.*
- ✓ *Gender sensitive language, good manners, emotional intelligence and essential skills.*



**UNIT - 1****P-8**

**A) COMMUNICATION:** Need for effective communication - The process of communication, Levels of communication, Flow of communication, Choice of diction and style with reference to setting (formal, semi-formal or informal); Communication networks, Barriers to communication, Miscommunication, Noise and ways to overcome the barriers.

**B) SOFT SKILLS:** Difference between soft and hard skills, Need for soft skills, Professionalism, Employability skills.

**C) CAREER PLANNING:** Job vs career, Goal setting, SWOT analysis, Planning and prioritization, Four quadrant time management system, Self-management, Stress-management.

**ACTIVITY:** Johari Window for SWOT analysis, Setting a SMART goal using the provided grid, Writing a statement of purpose (SOP).

**UNIT - 2****P-8**

**A) VOCABULARY BUILDING:** Word etymology, Roots, Prefixes and suffixes, Synonyms and antonyms, Collocations, One-word substitutes, Analogies, Idioms and phrases, Contextual guessing of unfamiliar words, Task-oriented learning (50 words).

**ACTIVITY:** Making a flash card (one per day by each student), Vocabulary exercises with hand-outs, Vocabulary quiz (evaluation will be a combination of the 50 words provided by the instructor and the flash cards made by the student (one per day)).

**B) FUNCTIONAL ENGLISH:** Situational dialogues, Role plays (including small talk), Self introduction, Opening and closing a telephonic conversation, Making an appointment, Making a query, Offering/Passing on information, Communicating with superiors, Expressing agreement/objection, Opening bank account (combination of prepared and impromptu situations given to each student).

**C) GROUP DISCUSSION:** Articulation and flow of oral presentation, Dynamics of group discussion, Intervention, Summarizing and conclusion, Voice modulation, Content generation, Key word approach (KWA), Social, Political, Economic, Legal and technical approach (SPELT), View point of affected part (VAP), Language relevance, Fluency and coherence.

**ACTIVITY:** Viewing a recorded video of GD and Mock sessions on different types of GD topics - Controversial, Knowledge, Case study (including topics on current affairs).

**UNIT - 3****P-4**

**A) RESUME-WRITING:** Structure and presentation, Defining career objective, Projecting one's strengths and skill-sets, Summarizing, Formats and styles and covering letter.

**ACTIVITY:** Appraising some samples of good and bad resumes, Preparing the resume, Writing an effective covering letter.

**B) FACING INTERVIEWS:** Interview process, Understanding employer expectations, Pre-interview planning, Opening strategies, Impressive self-introduction, Answering strategies, Other critical aspects such as body language, Grooming, Other types of interviews such as stress-based interviews, Tele-interviews, Video interviews, Frequently asked questions (FAQs) including behavioural and HR questions and the aspect looked at by corporate during interviews.

**ACTIVITY:** Writing responses and practicing through role plays and mock interviews on the FAQs including feedback.

**UNIT - 4****P-4**

**A) READING COMPREHENSION:** Reading as a skill, Techniques for speed reading, Understanding the tone, Skimming and scanning, Appreciating stylistics, Impediments for speed reading, Eye fixation, Sub-vocalization, Critical reading, Reading based on purpose, Reading for information, Reading for inference.

**ACTIVITIES:**

- *Formal and informal communication.*
- *SWOT analysis.*
- *Stephen Covey Time Management matrix.*
- *Stress Management techniques.*
- *Vocabulary flash cards.*
- *Situational Dialogues.*
- *Group Discussion.*
- *Resume preparation.*
- *Mock Interview.*
- *Reading comprehension activities.*
- *Listening comprehension Activity by watching the American accent video.*
- *Emotional intelligence, etiquette quiz.*

**ACTIVITY:** Reading comprehension exercises with texts drawn from diverse subject areas (Hand-outs), Newspaper activity with students divided into 4 groups, Each group looks at critical component of communication such as Listening, Speaking, Reading and writing enabling them to be better communicators as well as be more aware about the current affairs, Which help in group discussion.

**B) LISTENING COMPREHENSION:** Listening as a skill, Different types of listening, Active and passive listening, Top-down approach, Bottom-up approach, Understanding the non verbal cues of communication, Intonation and stress.

**ACTIVITY:** Narration of a story, Speech excerpts with different accents (Indian, British, American), listening comprehension exercises with audio and video excerpts.

## UNIT - 5

**P-6**

**IMPACT OF LANGUAGE ON PERSONALITY:** Gender sensitive language in MNCs, Cultural sensitivity, Social awareness, Emotional intelligence, Good manners, Self-grooming, Positive body language, Accepting and handling responsibility, Assertiveness, Problem solving, Negotiating skills, Networking and creating a good first impression, Seven essential skills for a team player, Attentive listening, Intelligent questioning, Gently persuading, Respecting other's views, Assisting others, Sharing, Participating actively.

**ACTIVITY:** Johari Window, Games and case studies.

### REFERENCE BOOKS:

1. Edward Holffman, "Ace the Corporate Personality", McGraw Hill, 2001.
2. Adrian Furnham, "Personality and Intelligence at Work", Psychology Press, 2008.
3. John Adair Kegan Page, "Leadership for Innovation", 1<sup>st</sup> edition, Kogan, 2007.
4. M.Ashraf Rizvi, "Effective Technical Communication", 1<sup>st</sup> edition, Tata McGraw Hill, 2005.
5. Krishna Mohan and NP Singh, "Speaking English Effectively", 1<sup>st</sup> edition, Macmillan, 2008.
6. Soft Skills Material of Infosys Under the Academic Initiative of Campus Connect.
7. Dr. S.P. Dhanvel, "English and Soft Skills", Orient Blackswan, 2011.
8. Rajiv K. Mishra, "Personality Development", Rupa and Co, 2004.

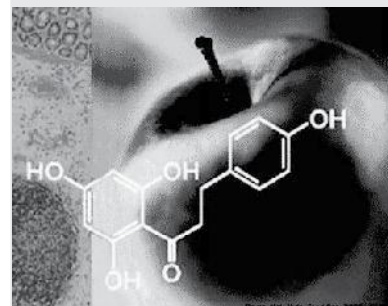
# 16FT201 FOOD CHEMISTRY

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	-	30	5	50	-	-	10	5



## Course Description and Objectives:

This course deals with the chemical composition and properties of food nutrients and their physical, chemical, nutritional and functional changes during handling, processing, storage and utilization. The objective of this course is to impart knowledge on innate properties of food molecules and their interactions with other food constituents and also to empower the students with analytical techniques for identification and quantification of various biomolecules present in food.

## Course Outcomes:

The student will be able to:

- understand the relationship between the chemical composition of food and food quality.
- elucidate why certain ingredients are used in food and major chemical reactions that limit shelf life of foods.
- explicate the rationale for certain food processes.

## SKILLS:

- ✓ *Perform analytical techniques associated with food using basic analytical instrumentation.*
- ✓ *Critically analyze the chemical information, synthesize the information and validate it.*
- ✓ *Select appropriate analytical technique when presented with a practical problem.*

**ACTIVITIES:**

- *Checking efficacy of various solvents for edible oil extraction.*
- *Shelf life prediction of food products.*
- *Estimation of enzymatic reactions using Michaelis-Menten Equation.*

**UNIT - 1****L-9**

**WATER AND ITS INFLUENCE** : Structure, Water in foods and its properties, Liquid water and Ice, Interactions with food components, Water binding capacity and its determination, Water activity and its role in enhancing shelf life in foods.

**UNIT - 2****L-9**

**CARBOHYDRATES**: Classification, Physical, Chemical, Nutritional and Functional properties, Browning reactions, Caramelization, Gel formation, starch retro-gradation.

**UNIT - 3****L-9**

**PROTEIN**: Classification, Physical, chemical, nutritional, and functional properties, major food proteins and their sources, Changes in proteins during processing, Determination of proteins in foods.

**UNIT - 4****L-9**

**LIPIDS**: Classification, Physical, Chemical, Nutritional and functional properties, Edible oil refining, Technology of edible fats and oils processing: Fat hydrolysis, Interesterification, Hydrogenation, Shortenings and Spreads, Emulsions: properties and types.

**UNIT - 5****L-9**

**VITAMINS AND MINERALS**: Sources, Functions, Deficiency diseases, Requirements and recommended dietary allowances of vitamins, Changes during processing.

**PIGMENTS**: Introduction, Chlorophyll, Carotenoids, Flavonoid, Phenols, Betalains, Anthocyanins.

**LABORATORY EXPERIMENTS****LIST OF EXPERIMENTS**

Total hours: 30

1. Qualitative test for all carbohydrates - Solubility, Molisch, Anthrone, Iodine test.
2. Qualitative test for Pentoses, reducing sugars, (Bials, Fehlings, Benedicts, Barfoeds test)
3. Qualitative test for Glucose, Fructose, Sucrose (Osazone, Acid hydrolysis, Selewanooffs.)
4. Quantitative test for all Amino acids, aromatic amino acids, Sulphur containing amino acids. (Ninhydrin, Xanthoproteic, Nitro Prusside test).
5. Quantitative tests for peptide bonds and proteins (Biuret test & Folin - Lowry test).
6. Separation of amino acids by Paper chromatography.
7. Separation of lipids by thin layer chromatography.
8. Estimation of Viscosity and refractive index of foods.
9. Determination of free fatty acid content in fats and oils.
10. Estimation of chlorophyll and carotenoids in foods.

**TEXTBOOKS:**

1. H. D. Belitz, W. Grosch and P. Schieberle, "Food Chemistry", 4<sup>th</sup> edition, Springer, 2009.
2. O. R. Fennema, S. Damodaran and K. L. Parkin "Fennema's Food Chemistry", 4<sup>th</sup> edition, CRC press, 2007.

**REFERENCE BOOKS:**

1. M. Swaminathan, "Essentials of Food and Nutrition", 1<sup>st</sup> edition, Ganesh & Co, 1974.
2. L. H. Meyer, "Food Chemistry", 3<sup>rd</sup> edition, Reinhold Pub. Corp, 1960.
3. S. Ranganna, "Handbook of Analysis and Quality Control for Fruit and Vegetable Product", 2<sup>nd</sup> edition, Tata McGraw-Hill Education, 1986.

# 16FT202 FOOD MICROBIOLOGY

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	-	30	15	45	-	-	5	5



## Course Description and Objectives:

This course deals with basics of food microbiology, preservation and spoilage of various food products. The objective of this course is to enable students to apply identification and enumeration techniques of microbes found in food products.

## Course Outcomes:

The student will be able to:

- understand the characteristics, morphology and classification of food borne microorganisms.
- understand microbiology of food products.
- know about pathogens responsible for food spoilage.
- understand the principles involved in food preservation techniques.

## SKILLS:

- ✓ *Prepare and sterilize media.*
- ✓ *Identify types of microorganisms present in food products.*
- ✓ *Prepare pure cultures of microbes.*
- ✓ *Isolate microorganisms from the food sample.*

**ACTIVITIES:**

- Prepare flow charts for production of food products using different microorganisms.

**UNIT - 1****L-9**

**INTRODUCTION TO MICROBIOLOGY:** Classification of microorganisms, Importance of microorganisms in food industry, Moulds: General characteristic, Classification and Identification. Yeasts and Yeast like fungi: General characteristics, Classification, Identification, Yeasts of industrial importance. Bacteria: Morphological, Cultural and Physiological characteristics, Examples of bacteria important in food bacteriology.

**UNIT - 2****L-9**

**FOOD SPOILAGE:** Microbial spoilage of foods, Cause of spoilage, Classification of foods by ease of spoilage, Factors affecting kinds and numbers of microorganisms in food, Factors affecting growth and survival of microorganisms in foods: Intrinsic factors and Extrinsic factors, Chemical changes caused by microorganisms: breakdown of proteins, carbohydrates, fats and other constituents during spoilage, Contamination of Food, Sources of contamination.

**UNIT - 3****L-9**

**FOOD PRESERVATION:** Principles of preservation, Methods of food preservation: High temperature, Low temperature, Drying, Radiation, Chemical preservatives, Bio-preservatives, Hurdle technology, Active packaging, Novel processing technologies.

**UNIT - 4****L-9**

**MICROBIOLOGY OF MILK AND MILK PRODUCTS:** Microbiology of milk and milk products, Contamination, Preservation, Pasteurization, Freezing and Drying, Changes caused by microbes during milk and milk product spoilage: Gas production, Proteolysis, Ropiness, Changes in milk fat, Alkali production, Flavour changes and Colour changes.

**MICROBIOLOGY OF FRUITS AND VEGETABLES:** Contamination, Preservation of vegetables, Asepsis, Chilling, Freezing, Drying, Preservatives, CA storage, MA storage, Spoilage of fruits and vegetables.

**MICROBIOLOGY OF CEREAL AND CEREAL PRODUCTS:** Contamination, Preservation, Spoilage of flours and Bread.

**UNIT - 5****L-9**

**MICROBIOLOGY OF MEAT AND MEAT PRODUCTS:** Contamination, Preservation, Spoilage of meat and meat products, Changes during storage, Changes not caused by microorganisms, Changes caused by microorganism. Microbiology of canned foods: Causes of spoilage, Appearance of the unopened container, Types of biological spoilage of canned foods: Flat sour spoilage, TA spoilage, Sulphide spoilage. Types of spoilage of canned foods by Bacteria, Yeasts, Moulds. Spoilage of canned meat.

**LABORATORY EXPERIMENTS****LIST OF EXPERIMENTS**

Total hours: 30

1. Introduction to different types of equipment used in food Microbiology Lab.
2. Preparation and sterilization of media.
3. Gram staining and microscopic examination of bacteria.
4. Techniques of pure culture (Pour plate and streak plate).
5. Isolation and Identification of molds from foods.
6. Microbial examination of milk.
7. To perform MBRT for milk.

8. Microbial examination of fruits and vegetable products – Isolation, Identification
9. Microbial examination of Fermented food – Isolation, Identification
10. Determination of effect of various preservatives on the suppression of microbial growth.

**TEXT BOOKS:**

1. W. C. Frazier and D. C. Westhoff, "Food Microbiology", 4<sup>th</sup> edition, Tata McGraw Hills Publishing Company Limited, 2004.
2. J. M. Jay, "Modern Food Microbiology", 4<sup>th</sup> edition, Springer, 2000.

**REFERENCE BOOKS:**

1. J. Garbutt, "Essentials of Food Microbiology", 2<sup>nd</sup> edition, Taylor and Francis, 1997.
2. M. J. Pelczar, E. C. S. Chan and N. R. Krieg, "Microbiology", 5<sup>th</sup> edition, Tata McGraw-Hill Education Pvt. Ltd, 1998.
3. S. J. Forsythe, "Microbiology of Safe Food", 2<sup>nd</sup> edition, Blackwell Publishing Limited, 2010.

# 16FT203 THERMODYNAMICS AND HEAT ENGINES

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	15	-	20	45	5	-	5	5

## Course Description and Objectives:

This course deals with laws of thermodynamics, refrigeration, liquefaction and steam generation processes. The objective of this course is to make students understand the theory and applications of classical thermodynamics, and thermodynamic properties, equations of state and the methods used to describe and predict phase equilibrium.

## Course Outcomes:

The student will be able to:

- understand fundamentals of thermodynamic properties.
- derive and discuss the laws of thermodynamics.
- develop profound knowledge on refrigeration cycles.
- gain knowledge on different types of steam generators.

## SKILLS:

- ✓ *Select suitable refrigerant for specific process.*
- ✓ *Estimate the thermal and volumetric properties of real fluids.*
- ✓ *Suggest industry specific boiler and usage.*



**UNIT - 1**

**L-9, T-3**

**BASIC CONCEPTS:** The scope of thermodynamics, Dimensions and units, Measures of amount or size, Force, Temperature, Pressure, Work, Energy, Heat, Zeroth law.

**UNIT - 2**

**L-9, T-3**

**FIRST LAW OF THERMODYNAMICS:** Joule's experiment, Internal energy, Statement of first law, Energy balance for closed system, Thermodynamic state and state functions, Equilibrium, phase rule, Reversible processes, Constant-v and Constant-p processes, Enthalpy, Heat capacity.

**UNIT - 3**

**L-9, T-3**

**THE SECOND LAW OF THERMODYNAMICS:** Statements of the second law, Heat engines, Thermodynamic temperature scales, Entropy, Mathematical statement of the Second law, Third law of thermodynamics.

**UNIT - 4**

**L-9, T-3**

**REFRIGERATION AND LIQUEFACTION:** The Carnot refrigerator, The vapor compression cycle, The choice of refrigerant, Absorption refrigeration, Liquefaction processes.

**UNIT - 5**

**L-9, T-3**

**STEAM GENERATORS:** Classification of boilers, Comparison of fire tube and water tube boilers, Function of mountings and accessories, Constructional and operational details of Cochran, Babcock and Wilcox boiler.

**TEXT BOOKS**

1. J. M. Smith, H. C. Vanness and M. M. Abbot, "Introduction to Chemical Engineering Thermodynamics", 6<sup>th</sup> edition, Tata McGraw Hill, 2005.
2. R. K. Rajput, "Thermal Engineering", 8<sup>th</sup> edition, Laxmi Publications, 2010.
3. Y. V. C. Rao, "Chemical Engineering Thermodynamics", 1<sup>st</sup> edition, Universities Press, 2004.

**REFERENCE BOOKS**

1. P. K. Nag, "Engineering Thermodynamics", 5<sup>th</sup> edition, McGraw-Hill Education India Private Limited, 2013.

**ACTIVITIES:**

- *Report on properties and environmental performance of some commonly used refrigerants in food industry.*
- *Report on Indian Boiler's Act and Indian Boiler Regulation.*

# 16FT204 FUNDAMENTALS OF FLUID MECHANICS

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P	WA/RA	SSH/HSH	CS	SA	S	BS
45	-	30	20	45	-	5	5	5

## Course Description and Objectives:

This course deals with fundamentals of fluid statics, dynamics, compressible and incompressible fluids, fluidization, transportation and metering of fluids. The objective of this course is to train students on the basic concepts of fluid flow and its application to chemical process industries.

## Course Outcomes:

The student will be able to:

- understand basic principles of fluid mechanics.
- analyze fluid flow problems with the application of the momentum and energy equations.
- analyze pipe flows as well as fluid machinery.

## SKILLS:

- ✓ Analyze fluid flow situations for type of flow.
- ✓ Prescribe conditions for maintaining a given type of flow.
- ✓ Determine the velocity and pressure drop of fluid flowing through pipes.
- ✓ Select a meter for measuring flow rate and velocity of a flowing fluid.
- ✓ Select the pump for a given engineering application.

**UNIT - 1****L-9**

**INTRODUCTION TO FLUIDS:** Definitions, Properties, Units and dimensions, Measurement of fluid pressure, Absolute and gauge pressure: Pressure head of the liquid, Pressure on vertical rectangle surfaces, Compressible and Non compressible fluids, Surface tension, Capillarity, Pressure measuring devices: Piezometer, Simple manometers, Inclined manometers, Differential manometers, Problems.

**UNIT - 2****L-9**

**KINEMATICS OF FLUID FLOW :** Introduction, Classification of flows: Steady, Uniform, Non uniform, Laminar and turbulent, Continuity of fluid flow, Boundary layer, Fully developed flow Bernoulli's theorem, Problems on Bernoulli's theorem, Venturimeter, Pitot tube, Orifice meter, Rotameter, Problems on Venturimeter ,Orifice meter.

**UNIT - 3****L-9**

**FLOW THROUGH SIMPLE PIPES:** Loss of head in pipes, Darcy's formula, Chezy's formula for loss of Head in pipes, Minor losses of energy, Hagen Poiseuille equation Drag, Drag Coefficients, Terminal velocity, Fluidization introduction, Types of fluidization Applications of fluidization, Problems on fluidization.

**UNIT - 4****L-9**

**FLOW THROUGH ORIFICES:** Types of orifices, Jet of water, Hydraulic coefficients, Experimental Method for Hydraulic Coefficients, Discharge through a rectangular orifice, Discharge over a Triangular Notch, Stepped Notch, Dimensional analysis and similitude, Buckingham's pi theorem, Hydraulic similitude.

**UNIT - 5****L-9**

**DESIGN OF PIPES AND PUMPS:** Pipes, Fittings, Valves, Pumps, Developed head & power requirement in pumps, Suction lift, Cavitation, Classification of pumps, Reciprocating pump, Centrifugal pumps, Pressure variation, Work efficiency, Types of chambers: Selection and sizing, Compressors, Fans and Blowers.

**ACTIVITIES:**

- Calibration of rotameter.
- Calibration of manometer.
- Fabrication of Venturi meter.
- Fabrication of Orifice meter.

**LABORATORY EXPERIMENTS****LIST OF EXPERIMENTS**

Total hours: 30

1. Identification of laminar and turbulent flows.
2. Verification of Bernoulli's Equation.
3. Measurement of flowing fluid using Venturimeter.
4. Measurement of flowing fluid using Orifice meter.
5. Determination of friction loss in fluid flow through pipes.
6. Determination of friction loss in fluid flow through fittings.
7. Determination of pressure drop in packed bed.
8. Determination of pressure drop in fluidized bed.
9. Determination of characteristics of centrifugal pump.
10. Determination of characteristics of reciprocating pump.

**TEXTBOOKS**

1. P. N. Modi and S. M. Seth, "Hydraulics and Fluid Mechanics", 14<sup>th</sup> edition, Standard Publishers Distributors, 2002.

**REFERENCE BOOKS**

1. R. K. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machinery", 1<sup>st</sup> edition, Laxmi Publications (P)Ltd, 2002.
2. R. J. Grade, "Fluid Mechanics Through Problems", 1<sup>st</sup> edition, Wiley Eastern Ltd, 1992.
3. A. M. Micheal and S. D. Khepar, "Water Well and Pump Engineering", 2<sup>nd</sup> edition, Tata McGraw Hill, 2005.
4. J. Lal, "Hydraulic Machines", 6<sup>th</sup> edition, Metropolitan Book house, 2001.
5. A. M. Michael, "Irrigation Theory and Practice", 2<sup>nd</sup> edition, Vikas Publishing House, 2008.

# 16EL 103 PROFESSIONAL COMMUNICATION LABORATORY

Hours Per Week :

L	T	P	C
-	-	2	1

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
-	-	30	-	-	-	-	-	-



## Course Description and Objectives:

The Professional Communication Laboratory course is aimed at improving professional communication skills (LSRW – Listening, Speaking, Reading and Writing) of undergraduate students and preparing them for their profession as engineers and managers. This course will help students to understand professional communication and personality as two interlinked spheres of influence, and provide them with exposure to conventions of corporate communication involved in the functioning of the business world.

## Course Outcomes:

The student will be able to :

- clear industry recognized certification such as BEC Vantage by the University of Cambridge.
- stand out both in the professional setting as well as for further pursuits in the academic world.
- succeed confidently in all four critical components of communication - LSRW (listening, speaking, reading and writing).

## SKILLS:

- ✓ *Grammar rules in writing sentences, paragraphs and paraphrasing.*
- ✓ *Compose business emails, memos, letters, reports and proposals.*
- ✓ *Comprehend business articles and documents.*
- ✓ *Use of expressions in professional context and acquire presentation skills like one minute talk and pair discussion.*
- ✓ *Familiarize and comprehend British accent by listening to recorded speeches and discussions.*

**ACTIVITIES:**

- *Basic grammar practice, framing paragraphs on topics allocated.*
- *Paraphrasing an article or a video in your own words. Finding topic sentences in newspaper articles.*
- *Finding out new words from a professional viewpoint. Understanding the meaning and its usage.*
- *Perusing samples of well prepared proposals and reports.*
- *Draft different proposals/reports on topics assigned.*
- *Watching videos/ listening to audios of business presentations.*
- *Classroom activities of team and individual presentations.*
- *Using PPTs, mock exercises for BEC speaking.*
- *Presenting (speaking) the written components completed in Unit 1.*
- *Hand-outs; matching the statements with texts.*
- *Finding missing appropriate sentence in the text from multiple choice, multiple choices.*
- *Using right vocabulary as per the given context and editing a paragraph.*

**UNIT - 1****LEARNING - 3 HRS + PRACTICE - 3HRS = 06 HRS**

**BUSINESS ENGLISH VOCABULARY:** Glossary of most commonly used words (formal and informal usage) **Elements of Technical Writing-** Sentence structure, reducing verbosity, arranging ideas logically, building coherence, paragraph level and document level, topic sentence, cohesive devices, transitional words, paraphrasing and précis-writing.

**Mechanics of Writing-** Stylistic elements, the rapporteur, the purpose, the reader's viewpoint (audience), elementary rules of grammar, choice of diction, elementary principles of composition, matters of form, punctuation, conventions of business communication, language and professional tone, weak links in business correspondence, ethical concerns in business writing, code of conduct (not sending illegal, offensive, disparaging personal remarks or comments) in written business communication.

**UNIT - 2****LEARNING - 3 HRS + PRACTICE - 3HRS = 06 HRS**

**BUSINESS CORRESPONDENCE:** E-mail- nature and scope, e-mail etiquette, clear call for action, common errors in composing e-mails, office communication such as meeting agenda and minutes of the meeting, notice, circular and memo.

**Letter Writing** - Formal and informal letters, structure of formal letters, expressions of salutations, different types of letters [such as sales letter, complaint letter, response to the complaint letter (dispute resolution), letter of permission, letter of enquiring, claim letter, letter of apology etc]; Introductory and concluding paragraphs and clear call for action.

**PROFESSIONAL PROPOSAL/REPORT:** Differentiating proposals and reports, Drafting formal business proposals, types of reports such as factual reports, feasibility reports and survey reports, parts of a report (such as title page, declaration, acknowledgements, table of contents, abstract, introduction, findings, conclusions, recommendations, citations, references and appendices).

**UNIT - 3****LEARNING - 3 HRS + PRACTICE - 3HRS = 06 HRS**

**SPEAKING:** Speaking in business context, assertiveness, politeness, making requests, queries and questions, negotiations, asking for information, offering suggestions, conflict resolution, contacting clients, initiating, addressing delegates (in public), features of a good power point presentation (making the PPT), delivering the presentation effectively, telephone etiquettes, delivering seminar/proposal/report effectively, team meeting etiquettes (face to face and conference call), making effective one minute presentations.

**UNIT - 4****LEARNING - 3 HRS + PRACTICE - 3HRS = 06 HRS**

**READING:** Reading and comprehending business documents, learning business register, regularizing the habit of reading business news, suitable vocabulary, skimming and scanning text for effective and speedy reading and dealing with ideas from different sectors of corporate world in different business contexts.

**UNIT - 5****LEARNING - 3 HRS + PRACTICE - 3HRS = 06 HRS**

**LISTENING:** Specific information in business context, listening to telephonic conversations/messages and understanding the correct intended meaning, understanding the questions asked in interviews or in professional settings, summarizing speaker's opinion or suggestion and enable active listening.

**TEXT BOOKS: BEC**

1. G. B. Hart, "Cambridge English Business Bench Mark: Upper Intermediate", 2<sup>nd</sup> edition, CUP, 2004.
2. CUP, Cambridge: BEC VANTAGE: Practice Tests, CUP, 2002.

**ONLINE REFERENCES:**

1. <http://www.cambridgeenglish.org/exams/business-certificates/business-vantage/preparation/>
2. <https://www.youtube.com/watch?v=qxFtn9pGaTI>.

# 16HS202 PROBABILITY AND STATISTICS

Hours Per Week :

L	T	P	C
4	-	-	4

Total Hours :

L	T	P	WA/RA	SSH/HSH	CS	SA	S	BS
60	-	-	20	35	-	10	2	-



## Course Description and Objectives:

This course deals with descriptive statistics, correlation and regression and their applications, probability, theoretical distributions and testing of hypothesis.

The objective of this course is to enable the student to understand and apply statistical techniques, curve fitting, correlation and regression, probability and also to make the student familiar with discrete, continuous distributions and testing of hypothesis.

## Course Outcomes:

The student will be able to:

- distinguish between quantitative and categorical data and represent the data in graphical and tabular forms.
- calculate and interpret measures for the centre and spread of a data set.
- decide how and when to use the normal model.
- calculate and interpret correlation coefficient and regression lines.
- understand the rules of probability and apply them.
- compute probabilities using theoretical distributions.
- test hypothesis for population parameters.

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**UNIT - 1****L-9**

**STATISTICS** : Basic definitions, Frequencies, Graphical representation, Histogram, Ogive curves, Measures of central tendency, Arithmetic mean, Median, Mode, Mean deviation, Standard deviation, Symmetry and skewness, Karl Pearson's coefficient of skewness.

**UNIT - 2****L-9**

**CURVE FITTING, CORRELATION & REGRESSION** : Least squares method, Curve fitting (straight line and parabola only). Covariance, Correlation, Types, Pearson's coefficient of correlation, Rank correlation, Spearman's rank correlation. Regression, Regression lines.

**UNIT - 3****L-8**

**PROBABILITY** : Introduction, Definition (classical and axiomatic approach), Addition theorem, Conditional probability, Multiplication theorem, Total probability, Bayes theorem.

**UNIT - 4****L-8**

**DISTRIBUTIONS**: Random variables, Discrete and continuous variables, Introduction to distributions.

**BINOMIAL DISTRIBUTION** : Definition, Mean and Standard deviation, Recurrence relation, Applications, Fitting of binomial distribution.

**POISSON DISTRIBUTION** : Definition, Mean and standard deviation, Recurrence relation, Poisson Distribution is an approximation of Binomial distribution, Applications, Fitting of Poisson distribution.

**NORMAL DISTRIBUTION** : Definition, Normal curve, Mean and standard deviation, Median, Mode, Normal distribution applications.

**UNIT - 5****L-12**

**SAMPLING METHODS** : Population and sampling, Parameters and statistics, Types of sampling–Test of hypothesis and test of significance: Null hypothesis, Errors, Level of significance, Confidence Limits, Testing large samples, Sample distribution of proportion; T-distribution for small sample, difference between means of small sample, Chi square test for goodness of fit, Chi square test for test of independence.

**TEXTBOOKS:**

1. Miller and Freund, "Probability and Statistics for Engineers", 8<sup>th</sup> edition, Pearson Publishers, 2013.
2. H. K. Dass & Er. Rajanish Verma, "Higher Engineering Mathematics", 3<sup>rd</sup> revised edition, S. Chand and Company, 2014.

**REFERENCE BOOK:**

1. S.C. Gupta and V.K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Company, New Delhi, 2005.



# 16FT205 PRINCIPLES OF FOOD PRESERVATION

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	15	-	10	40	-	-	5	5



## Course Description and Objectives:

This course deals with the basic principles involved in food preservation methods. The objective of this course is to provide students with the knowledge of basic food preservation principles and processing methods to control food spoilage and deterioration.

## Course Outcomes:

The student 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.

## SKILLS:

- ✓ *Identify appropriate processing and preservation method for a given food.*
- ✓ *Identify and suggest suitable food additive for a given food product.*
- ✓ *Troubleshoot problems related to food safety during food processing.*

**ACTIVITIES:**

- *Prepare a table with different foods and their preservation methods.*
- *Report on permissible limits for various food additives as per regulatory standards.*

**UNIT - 1****L-9**

**INTRODUCTION:** Scope of food processing, Historical developments, Principles of food preservation, Preservation by physical methods and chemical methods.

**UNIT - 2****L-9**

**FOOD PRESERVATION BY LOW TEMPERATURE:** Processing, Preservation by low temperature, Refrigeration, Freezing, Freezing curve, Changes occurring during freezing, Types of freezing, Thawing and its effects.

**UNIT - 3****L-9**

**FOOD PRESERVATION BY HIGH TEMPERATURE:** Sterilization, Pasteurization, Blanching, and UHT processing, Canning: different unit operations involved, Canning-equipment, Types of canning containers.

**UNIT - 4****L-9**

**FOOD PRESERVATION BY NON-THERMAL METHODS:** Processing, Preservation by: Irradiation, Dielectric heating, High pressure processing, Pulsed electric field, Hurdle technology, Ohmic heating.

**UNIT - 5****L-9**

**FOOD PRESERVATION BY FOOD ADDITIVES:** Definition, Types, Functions, Permissible limits and Safety aspects.

**TEXT BOOKS:**

1. J. P. Fellows, "Food Processing Technology, Principles and Practices", 2<sup>nd</sup> Edition, Wood Head Publishing, 1999.
2. N. N. Potter and J.H. Hotchkiss, "Food Science", 5<sup>th</sup> Edition, Springer, 1998.

**REFERENCES:**

1. B. Lal, G. B. Siddappa and G. N. Tandon, "Preservation of Fruits and Vegetables", 2<sup>nd</sup> edition, ICAR Publication, 1967.
2. S. Ranganna, "Handbook of Analysis and Quantity Control for Fruit and Vegetable Products", 2<sup>nd</sup> edition, CFTRI, 1986.
3. N. Shakuntala and M. Shadaksharaswamy, "Foods, Facts and Principles", 3<sup>rd</sup> edition, New Age Publishers, 2008.

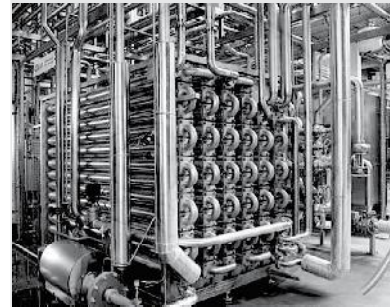
# 16FT206 FUNDAMENTALS OF HEAT AND MASS TRANSFER

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	-	30	25	45	-	5	5	5



## Course Description and Objectives:

This course deals on imparting fundamental understanding on the phenomena of heat and mass transfer. The objective of this course is to train students on principles of heat and mass transfer, methodologies for determining the rate of heat and mass transfer and perform heat exchanger design calculations.

## Course Outcomes:

The student will be able to:

- understand the basic laws of heat and mass transfer.
- account for the consequence of heat transfer in thermal analyses of engineering systems.
- analyze problems involving steady state heat conduction in simple geometries.
- obtain numerical solutions for conduction and radiation heat transfer problems.
- understand the fundamentals of convective heat transfer process.
- know about the basic mechanism behind boiling and condensation processes.
- analyze heat exchanger performance by using the method of log mean temperature difference.
- calculate radiation heat transfer between black body surfaces.
- understand the basic principles of mass transfer.

## SKILLS :

- ✓ *Estimate the rate of heat flow through a wall, cylinder or sphere.*
- ✓ *Insulation thickness estimation.*
- ✓ *Determine heat transfer coefficients.*
- ✓ *Estimate double pipe heat exchanger length required for specified conditions*
- ✓ *Perform basic calculations required for heat exchanger design.*
- ✓ *Select the correct type of heat exchanger required for a specific process.*
- ✓ *Determine the emissivity of a body.*

**ACTIVITIES:**

- *Mix the heat*
- *Feel the heat*
- *Effect of radiation on test tube filled with water.*
- *Window Insulation*
- *Connecting shell and tube heat exchanger setup.*
- *Feel the fragrance*
- *Calculate critical thickness*
- *Design of double pipe heat exchanger*
- *Design of shell and tube heat exchanger*
- *Design of evaporator for fruit juice concentrate*

**UNIT - 1****L-9**

**HEAT TRANSFER AND ITS APPLICATIONS:** Nature of heat flow, Conduction, Convection, radiation, Heat transfer by conduction: Fourier's Law, One dimensional heat flow through slab/cylinder/sphere derivation, Concept of electrical analogy, Thermal resistance, Heat flow through composite wall/cylinder and sphere, Thermal contact resistance, Composite wall/ sphere/cylinder connected in series and parallel.

**UNIT - 2****L-9**

**CONVECTION:** Concept of overall heat transfer coefficient, Critical thickness of insulation, Heat transfer through extended surfaces, Application of fins, General fin equation, Effectiveness and efficiency of fins. Dimensional analysis, Rayleigh's and Buckingham pi theorem, Dimensionless number, Heat transfer by convection, Concept of thermal boundary layers, Heat transfer by forced convection in laminar and turbulent flow, Natural convection principle, Important correlations in forced and natural convection.

**UNIT - 3****L-9**

**HEAT EXCHANGER:** Applications of correlation to determine heat transfer coefficients in free and natural convection, Heat exchange equipment, Counter currents and parallel currents flows, Energy balances, Rate of heat transfer, LMTD, Individual heat transfer coefficient, Overall heat transfer coefficient, Fouling factors, Shell and tube and plate heat exchangers, Heat exchanger design, Application of different types of exchangers in dairy and food industry.

**UNIT - 4****L-9**

**BOILING AND CONDENSATION:** Boiling heat transfer, Types of boiling, Pool boiling of liquid, Critical heat flux concept, Pool boiling of saturated liquids, Film boiling, Condensation heat transfer: Drop wise and film type condensation, Radiation: Heat radiation, Emissivity, Absorptivity, Transmissivity, Radiation through black and grey surfaces, Determination of shape factors, Combined heat transfer by conduction, Convection and radiation.

**UNIT - 5****L-9**

**MASS TRANSFER:** Introduction, Fick's law of diffusion, Steady state diffusion of gases and liquids through solids, Equimolar counter diffusion, Isothermal evaporation of water into air, Mass transfer coefficient, Qualitative discussion on various mass transfer operations: Drying, Humidification, Distillation, Liquid extraction, Leaching and Adsorption.

**LABORATORY EXPERIMENTS****LIST OF EXPERIMENTS**

Total hours: 30

1. Determination of heat transfer coefficient by natural convection.
2. Determination of overall resistance in composite wall.
3. Emissivity measurement.
4. Determination of thermal conductivity of metal rod.
5. Determination of heat transfer coefficients of double pipe heat exchanger.
6. Determination of critical heat flux points of Nichrome Wire.
7. Shell and Tube heat exchanger.
8. Liquid-liquid diffusivity experiment.

9. Surface evaporation experiment.
10. Gas-diffusivity measurement experiment.

**TEXT BOOK:**

1. R. K .Rajput, "Heat and mass transfer", S. Chand and Co. Ltd, 2008.

**REFERENCE BOOKS:**

1. Y. A. Cenger and A. Ghajar, "Heat and Mass Transfer: Fundamentals and Applications", 5<sup>th</sup> edition, McGraw Hill India, 2014.
2. A. S. Lavine, F. P. Incropera, D. P. DeWitt and T. L. Bergman, "Fundamentals of Heat and Mass Transfer", 7<sup>th</sup> edition, Wiley India, 2011.
3. R. E. Treybal, "Mass Transfer Operations", 3<sup>rd</sup> edition, McGraw-Hill Book Company, 1980.

# 16FT207 UNIT OPERATIONS

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	-	30	25	45	-	5	5	5

## Course Description and Objectives:

This course deals with the principles and practices of unit operations involved in process industries. The objective of this course is to impart knowledge to students on engineering concepts of unit operations and processes.

## Course Outcomes:

The student will be able to:

- understand the basic methods of characterization of particles and bulk solids.
- know basic principles of various unit operations.
- identify the range of equipments used to perform each major unit operation.
- gain knowledge on different drying techniques and their effect on food quality.

## SKILLS:

- ✓ *Perform cumulative and differential particle size analysis.*
- ✓ *Identify the suitable mixer required for mixing cohesive and non cohesive solids.*
- ✓ *Recognize the required specifications of the size reduction equipment for a given feed.*
- ✓ *Identify the filtration equipment required for a specific application.*
- ✓ *Compare the efficiency of separation, size reduction, mixing and drying equipments.*

**UNIT - 1****L-9**

**PROPERTIES AND CHARACTERIZATION OF SOLIDS:** Properties, Handling and Characterization of particulate solids, Properties of particulate masses, Storage and mixing of solids, Mixers for cohesive and non-cohesive solids, Transportation of solid particulate mass, Belt, Screw, Apron conveyers, Bucket elevators, Pneumatic conveying.

**UNIT - 2****L-9**

**PRINCIPLE OF COMMINATION:** Laws of Size reduction - Rittingers Law, Kicks law, Bondscrushing law, Work index, Problems, Classification of size reduction equipment : Crushers, Grinders, Ultra fine grinders, Cutting machines, Problems.

**Industrial Screening:** Different types of screening equipment in industries, Screen efficiency.

**UNIT - 3****L-9**

**FILTRATION:** Classification of filters based on nature of filtration and external force, Principles of cake filtration, Specific cake resistance, Filter-medium resistance, Types of membranes, Permeate flux, Concentration polarization, Micro filtration.

**SEPARATION TECHNIQUES:** Separations based on motion of particles through fluids, Gravity settling, Centrifugal settling, Sink and Float method, Flotation, Flotation agents.

**UNIT - 4****L-9**

**AGITATION AND MIXING OF LIQUIDS:** Agitation equipment, Impellers, Propellers, Paddles, Turbines, Power consumption in agitated vessels.

**Crystallization:** Crystal geometry, Principles of crystallization, Nucleation, Types of nucleation.

**UNIT - 5****L-9**

**DRYING:** Psychrometry, Humidification and dehumidification operations, Drying theory: thin layer drying, Deep bed drying, and types of dryers.

**Leaching:** Leaching principles, Leaching process with examples.

**ACTIVITIES:**

- Comparing the working of different types of crushers
- Finding the optimum time of sieving
- Comparing the working of leaf filter and plate and frame filter press.

**LABORATORY EXPERIMENTS****LIST OF EXPERIMENTS**

Total hours: 30

1. Determination of particle size using screen Analysis.
2. Finding the effectiveness of a screen.
3. Verification of size reduction laws using Jaw Crusher.
4. Verification of size reduction laws using Ball Mill.
5. Verification of size reduction laws using Roll Crusher.
6. Determination of compressibility coefficient using sedimentation process.
7. Determination of filter Medium resistance and cake resistance using plate and frame filter press.
8. Determination of percent recovery of coal from coal-sand mixture using Froth Flotation cell.
9. Determine the efficiency of cyclone separator.
10. Drying characteristics of food material.

**TEXTBOOKS:**

1. R. L. Earle, "Unit Operations in Food Processing", 2<sup>nd</sup> edition, Pergamon Press, 2003.
2. W. L. McCabe, J. C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", 7<sup>th</sup> edition, McGraw-Hill, Inc, 2005.

**REFERENCE BOOKS:**

1. J. M. Coulson and J. F. Richardson, "Chemical Engineering" 1<sup>st</sup> to 5<sup>th</sup> volume, The Pergamon Press, 1999.
2. K. M. Sahay and K. K. Singh, "Unit operation of Agricultural Processing", 2<sup>nd</sup> edition, Vikas Publishing House Pvt. Ltd, 2004.
3. C. J. Geankoplis, "Transport Process and Unit Operations", 4<sup>th</sup> edition, Prentice-Hall of India, 2004.