Syllabus of

B. Tech. (Food Tech.)

(Overall Structure and Revised Syllabus w. e. f. 2018-19)

Faculty of Science andTechnology

University Institute of Chemical Technology

KBC North Maharashtra University,Jalgaon

Summary of Distribution of Credits under Academic Flexibility Scheme for

B. Tech (Food Technology)

at

UICT, KBCNMU, Jalgaon

[University Campus under Academic Flexibility w.e.f. 2018-19]

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Sem VII	Sem VIII
01	Core	**15**	**15**	**18**	**23**	**16.5**	**10**	**-**	**15.5**
02	Skill based	**05**	**06**	**03**	**03**	**-**	**3**	**-**	**-**
03	Institute Elective	**-**	**-**	**-**	**-**	**3**	**6**	**-**	**3**
04	Project	**-**	**-**	**-**	**-**	**-**	**-**	**15**	**-**
05	Audit	**NC**	**NC**	**NC**	**-**	**NC**	**-**	**-**	**-**
06	Total Credits	**20**	**21**	**21**	**26**	**19.5**	**19**	**15**	**18.5**

Number of Audit Courses	**01**	**01**	**01**	**-**	**01**	**-**	**-**	**-**

Subject Type	Core	Skill based	Institute Elective	Project	Audit	Total
Credits	**113**	**20**	**12**	**15**	**NC**	**160**

Total Credits = 160

Program at a Glance

Name of the program (Degree)	: B. Tech (Food Technology)		
Faculty	: Science & Technology		
Duration of the Program	: Four Years (Eight Semesters)		
Medium of Instruction and Examination	: English		
Exam Pattern	: 60: 40 (60 Marks University Exam& 40 Marks Continuous Internal Departmental Exam/Assessment)		
Passing Standards	: 40% in Each Exam separately for Theory courses and 50 % in Each Exam separately for Practical Courses.		
Evaluation Mode	: CGPA		
Total Credits of the Program	: 160	[Core Credits	:113]
		[Skill Based Credits	:20]
		[Inst. Elective Credits	:12]
		[Project Credits	:15]
		[Audit Credits	:NC]

Program Objectives (POb'S):

1. To impart basic engineering knowledge as well as capability of problem analysis.
2. To develop ability of investigation of complex problem and design/develop solutionfor their management.
3. To train the graduate for usage of modern tools in teaching - learning process
4. To develop ethics team spirit among the graduates.

Program Specific Outcomes (PSOb'S) (Food Technology):

PO No.	PO	Cognitive level
PSO1	Inculcate the thought process for creative analysis and execution of fundamentals of basic sciences, unit operations, Food & food processing technology.	4
PSO2	Develop the graduates with competitive skills to pursue career in academics, food and allied industries as well as innovative start-up.	6
PSO3	Prepare the professional Food Technologists with integrity and ethical values to become effective associate while addressing the social, moral, environmental and technically sustainable challenges.	3

Program Outcomes (PO) for B.Tech.

Upon successful completion of the B.Tech. Program, the graduate student will be able to:

PO No.	PO	Cognitive level
PO1	Apply knowledge of mathematics, science, and engineering fundamentals to the solution of complex engineering problems.	3
PO2	Identify, formulate and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	1
PO3	Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.	6
PO4	using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.	5
PO5	Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an under- standing of the limitations.	6
PO6	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	3

PO7	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	2
PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	3
PO9	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	6
PO10	Communicate effectively on complex engineering activities with the engineering com- munity and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.	2
PO11	Demonstrate knowledge and understanding of Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments	2
PO12	Recognize the need for and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.	6

Program Specific Outcomes

PSO1: Inculcate the thought process for creative analysis and execution of fundamentals of basic sciences, unit operations, Food & food processing technology.

PSO2: Develop the graduates with competitive skills to pursue career in academics, food and allied industries as well as innovative start-up.

PSO3: Prepare the professional Food Technologists with integrity and ethical values to become effective associate while addressing the social, moral, environmental and technically sustainable challenges.

B. Tech. (Food Technology) Revised Syllabus w.e.f. 2018-19							
Course Code	**Title of Course**	**Teaching Hrs**	**Tutorial**	**Credits**	**Practical Hrs**	**Credits**	**Total Credits**
First Semester							
BSL-101	Mathematics-I	03	01	04	-	-	04
BSL-105	Thermodynamics-I	03	01	04	-	-	04
ESL-102	Electrical and Electronics Engineering	03	01	04	-	-	04
ESC-103	Computer Lab (Programming for problem solving)	03	-	03	04	02	05
ESL-104	Material Science and Technology	03	-	03	-	-	03
NC-101	Induction Programme	-	-	-	-	-	NC
						Total	**20**
Second Semester							
Course Code	**Title of Course**	**Teaching Hrs**	**Tutorial**	**Credits**	**Practical Hrs**	**Credits**	**Total Credits**
BSL-104	Mathematics-II	03	01	04	-	-	04
BSC-102	Physics	03	01	04	03	1.5	5.5
BSC-103	Chemistry-I	03	01	04	03	1.5	5.5
HMC-101	Communication Skill	02	-	02	02	01	03
ESC-101	Engg Graphics	01	-	01	04	02	03
5555	Environmental Studies	-	-	-	-	NC	NC
						Total	**21**
Third Semester							
Course Code	**Title of Course**	**Teaching Hrs**	**Tutorial**	**Credits**	**Practical Hrs**	**Credits**	**Total Credits**
CHC-203	Heat Transfer	03	01	04	03	1.5	5.5
CHL-204	Fluid Mechanics	03	01	04	-	-	04
CHL-206	Material and Energy Balances Computations	03	01	04	-	-	04
HML-202	Industrial Management and Economics	03	-	03	-	-	03
FTC-201	Food Chemistry	03	-	03	03	1.5	4.5
NC-202	Indian Constitution	-	-	-	-	NC	NC
						Total	**21**

Fourth Semester							
Course Code	**Title of Course**	**Teaching Hrs**	**Tutorial**	**Credits**	**Practical Hrs**	**Credits**	**Total Credits**
ESL-205	Engg and Solid Mechanics	03	01	04	-	-	04
BSC-206	Chemistry II	03	01	04	03	1.5	5.5
CHL-201	Thermodynamics-II	03	01	04	-	-	04
CHC-207	Mechanical Operations	03	-	03	04	02	05
ESC-206	Engg Workshop	01	-	01	04	02	03
FTC-202	Food Bichemistry and Nutrition	03	-	03	03	1.5	4.5
Total							**26**
Fifth Semester							
Course Code	**Title of Course**	**Teaching Hrs**	**Tutorial**	**Credits**	**Practical Hrs**	**Credits**	**Total Credits**
CHL-314	Mass Transfer Operations	03	-	03	-	-	03
CHP-315	Mass &Momentum TransferOperations				03	1.5	1.5
CHL-312	Process Design and Project Management	03	-	03	-	-	03
FTC-301	Principles of Food Preservation	03	-	03	03	1.5	4.5
FTC-302	Microbiology and Molecular Biology	03	-	03	03	1.5	4.5
Elective I	Open Elective	03	-	03	-	-	03
NC-303	Essence of Indian Traditional Knowledge	-	-	-	-	NC	NC
						Total	**19.5**
Sixth Semester							
Course Code	**Title of Course**	**Teaching Hrs**	**Tutorial**	**Credits**	**Practical Hrs**	**Credits**	**Total Credits**
CHL-316	Chemical Reaction Engineering	03	01	04	-	-	04
HML-309	Psycho-social Dimensions of Industrial Management	03	-	03	-	-	03
FTL-303	Food Biotechnology	03	-	03	-	-	03
FTP-304	Food Processing and Biotechnology	-	-	-	06	03	03
Elective II	Open Elective	03	-	03	-	-	03
Elective III	Professional Core Elective	03	-	03	-	-	03
Total							**19**

Seventh Semester							
Course Code	**Title of Course**	**Teaching Hrs**	**Tutorial**	**Credits**	**Practical Hrs**	**Credits**	**Total Credits**
FTP-401	Industrial Training/ Project	-	-	-	24	12	12
FTP-402	Technical Seminar	-	-	-	06	03	03
						Total	**15**
Eighth Semester							
Course Code	**Title of Course**	**Teaching Hrs**	**Tutorial**	**Credits**	**Practical Hrs**	**Credits**	**Total Credits**
CHC-416	Process Dynamics and Control	03	-	03	03	1.5	4.5
CHC-417	Process Equipment Design and Drawing	01	-	01	02	01	02
FTL-403	Food Processing - II	03	-	03	-	-	03
FTL-404	Food Quality	03	-	03	-	-	03
FTP-405	Food Processing and Quality	-	-	-	06	03	03
Elective IV	Professional Core Elective	03	-	03	-	-	03
						Total	**18.5**

Elective I (Open Elective) FTL-305 Advanced Technology in Food Packaging OTL-305 Technology of Perfumery and Cosmetics PTL-305 Specialty Pigments and Additives in Coatings PLL-304 Polymer Rheology CHL-320 Nanoscience and Nanotechnology	**Elective II (Open Elective)** FTL-306 Treatment and Disposal of Food Industrial Waste OTL-306 Biochemistry & Biotechnology of Lipids PTL-306 Technology of Printing Inks PLL-305 Plastics Waste Management CHL-321 Water Conservation and Management
Elective III (Professional Core Elective) FTL-307 Food Processing-I FTL-308 Fruits and Vegetable Processing Technology	**List of Electives: Elective IV (Professional core Elective)** FTL-406 – Biochemical Engineering FTL-407 – Dairy Technology

Total credits (20 + 21+ 21 + 26 + 19.5 + 19 +15 +18.5) **= 160**

Semester-I

Course Title: Mathematics- I

Course Code: BSL-101

Course Prerequisite:

The background expected includes a prior knowledge of mathematics from H.S.C. (Science) and familiarity with various principles and theorems.

Course Objectives:

The necessity for the foundation of Engineering and Technology being Mathematics, the main objective is to provide sufficient practice in the mathematical methods presented and develop mathematical skill and enhance thinking and decision-making power of student.

Unit –I: Linear Algebra

Elementary transformations on a matrix; Rank of a matrix; normal forms; Consistency and solutions of systems of linear equations; orthogonal matrix; Eigen values and eigen vectors; Cayley-Hamilton's theorem (without proof). (10)

Unit –II: Differential Calculus and Its Applications

Successive differentiation – standard results; Leibnitz's theorem; Expansions of functions: Maclaurin's theorem, Taylor's theorem; Application of Taylor's theorem. (10)

Unit –III: Partial Differentiation

Partial derivatives of first and higher orders; Homogeneous functions – Euler's Theorem; Total derivatives; Change of variables. (10)

Unit –IV: Applications of Partial differentiations

Jacobians - properties; Errors and approximations; Maxima and minima of functions of two variables; Lagrange's method of undetermined multipliers for single constraints. (10)

Unit –V: Complex Numbers

Definition and geometrical representation; De-Moivre‟s theorem (without proof); Roots of complex numbers by using De-Moivre‟s theorem; Circular functions of complex variable – definition; Hyperbolic functions; Relations between circular and hyperbolic functions; Real and imaginary parts of circular and hyperbolic functions; Logarithm of Complex numbers. (10)

Text/Reference Books:

1. Erwin Kreyszig, “Advanced Engineering Mathematics”, Wiley Eastern Ltd, 10th Edition.
2. B S Grewal, “Higher Engineering Mathematics”, Khanna Publication.
3. H K Das, “Advanced Engineering Mathematics”, S. Chand & Company.
4. N.P. Bali and M. Goyal, “A text book of Engineering Mathematics”, Laxmi Publications, 2008.
5. T. Veerarajan, “Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Apply** knowledge of mathematics in engineering and technology.	3
2	**Identify, formulate** and **solve** engineering problems.	4
3	**Design** Mathematical models for engineering problems and solve them.	5
4	**Use** partial derivative to find total derivative of implicit functions and to find Jacobians.	4
5	Find error and approximate values of problems **related** to engineering field.	4

Course Title: Thermodynamic-I

Course Code: BSL-105

Course Prerequisite:

The background expected includes a prior knowledge of physical chemistry, H.S.C. (Science) and familiarity with various basic laws, principles and theories.

Objectives:

Course objective are practical applicability of theoretical concepts of basic organic chemistry and thermodynamics to its practical applications.

UNIT-I: Introduction to Thermodynamics

Scope of thermodynamics, systems and process, homogeneous and heterogeneous system, closed and open systems, state functions, equilibrium, reversible process, irreversible process. (10)

UNIT-II : First law of thermodynamics and gas laws

work, energy, first law of thermodynamics, internal energy, Gas law: Boyl's law, Charls law, Avogadro's law, ideal gas equation, van der waals constant.

(10)

UNIT-III: Second law of thermodynamics

Heat engine, Carnot theorem. Heat effect: latent heat, sensible heat, standard heat of formation, reaction and combustion. Entropy, Enthalpy, Second law of thermodynamics. (10)

UNIT-IV: Some applications of the laws of Thermodynamics

Flow processes, continuity equation, energy balance, flow in pipes, flow through nozzles, ejectors, throttling process, compressors. (10)

UNIT-V: Refrigeration

Coefficient of performance, refrigerator capacity, Vapour- compression cycle, Absorption refrigeration, heat pump, Liquefaction processes. (10)

Text/Reference Books:

1) J M Smith, H C Van Ness and M M Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw- Hill International Edition, 2005.

2) M J Moran, H N Shapiro, D DBorttner and M B Bailey, Principal of Engineering Thermodynamics, 8th Edition, Willey.

3) K.V. Narayanan, A textbook of chemical engineering thermodynamics, PHI, Delhi,2001.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	To The concepts of Electromagnetism, basic laws related to magnetic and dielectric properties of material.	2
2	The concepts of Optics such as interference, diffraction and polarization.	2
3	Some of the basic laws of quantum mechanics, Photoelectric effect	2
4	Basic concepts of Semiconductors, superconductors.	2
5	The X-rays, LASERS, Principles, production, properties and **applications** of X-rays and LASERS.	3

Course Title: Electrical & Electronics Engineering
Course Code: ESL-102

Course Prerequisite: The course provides basic knowledge of electrical engineering. Course explores the knowledge of electrical, magnetic circuit and AC circuit. Course also provides the basic working operation of different electrical machine along with their characteristics and applications. It also provides ideas of electrical installation and different switches. Higher standards of safety and precautions are important in any industry Chemical industries therefore electrical safety and safety measures also incorporated in the course. Energy calculation and optical use of electrical energy are important in view of entrepreneur, electric tariff also included in the syllabus.

Course Objectives:

1. Students will able to understand the basic concept of electric power, energy in the field of chemical engineering and technology.
2. Students will able to understand the characteristic of motor for suitability of different applications in chemical engineering and technology.
3. Students will able to control and use electrical appliances in chemical engineering and technology.

4. Students will able to calculate power and energy for efficient, economical process of plants.

5. Students will able to apply good electrical safety precaution even in temporary works.

Unit-I:

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, open and short circuit in series and parallel circuit, effect of temperature on resistance.Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Loop analysis, Superposition and Thevenin Theorems.

Magnetic circuit: Concept of magnetic circuit, MMf, Flux and reluctance. Magnet circuit, composite magnetic circuit, Comparison of magnetic and electric circuit, B-H curve, hysteresis and eddy current loss. (10)

Unit-II:

AC Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor.Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections. Power in three phase circuit, Measurement of power in three phase circuit. (10)

Unit-III:

Transformers Magnetic materials, ideal and practical single-phase transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections. (10)

Unit-IV:

Electrical Machines:

DC Motor: Construction of DC motor, working operation, back emf, need of starter, classification of DC motors, torque, speed, characteristic of DC motor, speed control and applications.

AC Motor; Construction, working operation of three phase induction motor, Torque slip characteristic of induction motor, loss components and efficiency, Slip ring induction motor and applications. Classification and application of single phase motors.(10)

Unit-IV:

Electrical Installations Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption,small and medium industrial electric tariff, power factor improvement and battery backup. Electrical safety precaution and measures in chemical industry. (10)

Text/Reference Books:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
6. B L Theraja, " Electrical Technology Vol-I and II", S Chand Publication
7. V N Mittal, "Basic Electrical Engineering"

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Use** the latest techniques, skills, and modern tools necessary for engineering practices.	3
2	**Design** a component, system or process to meet desired needs with in realistic constraints.	6
3	**Determine** the values of constants such as Stefan's constant, Planck's constant specific charge etc	3

Course Title: Computer Lab (Programming for problem solving)

Course Code: ESC-103

Course Prerequisite: This course provides students with a comprehensive study of the C programming language. Introduction to program design and problem solving using the C programming language. Programming topics include control structures, functions, arrays, pointers, and file I/O.

Course Objectives: To impart knowledge so that the student will:

1. Learn the fundamentals, structure and syntax of C Language.
2. Write simple programs in C Language.

UNIT-I:

What is C?, The C Character set, Constant, Variables & Keywords, Types of C Constants, Rules for constructing Integer Constants, Rules for constructing Real Constants, Rules for constructing Character Constants, Types of C Variables, Rules for constructing Variable Names, C keywords, Comments in a C Program, Types of instructions, Type Declaration instruction, Arithmetic

instruction, Integer and Float Conversion, Type Conversion in Assignments, Hierarchy of Operations, Associativity of Operations, Control instructions, Data Types Revisited: Integers, long & short, signed & unsigned, Chars, signed & unsigned, Float & Doubles, Console Input/Output: Types of I/O, Console I/O Function, Formatted Console I/O Functions, Unformatted Console I/O Functions, Decision Control Instruction: The if statement, Multiple Statements within if, The if- else statement, Nested if-else, Use of Logical Operators, The else if Clause, The !Operator.(08)

UNIT-II:

Loop Control Instruction: Loops, the while Loop, Tips & Traps, More Operators, The for Loop, Nesting of Loops, Multiple Initializations in the for Loop, The break Statement, The continue Statement, The do-while Loop, The Odd Loop, Case Control Instruction: Decisions using switch, The Tips & Traps, switch versus if-else Ladder, The goto Keyword. (08)

UNIT-III:

Functions: What is a Function? Why use Functions? Passing Values between Functions, Scope Rule of Functions, Order of Passing Arguments, Using Library Functions, Pointers: Call by Value and Call by Reference, An Introduction to Pointers, Pointer Notation, Back to Function Calls, Recursion Function. (08)

UNIT-IV:

Arrays: What are Arrays? A Simple Program using Array, More on Arrays, Array Initialization, Array Elements in Memory, Bounds Checking, Passing Array Elements to a Function, Pointers and Arrays, Passing an Entire Array to a Function, The Real Thing, Multidimensional Array: Two Dimensional Arrays, initializing a Two-Dimensional Array, Memory Map of a Two-Dimensional Array, Pointers and Two-Dimensional Arrays, Pointer to an Array, Passing 2-D Array to a Function, Array of Pointers. (08)

UNIT-V:

Strings: What are Strings? More about Strings, Pointers and Strings, Standard Library String Functions, Handling Multiple Strings: Two-Dimensional Array of Characters, Array of Pointers to strings, Limitations of Array of Pointers to Strings, Structures: Why use Structures? Declaring a

Structure, Accessing Structure Elements, How Structure Elements are Stored? Array of Structure. (08)

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the fundamentals of C programming.	2
2	**Choose** the loops & decision-making statements to **solve** problem.	6
3	**Use** functions to **solve** the given problem.	6
4	**Implement** different Operations on arrays.	3
5	**Understand** strings and structures.	2
6	**Understand** the usage of pointers.	2

Computer Lab

Course description: This course provides students with a comprehensive study of the C programming language. Introduction to program design and problem solving using the C programming language. Programming topics include control structures, functions, arrays, pointers, and file I/O.

Course Objectives: To impart knowledge so that the student will:

1. Learn the fundamentals, structure and syntax of C Language.
2. Write simple programs in C Language.

Course Content:

1. Write a C program to find area of circle, triangle, rectangle, square using switch statement.
2. Write a C program to find the sum of a series (looping).
3. Write a C program to accept a string and reverse it without using library functions. Display the original and reversed string. (String handling).
4. Write a C program that uses functions to perform the following string operations using function and pointers:
    a. To insert a sub-string in to given main string from a given position.
    b. To delete n Characters from a given position in each string.
5. Write a C program to read ‘N’ elements into an array and compute the sum of all the elements stored in an array using pointer. (Arrays and pointers).

6. Write a C program to read a matrix of order (M *N) and (P * Q) and compute the addition and multiplication of two matrices. (Passing matrix to functions).
7. Write a C program to read 'N' students information and display the information with appropriate headings, where each student information consists of roll number, Name, total marks scored etc. (Structure handling).
8. Write a C program to find Factorial using Recursion.
9. Write a C program for Root Finding using Numerical Methods.
10. Write a C program to solve Linear Equations.

Text /Reference Books:

1. "Programming in ANSIC C" by E Balagurusamy, Tata McGraw Hill, 4/E, 2007
2. "Mastering C" by K. R. Venugopal and S. R. Prasad, Tata McGraw Hill, 2011
3. "The C Programming Language" by Brian W. Kernighan and Dennis M. Ritchie, PHI
4. "C How to Program" by Paul Deitel and Harvey Deitel, 8th Edition, Pearson
5. "Let Us C" by YashavantKanetkar, 14th Edition, BPB Publication.
6. "Test Your C Skills" By YashavantKanetkar, 5th Edition, BPB Publication.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the fundamentals of C programming.	2
2	**Choose** the loops & decision-making statements to **solve** problem.	6
3	**Use** functions to **solve** the given problem	6
4	**Implement** different Operations on arrays.	3
5	**Understand** strings and structures.	2
6	**Understand** the usage of pointers.	2

Course Title: Material Science &Technology

Course Code: ESL-104

Course Prerequisite:

The goals of the course are to understand the basic principles of Material science and their applications in different areas. The background expected includes a prior knowledge of physics and Chemistry from H.SC. (Science) and familiarity with various laws, principles and

theories.

Course Objectives:

The objective of this course will provide the students basic introduction to different concepts of Materials, different classes of materials relevant to Chemical Engineering. The intent of the course will be to relate the underlying molecular structure of the materials to their physical and chemical properties, and their processing and performance characteristics.

UNIT – I

Classification of solids (Amorphous, crystalline, polycrystalline), Space lattice, Bravais Lattices. Miller Indices, inter planar distances, Coordination number, Packing fractions. Imperfections in solids: point defects (stoichiometric defects and nonstoichiometric defects), line imperfections, surface imperfections, volume imperfection. (08)

UNIT – II

Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, vanderwaals bond, hydrogen bond. Mechanical properties of solids such as plastic deformation, Mechanism of plastic deformation-slip, twinning,modulus of elasticity, tensile strength,ducktility, toughness, elongation, plastic deformation, Schmid's law. Creep, requirement for creep resistance material, fracture, fatigue. (08)

UNIT – III

Classification of engineering materials (Metals, Polymers, Ceramics, Composites, Nanomaterials and Biomaterials). Polymers: classification of polymers, mechanism of polymerization, crystallization of polymers. Ceramics and glasses- properties of ceramics, Types of ceramics, electrical properties of ceramics, glasses, cermets. Nanomaterials-Introduction to nanomaterials, properties. Fabrication process-top down and bottom up approach.

Composite materials-dispersion reinforced composites, laminated composites, fiber reinforced composites, loading under isostrain and isostress condition. Biomaterials. (08)

UNIT – IV

Corrosion: Electrochemical principles, mechanisms, Formation and Growth of film, Growth Laws, polarization. Types of corrosion, prevention and control. Protective coatings, Application of inhibitors. Role of materials selection in design, structure-property–processing-performance relationships. (08)

UNIT – V

Material characterization techniques, X-Ray Diffraction, Braggs X-ray spectrometer, Debye Scherrer Camera. Principles of Raman Spectroscopy. Particle size analyzers. (08)

Text/Reference Books:

1. Material Science and Engineering Metallurgy: V. D. Kodgire.
2. Material Science: G.B.S. Narang.
3. Material Science: O P Khanna.
4. Engineering Metallurgy and Material Science: S.P. Nayak.
5. Material Science: Raghavan.
6. Material Science: Hazra Chaudhari.
7. Principles of Material Science and Engineering: William F. Smith
8. Material Science-Tata MC-Graw Hill Publication, V. Rajendran, R. A. Maricani.
9. Material Science and Engineering an Introduction, William D. Callister, David G. Rethwisch. WILEY Publications.
10. Instrumental Methods of Chemical Analysis, Gurdeep R. Chatwal, Sham K Anand.
11. Nanotechnology: Principles and Practices: S. K. Kulkarni.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Acquaint** students with the basic concepts and properties of Materials and their use in Engineering applications.	2
2	**Develop** futuristic insight into Materials and introduction to some characterization technique	6

Course Title: Induction Programme

Course Code: NC-101

Course Objectives:

1. It aims at helping new students to adjust and feel comfortable in new environment
2. It will facilitate the students for self-exploration and helps to rectify critical lacunas if any.
3. It will develop ethical thinking in student to understand the importance of value-based education.

There will be a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. The purpose of the *Student Induction Programme*is to help new students adjust and feel comfortable in the new environment, inculcate in them the ethos and culture of the institution, help them build bonds with other students and faculty members, and expose them to a sense of larger purpose and self-exploration.

Student Induction Program engages with the new students as soon as they come into the institution. At the start of the induction, the incumbents learn about the institutional policies, processes, practices, culture and values, and their mentor groups are formed. The time during the Induction Programme is also used to rectify some critical lacunas, for those students who have deficiency in it. Different activities, including those which are daily are to be planned. Here is a list of activities:

- Physical Activity

- Creative Arts and Culture
- Mentoring & Universal Human Values
- Familiarization with College, Dept./Branch
- Literary Activity
- Proficiency Modules
- Lectures & Workshops by Eminent People
- Visits in Local Area
- Extra-Curricular Activities in College
- Feedback and Report on the Program

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	Familiar with the institutional and departmental policies, processes, and practices	1
2	Get sensitized to the engineering needs of the society.	1
3	Understand the importance of healthy lifestyle, yoga, meditation in their professional development	2
4	Understand the broader perspective of universal human values in technical education	2

References:

1. Student Induction Program: A Detailed Guide by AICTE dated 30 July 2018 https://www.aicte-india.org/content/student-induction-program-detailed-guide
2. A Guide to Student Induction Programme by UGC dated 15 August 2018 https://www.ugc.ac.in/pdfnews/0559509_A-Guide-to-Student-Induction-Programme.pdf

Semester-II

Course Title: Mathematics- II

Course Code: BSL-104

Course Prerequisite:

Mathematics-I course of H.S.C. and BSL-101 (Mathematics-I) course of F. Y. B. Tech. (Semester- I).

Course Objectives:

To make aware students about the importance and symbiosis between Mathematics and Engineering. To develop the ability of mathematical modelling of systems using differential equations and ability to solve the differential equations.

Unit –I: Linear Differential Equations of n^{th} Order with Constant Coefficient

Solution of LDE of order n with constant coefficients, Method of variation of parameters (only second order), Cauchy's linear equation and Legendre's linear equation. (10)

Unit –II: Applications of Linear Differential Equations and Partial Differential equations

Applications of linear differential equations to Chemical Engineering, Applications of Partial Differential equations to one dimensional heat flow equation and two-dimensional heat flow equation. (10)

Unit –III: Laplace Transform

Definition and existence of Laplace transforms, Theorems and Properties of Laplace Transform (without proof), Laplace Transform of some special functions, Inverse Laplace Transform, Convolution Theorem, Solution of linear differential equations using Laplace Transform. (10)

Unit –IV: Multiple Integrals and Their Applications

Double integrals and their evaluation; Change of order for integration; Double integrals in polar coordinates;Triple integrals; Application of multiple integrals to find area, volume, surface area. (10)

Unit –V: Complex Variable

Analytic function, Harmonic function, Cauchy Riemann equations, Cauchy integral formula, Cauchy integral theorem, Residue theorem and Bilinear transformation. (10)

Text/ Reference Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley Eastern Ltd, 10th Edition.
2. B S Grewal, "Higher Engineering Mathematics", Khanna Publication.

3. H K Das, “Advanced Engineering Mathematics”, S. Chand & Company.
4. N.P. Bali and M. Goyal, “A text book of Engineering Mathematics”, Laxmi Publications, 2008.
5. T. Veerarajan, “Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.
6. S. C. Gupta, “Fundamental of Statistics”, Publisher: Himalaya Publishing House Pvt. Ltd.; Seventh Edition (2016).

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Apply** knowledge of mathematics in engineering and technology.	3
2	**Identify, formulate** and **solve** engineering problems.	4
3	**Design** Mathematical models for engineering problems and solve them.	5
4	**Use** partial derivative to find total derivative of implicit functions and to find Jacobians.	4
5	Find error and approximate values of problems **related** to engineering field.	4

Course Title: Physics

Course Code: BSC-102

Course Prerequisite:

This course is aimed at introducing the fundamentals of basic sciences to undergraduate students. The background expected includes a prior knowledge of physics and mathematics from H.S.C. (science) and familiarity with various laws, principles and theories. The goals of the course are to understand the basic principles of science(physics) and their applications in different areas.

Course Objective:

The objective of this course is to provide learners with basic concepts and knowledge of sciences (various principles, theories, laws etc.) and to analyse it from experiments. The learner can apply the same in Chemical Engineering and Technology.

UNIT I:

Laws of electrostatics, electric current and the continuity equation, laws of magnetism, Ampere’s law, Faraday’s laws. Maxwell’s equations. polarization, permeability and dielectric constant, polar and nonpolar dielectrics, internal fields in a solid, Clausius-Mossotti equation, Millikan’s oil drop experiment.

Magnetic materials: Magnetization, permeability and susceptibility, diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic ferromagnetic materials, Hysteresis , applications. (10)

UNIT II:

Interference: Conditions for interference of light, Interference in thin films, Newton's Rings experiment.

Diffraction: Fresnel & Fraunhofer diffraction, diffraction grating, Characteristics of diffraction grating and its applications.

Polarization: Introduction, polarisation by reflection, double refraction, scattering of light, circular and elliptical polarisation, optical activity, polaroids, applications of polaroids. (10)

UNIT III:

Introduction to quantum physics, blackbody radiation, Stefan's law. Explanation using the photon concept, photoelectric effect, Einstein's equation, photo-multiplier tubes, solar cell-working, merits and demerits. Production and detection of ultrasonic waves, properties and application of ultrasonic waves. (10)

UNIT IV:

Semiconductors: energy band diagram for conductor, semiconductor and insulator, Fermi level &Fermi function. Position of Fermi level in semiconductors in intrinsic and extrinsic semiconductors. Effect of temperature on the Fermi level.

Superconductivity: principle of superconductivity, properties of superconductors, Type-I and Type-II superconductors, applications of superconductors. (10)

UNIT V:

X-Rays: Production & properties of X-Rays, characteristics and continuous X-rays, Moseley's law, engineering applications of X-rays.

LASER: Principle and working, spontaneous and stimulated emission, population inversion, types of LASER-solid state, semiconductor and gas, application of LASERS. (10)

Text/Reference Books:

1. Concepts of Modern Physics, S. L. Gupta and S. Gupta.
2. Concept of Modern Physics, AurtherBiser, EditionThree.
3. Engineering Physics, R. K. Gaur & S.L. Gupta.
4. Applied Science - II by S. J. Walzade& S. N.Narkhede
5. Physics for Scientist and Engineers-5th Edition, Paul Tipler, Gene Mose
6. Text book of Engineering Physics, M. N. Avadhanulu, P. G. Kshirsagar, S. Chand Publication

7. M. R. Srinivasan, “Physics for Engineers”, New Age International Publishers.
8. “Optics”, S. Chand Publication, N. Subrahmanyam, M.N.Avadhanulu.
9. “Engineering Physics”, Sanjay Jain, Universities Press (India) Pvt Ltd.
10. “Semiconductor physics devices”, Donald A. Neamen, MC Graw Hill Publication.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	To The concepts of Electromagnetism, basic laws related to magnetic and dielectric properties of material.	2
2	The concepts of Optics such as interference, diffraction and polarization.	2
3	Some of the basic laws of quantum mechanics, Photoelectric effect	2
4	Basic concepts of Semiconductors, superconductors.	2
5	The X-rays, LASERS, Principles, production, properties and **applications** of X-rays and LASERS.	3

Physics Lab

Course Prerequisite:

In this laboratory, course emphasis is on the understanding of basic principles, characteristic – properties of different instruments used in a field of optics, Heat and thermodynamics, Modern Physics and electronics. The learner here can use this knowledge and apply in various branches of engineering as required.

Course Objective:

The objective of the laboratory is to impart the fundamental knowledge of physics to the students and develop their ability to apply the specific procedures to analyze the experimental results.

In this lab, students will be familiar with the use of different equipments, basic principles, properties etc. which they can apply in various disciplines of engineering during their studies and in future.

Practical’s List:

1. Determination of Stefan's constant.

2. Newton's Rings for the determination of radius of planoconvex lens.
3. Determination of specific rotation of given solution using polarimeter.
4. Determination of wavelength of Laser light by using diffraction grating.
5. To study I-V Solar cell characteristics.
6. To study I-V Characteristics of Photo-cell.
7. Surface Tension by capillary rise method.
8. e/m by Magnetron method.
9. Determination of Planck's constant using photocell.
10. Determination of divergence of He-Ne Laser beam.
11. Determination of conductivity of the sample by four probe method.
12. Thermal conductivity by Lee's method.

Text/Reference Books:

1. N Avadhanulu, A. A. Dani, P M Pokley, "Experiments in Engineering Physics", S.Chand Publication.
2. S P Singh, "Advanced Practical Physics", Pragati Prakashan.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Use** the latest techniques, skills, and modern tools necessary for engineering practices.	3
2	**Design** a component, system or process to meet desired needs with in realistic constraints.	6
3	**Determine** the values of constants such as Stefan's constant, Planck's constant specific charge etc	3

Course Title: Chemistry-I

Course Code: BSC-103

Course Prerequisite:

The background expected includes a prior knowledge of chemistry, H.S.C. (Science) and familiarity with various laws, principles and theories.

Course Objectives:

This course provides basic knowledge of chemistry for undergraduate students of technology. It will develop their fundamentals to build own interface of applied chemistry concepts with industrial applicability in branch of chemical technology. This course will introduce to basic concepts of bonding, quantum chemistry, synthetic methodology, reagents in organic synthesis and influence of structure and its properties on bonding and chemical reactions.

UNIT-I: Quantum Theory

Introduction to quantum theory for chemical system: Postulates of quantum mechanics, Schrodinger equation, Application to hydrogen atom, Atomic orbitals (10)

UNIT-II: Chemical Bonding In Molecules

Coordination Chemistry, Magnetic properties and electronic spectra of complexes, bioinorganic-chemistry (haemoglobin, myoglobin, chlorophyll), organometallic chemistry.
(10)

UNIT-III: Reactivity of organic molecules

Factors influencing acidity, basicity, and nucleophilicity of molecules, kinetics Vs thermodynamic control reaction. (10)

UNIT-IV: Selective name reactions

Aldol condensation, Perkin reactions, Michael addition, Mannich reaction, Reagans: $LiAlH_4$, $NaBH_4$, DCC, SeO_2, crown ether. Rearrangement: Pinacol rearrangement, Beckman rearrangement, Favorskii rearrangement, Wolff rearrangement. (10)

UNIT-V: Strategies for synthesis of organic compounds

Reaction intermediates. Introduction to green chemistry, principles and concepts of green chemistry. Waste production, problem and prevention. Alternative reaction media, solvent-less reaction, Industrial uses of aqueous solvents. (10)

Text/Reference Books:

1) Molecular Quantum Mechanics, Fifth Edition, Peter W. Atkins and Ronald S. Friedman

2) Principles of Quantum Mechanics, Authors: Shankar, R.

3) Organic Chemistry, I L Finar, Vol-I and Vol-II

4) Organic Chemistry, Morrison and Boyd,

5) Organic Chemistry, S H Pine

6) Organic Reaction Mechanism, P S Kalsi

8) Organic Chemistry; Jonathan Clayden, Nick Greeves, Stuart Warren, OUP Oxford.

9) Organic Reaction Mechanisms; V. K. Ahluwalia, Rakesh Kumar Parashar; Edition 4; Publisher: Alpha Science International, 2011.

10)Concise Inorganic Chemistry, 5th Ed; J. D. Lee; John Wiley & Sons

11)Green Chemistry 3rd Edition; Mike Lancaster; Royal Society of Chemistry

Course outcome:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Appreciate** quantum theory of chemical system.	2
2	**Appreciate** co-ordination chemistry	2
3	**Write** simple organic mechanism	3
4	**Summaries** newer methods in organic synthesis	5
5	**Understand**environmental friendly chemistry	2

Chemistry –I Lab

Course Objectives:

Course objective are practical applicability of theoretical concepts of basic organic chemistry and thermodynamics to its practical applications.

About 08-10 experiments to illustrate the concept learn in chemistry -I

Suitable number of experiments from following categories.

1) Identification of organic compounds through group detection, physical constant (MP/BP)

2) Synthesis of Organic compound involving reactions such as oxidation, esterification, nitration, sulphonation etc.

3) Measurements of kinetics of simple reactions.

Course outcome:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Identify** the simple organic compound	1
2	**Identify** reaction rate parameter,	1
3	**Perform** and **optimize** the reaction conditions.	3

Course Title: Communication Skills
Course Code: HMC-101

Course Objectives:

To achieve the following objectives through this course:

a) To make the student industry ready in terms of his/her ability to communicate effectively

b) To augment the ability of the student to create, compose and render presentations with or without the help of media

c) To understand the importance of public speech and the role language plays in that.

d) To enhance the ability of written communication by giving a primer on English

UNIT I: **Communication Skills:** Introduction to major grammatical models. Phonological and syntactical structure of present-day English. Language of science and technology. Aspects of style. Vocabulary building, spelling patterns, some common errors, Reading and Comprehension Organizing principles of paragraphs in documents (05)

UNIT II: Communication Effectiveness: Importance of proper punctuation Formal and informal communication. The art of listening. Listening Comprehension, Strategies for effective communication, Social perception communication, written communication. Writing introduction and conclusion.Managerial report writing. Graphical representation of technical data, Technical presentations design and delivery. Resume Writing, Business etiquettes, social grace(05)

UNIT III: Personality Development: Concept of Soft Skills, Problem solving, decision making,

Positive Attitude and mindset, Communication at Work place, Analytical Skills, Basic Writing Skills,Desire to learn and to be trained, coping with stress, Précis Writing Essay Writing, Multitask ability, Time Management, Model of success and failure in adjustment. (05)**UNIT IV: Interpersonal skills and rapport:** Work Ethics, Personal Integrity & commitment, Flexibility, Team work and spirit, Group process, Group task performance, Adaptation development processes, Cultural influences on personality and social behavior. Managing Ability, Aggression and its management. (05)

UNIT V: Problem solving cooperation and competition, Motivational Skills:

Personality and social phenomenon. Negotiation Skills, Networking with industries and institutions. Approaches to the study of personality. Models of healthy & mature personality; Describing oneself and SWOT analysis, Emotional Intelligence (05)

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the importance of communicating effectively	2
2	**Communicate** effectively by removing barriers	3
3	**Address** an audience effectively and deliver speeches without inhibition	3
4	**Create** and **deliver** effective e-presentations	3
5	**Understand** the meaning and utility of Active Listening in communication	2
6	**Use** the vocabulary more effectively	3
7	**Expand** and **enrich** grammatical structure and vocabulary in English	3
8	**Comprehend** thoughts through body language and **use** it as a tool to understand non-verbal.	3

Communication Skills

Practical List:

1) Pronunciation & Spelling
2) Stress and Intonation
3) Errors in Spoken English
4) Business Letter (Layout)
5) Job application with Resume preparation
6) Newspaper Reading

Text/Reference Books:

1. English Pronouncing Dictionary, Cambridge University Press, India, 2012.

2. A Textbook of English Phonetics for Indian Students by T. Balasubramanian, Macmillan Publisher,

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Use** various drawing instruments to layout and draw a sheet.	3
2	**Explain** several types of lines used, Lettering, Numbering and Dimensioning and Scales.	2
3	**Draw** and **explain** Planes of projection, quadrants and first angle & third angle method of projection. To draw front view, Top View and side View of Simple objects.	3
4	**Illustrate** Principles of Isometric projection and Isometric view.	4
5	**Explain** energy management strategy and energy audit.	2
6	**Illustrate** with principle various conventional energy producing devices and energy absorbing devices.	4
7	**Illustrate** with principle various power transmission elements, drives, direction and flow control valves.	4

Course Title: Engineering Graphics

Course Code: ESC-102

Course Objective:

The student after studying this subject will be able to:-

1. Draw different engineering curves and know their applications.
2. Draw orthographic projections of different objects.
3. Visualize three dimensional objects and draw Isometric Projections.
4. Understand the basic concepts of projection of different entities.
5. Visualize and draw views of objects in various positions.
6. Develop lateral surfaces of different solids

Course Contents:

Unit - I: Introduction to Engineering Graphics

Principles of Engineering Graphics and their significance, usage of Drawing Instruments and Supporting Material, Letters and Numbers as per BIS: SP46-2003, Scale (Plane , diagonal & Vernier scale) .

Curves and Conic Section draw ellipse by directrix and arc of circle method. draw parabola by directrix and rectangle method. Draw hyperbola by rectangle and directrix method. Cycloid, Epicycloid, Hypocycloid and Involute. (04)

Unit – II: Orthographic Projections

Orthographic Projection: Types of lines, Methods of dimensioning, first angle method of projection and third angle method of projection. Principle of Orthographic Projections, Projections of Points, Projection of Line, Lines inclined to both the Planes.Projection of different simple shapes e.g. Circle, Triangle, Rectangle, Pentagon and Hexagon on principle plane (Inclined to one plane and to both planes). Conversion of pictorial view into sectional orthographic views. (04)

Unit – III: Projection of Solids

Introduction to solids, prism, cone, cylinder, pyramid, cube, tetrahedron. Projection of above solids with axis inclined to one plane and both planes. (04)

Unit – IV: Section of Solids

Introduction, section planes, true shapes of section, section plane parallel to VP, section plane parallel to HP, section plane perpendicular to HP and section plane inclined to VP, section plane inclined to HP. Section of prism, section of pyramid, section of cone, section of cylinder. (04)

Unit – V: Isometric Projection

Introduction to pictorial views, Isometric axes, lines and plane, true scale and Isometric scale. Isometric projection and Isometric View Conversion of given orthographic view into isometric projection. (04)

Text/Reference Books

1. Engineering Drawing: N.D. Bhatt, V. M. Panchal, by Charotar Publication
2. Engineering Drawing: M. L. Dobhade (Vol I + II), by Vision Publications
3. Engineering Drawing: P. S. Gill, by S. K. Kataria Publications
4. Engineering Drawing: Mali and Chaudhari
5. Engineering Drawing: Venugopal and Prabhu Raja V.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Use** various drawing instruments to layout and draw a sheet.	3
2	**Explain** several types of lines used, Lettering, Numbering and Dimensioning and Scales.	2
3	**Draw** and **explain** Planes of projection, quadrants and first angle & third angle method of projection. To draw front view, Top View and side View of Simple objects.	3
4	**Illustrate** Principles of Isometric projection and Isometric view.	4
5	**Explain** energy management strategy and energy audit.	2
6	**Illustrate** with principle various conventional energy producing devices and energy absorbing devices.	4
7	**Illustrate** with principle various power transmission elements, drives, direction and flow control valves.	4

Engineering Graphics Lab

Practical: 04 Hrs/Week **Credits: 2.0**

Course Contents:

2. One drawing sheet on Lettering & Numbering
3. One drawing sheet on Engineering curves: Three different curves are to be draw using any one method
4. One drawing sheet on Projection of lines and Planes: Two problems on projection of lines and two problems on projection of planes

5. One drawing sheet on Projection of Solids: Two problems on two different solids
6. One drawing sheet on Section of Solids: Two problems on two different solids
7. One drawing sheet on Isometric Projections: Isometric views of two objects

Text/Reference Books

1. Engineering Drawing: N.D. Bhatt, V. M. Panchal, by Charotar Publication
2. Engineering Drawing: M. L. Dobhade (Vol I + II), by Vision Publications
3. Engineering Drawing: P. S. Gill, by S. K. Kataria Publications
4. Engineering Drawing: Mali and Chaudhari
5. Engineering Drawing: Venugopal and Prabhu Raja V.

Course Outcomes:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1	**Use** various drawing instruments to layout and draw a sheet.	3
2	**Explain** several types of lines used, Lettering, Numbering and Dimensioning and Scales.	2
3	**Draw** and **explain** Planes of projection, quadrants and first angle & third angle method of projection. To draw front view, Top View and side View of Simple objects.	3
4	**Illustrate** Principles of Isometric projection and Isometric view.	4
5	**Explain** energy management strategy and energy audit.	2
6	**Illustrate** with principle various conventional energy producing devices and energy absorbing devices.	4
7	**Illustrate** with principle various power transmission elements, drives, direction and flow control valves.	4

Semester-III

Course Title: Heat Transfer

Course Code: CHC – 203

Course Objective: The objective of this course is to provide basic knowledge of various modes of heat transfer and detail design knowledge of various heat exchangers and evaporators.

Course Contents:

Unit - I

Concept of heat transfer and transport of heat. Fourier's law, significance of thermal conductivity of solid, liquid and gases, heat transfer through plane and composite wall, sphere and cylinder, problem related to this case. Thermal diffusivity, differential equation of heat conduction, lagging of pipes and other equipment, optimum lagging thickness, critical radius of insulation. Heat Transfer from extended surfaces (fins). (10)

Unit – II

Convection: Individual and overall heat transfer coefficients, natural and forced convection, laminar and turbulent flow, significance of dimensional numbers, dimensional analysis and heat transfer analogy, flimwise and dropwise condensation (horizontal & vertical Surfaces). (10)

Unit – III

Design aspects of condensers reboilers and evaporators, Concept of Boiling and their types, Nussult Equation. Evaporation: Single and Multiple effect evaporator. B.P.R. and hydrostatic head. Economy and capacity of evaporator. Problem based on single effect evaporator. (10)

Unit – IV

Radiation: Laws of radiation, radiation from solid surfaces ,types of surfaces. Heat exchange by radiation between two finite black surfaces, between two infinite parallel surfaces, shape factor. Laws of shape factor, solid angle and radiation intensity, Green House effect. Electrical analogy of radiation shield. (10)

Unit – V

Heat Exchangers: classification, overall heat transfer coefficient, fouling factor, LMTD in single pass parallel, counter and cross flow arrangements. N.T.U.- effectiveness method for parallel and counter flow heat exchangers, general design aspect of heat exchangers. Problem based on LMTD and NTU effectiveness method. (10)

Text/ Reference Books

1. Holman,J..P.,S. Bhattacharya, Heat Transfer,10th edition, Tata McGraw-Hill,2011.
2. D.Q.Kern, Process heat transfer, Tata-McGraw Hill,1997.
3. R.Welty, C.E. Wicks, R.E.Wilson, G.Rorrer, Fundamentals of Momentum, Heat and Mass Tranfer, 4th edition, Wiley,2007.
4. W.J.Mccabe, J.Smith, P.Harriot, Unit Operations of Chemical Engineering, 6th edition, McGraw Hill, 2005.

Course Outcome:

Upon successful completion of the course students will have:

CO. No	CO	Cognitive level
1.	**Understands** the various modes of heat transfer.	2
2.	**Understands** the basics of fins.	2
3.	**Design** double pipe heat exchanger, shell and tube heat exchanger.	6
4.	**Design** single effect evaporator	6

Heat Transfer Lab

Course Code: CHC-203 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Contents:

1. To determine the heat transfer coefficient of air by using natural convection.
2. To determine the Stefan Boltzmann constant for radiation.
3. To determine the thermal conductivity of metal bar.
4. To determine the thermal conductivity of liquid (Lubricating oil).
5. To determine the heat transfer coefficient of double pipe finned tube heat exchanger.
6. To determine the log mean temperature difference in double pipe heat exchanger for parallel flow arrangement.
7. To determine the log mean temperature difference in double pipe heat exchanger for counter flow arrangement.
8. To Study the drop-wise and film-wise condensation.

Text/ Reference Books

1. Holman,J..P.,S. Bhattacharya, Heat Transfer,10th edition, Tata McGraw-Hill,2011.
2. D.Q.Kern, Process heat transfer, Tata-McGraw Hill,1997.
3. R.Welty, C.E. Wicks, R.E.Wilson, G.Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th edition, Wiley,2007.
4. W.J.Mccabe, J.Smith, P.Harriot, Unit Operations of Chemical Engineering, 6th edition, McGraw Hill, 2005.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Enhance the knowledge and clear the theoretical concepts of heat transfer by performing the hands-on experiments in the laboratory for detail understanding of the topic.	2

Course Title: Fluid Mechanics

Course Code: CHL-204

Course Objectives

The objective of this course is to make student well acquainted with different concepts in fluid mechanics like fluid statics, kinetics, dynamics, hydrostatic forces on submerged bodies, flow through pipes, instruments for flow & pressure measurement, types of flows, boundary layer theory, dimensional analysis & transportation of fluids by pumps, blowers and compressors etc& their applications particularly in chemical engineering.

Course Contents:

UNIT I

Concept of Fluid, Properties of Fluids, Viscosity, Newton's Law of Viscosity, Types of Fluids, Measurement of Pressure, Fluid Pressure at a Point, Pascal's Law, Hydrostatic Law, Absolute, Gauge, Atmospheric & Vacuum Pressures, Measurement of Pressure, Simple Manometers, Differential Manometers, Total Pressure & Centre of Pressure for a Vertical, Horizontal Surface Submerged in Liquid, Buoyancy, Centre of Buoyancy, Stability of Floating & Submerged Body.
Problems Based on All the Topics in a Unit. (10)

UNIT II

Kinematics of Flow: Types of Fluid Flows, Continuity Equation, Continuity Equation in Three Dimensions, Continuity Equation in Cylindrical Polar Coordinates, Velocity & Acceleration Concept, Stream Functions, Potential Flow & Its Important Cases.
Dynamics of Flow: Euler's Equation, Bernoulli's Equation, Applications of Bernoulli's Equation (Venturi Meter, Orifice Meter, Pitot Tube), Rotameter, Notches & Weirs.
Problems Based on All the Topics in a Unit. (10)

UNIT III

Flow Through Pipeline System: Loss of Energy in Pipes, Laws of Friction, Major Losses & Minor Losses, Loss of Head Due to Friction in Pipes (Darcy-Weisbach Formula), Chezy's Formula, Water Hammer in Pipes, Hydraulic & Total Energy Line.
Viscous Flow: Flow of Viscous Fluid through Circular Pipe (Hagen Poiseuille Formula), Between Two Parallel Plates, Methods of Determination of Coefficient of Viscosity, Kinetic Energy & Momentum Correction Factor.
Turbulent flow: Reynolds Experiment, Velocity Distribution in Turbulent Flow in Pipes, Hydrodynamically Smooth & Rough Boundaries, Velocity Distribution for Turbulent Flow in Smooth & Rough Pipes, Velocity Distribution for Turbulent Flow in Terms of Average Velocity, Variation of Friction Factor.
Problems Based on All the Topics in a Unit. (10)

UNIT IV

Dimensional Analysis: Fundamental Dimensions, Methods of Dimensional Analysis, Rayleigh's Method, Buckingham's π Theorem, Types of Similarities, Types of Forces Acting on Moving Fluid, Dimensionless Numbers, Classification of Models.

Boundary Layer Theory: Laminar & Turbulent Boundary Layer, Boundary Layer Thickness, Displacement Thickness, Momentum Thickness, Energy Thickness, Drag Force on a Flat Plate Due to Boundary Layer, Separation of Boundary Layer, Methods of Preventing Separation of Boundary Layer.

Problems Based on All the Topics in a Unit. (10)

UNIT V

Pumping of Liquids: Classification of Pumps, Principle, Construction, Working, Design, Discharge, Work Done & Power Requirement by Centrifugal Pump, Reciprocating Pump (Single & Double Acting), Pumps in Series, Pumps in Parallel, All Curves for Centrifugal Pump, Pump Efficiencies, Selection of Pumps, Priming, NPSH, Cavitation.

Pumping of Gases: Classification of Compressors, Principle, Construction, Working, Design, Discharge, Work Done & Power Requirement by Centrifugal & Reciprocating Compressor, Blowers, Vacuum Pump.

Problems Based on All the Topics in a Unit. (10)

Text/Reference Books

1. M. White, Fluid Mechanics, 8th Edition, Tata-McGraw Hill, 2016.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
3. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill International Edition 2005.
4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.
5. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, Wiley-India 2010.
6. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Ed., Wiley (2007).
7. B. R. Munson, D. F. Young, T. H. Okiishi and W. W. Huebsch, 6th Edition, Wiley-India 2010.
8. R. B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley India 2002.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	The students will have thorough knowledge of fluid properties, behaviour of fluid under different conditions, hydrostatics & pressure measurement.	2
2	The students will get well acquainted with basic principles in kinematics & dynamics of fluid flow with its application.	2
3	It will clear the basic concepts about various types of flows, complexities in flow through pipeline systems with detail study of laminar, turbulent	2

	flow.	
4	Students will get well acquainted with phenomena of boundary layer formation and separation. Students will be able to understand dimensional analysis and its application to **solve** the complex problems in heat & momentum transfer.	3
5	Student will have thorough knowledge of handling of fluids by various pumps, compressors, blowers and will be able to **design** the fluid handling system with calculation of power requirement in it. It will enhance the ability of students to identify and solve various engineering problems.	6

Course Title: Material and Energy Balance Computations

Course Code: CHL-206

Course Prerequisites: Physics, Chemistry-I, Mathematics-I, Thermodynamics-I

Course Objectives:

1. To teach students fundamental knowledge of chemical engineering and application of this knowledge in the solving of material and energy balances of chemical processes.
2. The course will cover concepts ranging from basics such as units and dimensions, stoichiometry to the simultaneous application of material and energy balances with and without occurrence of chemical reaction.

Course Contents:

UNIT- I

Units and Dimensions: Basic and derived units, different ways of expressing units of quantities and physical constants.

Calculations for mole, molecular weight, equivalent weight, etc., Composition of gaseous mixtures, liquid mixtures, solid mixtures, etc., Ideal gas law & other equations of state and their applications, Dalton law, Raoult's law, Hess's Law, Henry's law, Solutions and their properties. (10)

UNIT-II

Stoichiometry and unit operations:

Introduction to unit operation, development of block diagram and material balance for unit operations like blending, evaporation, crystallization, extraction and leaching, distillation, absorption & stripping, drying etc. (10)

UNIT-III

Material balance involving chemical reaction:

Introduction, definition and concept of terminologies like Excess Reactant, Conversion, Yield, Selectivity. Problems on material balance for chemical reactions for calculation of feed composition and product composition, Conversion, Yield, Selectivity etc. (10)

UNIT-IV

Humidity: Terminologies of Humidification like Humid Heat, Humid volume, % saturation, Molal Humidity, Molal saturation, absolute humidity etc.

Energy balance: Enthalpy calculation for systems (single component and multi components) without Chemical Reaction with Mean and Temperature dependent Heat Capacity, Enthalpy calculation for systems with Chemical Reactions. Heat of Reaction from Heat of Formation and Heat of Combustion Data, Effect of Temperature and Pressure on Heat of Reaction. (10)

UNIT-V

Introduction to Recycle, Bypass and purge operations: Applications of Recycle, Bypass and purge operations in unit operations and processes for calculation of recycle ratio, purge ratio, combined feed ratio.

Fuels: Types of fuels, Calorific value of fuels, Problems on combustion of coal, liquid fuels, gaseous fuels, etc., Proximate and ultimate analysis, Combustion calculations, Air requirement and flue gases. (10)

Text/ Reference Books:

Author, name of Book, latest edition year, publication

1. Bhatt., B.I. and Vora S.M. "Stoichiometry*"* 2nd edition, Tata McGraw Hill.
2. O.A. Hougen, K.M. Watson and R.A. Ragatz "Chemical Process Principles" Part-I, CBS Publishers &distributors ,New Delhi.
3. K.A.Gavhane "Introduction to process calculations" Nirali Publications.
4. Shekhar Pandharipande and Samir Musharaf "Process Calculations" Pune Vidyarthi GrihaPrakashan, Pune.
5. Himmelblau, D.M. *"*Basic Principles and Calculations in Chemical Engineering*"*, 6th edition. Prentice Hall.

Course Outcome:

Upon successful completion of the course, students will be able to

S.No.	CO	Cognitive level
1.	The capability to convert units and dimensions and modify equations from system to another.	6
2.	The capability to apply the laws of physics and chemistry in solving process industry related applications	3
3.	The proficiency to integrate the data and formulate the mass and energy balance problems.	6
4.	The capability to use mathematical knowledge for solving mass and energy balance problems with and without chemical reactions.	3

Course Title: Industrial Management and Economics

Course Code: HML-202

Course Prerequisite: Basic Manufacturing Process, Principle of Economics

Course Objective

1. Identification and selection of management & administration with aspect towards the Production planning and management.
2. Understanding Micro and Macroeconomics Demand and Supply factors of market economy &institutional feature inside the organisation as well as outside the organisation.
3. Understanding GDP statement, Entrepreneurship Development

Course Content

Unit-I

Management: Introduction & meaning management & administration

Industrial management: Connotation of Industrial management

Organisation: Explication and Types of organisation

Manufacturing system: definition, class of manufacturing system
Plant layout: Classification of Plant layout (8)

Unit-II
Business organization: Forms of business organization
Productivity: Various techniques to increase Productivity
Sound wage program: Mechanics of sound wage program
Wages & Wage Administration: Introduction &meaning of Wages & Administration of remuneration (8)

Unit-III
Marketing management: Introduction meaning and Concept of marketing management
Concept Sales management: Introduction meaning and Concept of Sales management significance of Sales management
Functions of Marketing management: prominence of marketing management
Functions of Sales management, role of Sales management (8)

Unit-IV
Economics: Introduction, meaning of Economics
Concept of GDP: Introduction meaning and Concept of GDP
Concept of ADP: influence of ADP
Introduction of Micro economics and Macro economics
Difference between Micro economics and Macroeconomics (8)

Unit-V
Entrepreneurship: Introduction, meaning and Concept of Entrepreneurship,
Types of Entrepreneurship: Order of Entrepreneurship
Entrepreneurship Development (8)

Text/ References Books:

1) John R. Hicks, "Value and Capital", 10th edition, Oxford, Clarendon Press, 2017
2) R. R. Barthwal, "Industrial Economics: An Introductory Text Book", 11th edition, New Age International, 2015
3) Martin Ricketts, "The Economics of Business Enterprise", 5th edition, ELGAR International, 2019
4) H. L. Ahuja, "Modern Economics" 9th edition, S. Chand Publishing, 2016
5) Alfred Marshal, "principle of Economics", 15th edition, Prometheus Books, 2016.

Course Outcome:

Upon successful completion of this course the student will be able to:

S.No.	CO	Cognitive Level
1.	Understanding of management and Productivity aspect towards the material management Production planning. Processes/operations according.	2
2.	Identification, selection and understanding the meaning and utility of Marketing management, consumer satisfaction, sales and advertising	2
3.	Understand the importance of Entrepreneurship Development.	2

Course Title: Food Chemistry

Course Code: FTC – 201 (TH)

Course Prerequisite: Chemistry-I, Physics and Thermodynamics-I

Course Objectives:

1. The purpose is to provide basic knowledge of foodchemistry
2. To make technically competent to work in foodindustry.

Course Contents:

UNIT I

Development of food chemistry, Importance of water in food, water activity, structure and physico-chemical properties of water and ice, concept of free and bound water and their implication, Physical properties of food system,colloidalproperties. (6)

UNIT II

Chemistry of Carbohydrates: Classification, structure, physical and chemical properties of carbohydrates, pectic substances, gums and other polysaccharides, modified carbohydrates, Role of carbohydrates in differentfoodproducts (6)

UNIT III

Chemistry of Proteins: Classification, Structure and chemistry of amino acids & proteins, Sources and distribution of proteins, physico-chemical and functional properties of proteins, applications of proteins in food industry, Role of protein in differentfoodproducts. (6)

UNIT IV

Chemistry of Lipids: Classification of lipids, Chemistry of fatty acids and glycerides, Physico-chemical and functional properties, Processing of fats and oils, hydrogenated fats, Rancidity of fats and oils, its prevention, Antioxidants, fat replacer, emulsions and emulsifiers, Role of lipids in different foodproducts (6)

UNIT V

Enzymes: Industrial application. Papain, Phenol Oxidase, Amylase, Pectic and lypolytic enzymes. Browning reaction in foods: Enzymatic and non-enzymatic and their control. Food Additives: Classification and their applications infoodindustry. (6)

Text/ Reference Books:

1. Principles of Food Science: G. Borgstrom, McMillan Co. Ltd., London, Vol II
2. Essential of Food Science: Vaclavik V, Chapman and Hall, N. York, 3rdedition.
3. Food Chemistry: L.H. Meyer, CBS Publishers & Distributors, 3rdedition.
4. Principles of food Science: Owen R. Fenemma, New York; Basel: Dekker, 2ndedition
5. Biophysical Chemistry: Upadhyay and Nath, Himalaya Publication, 1stedition

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** and gain the basic industrial knowledge of foodchemistry.	2
2	The students will gain basic technical **knowledge** of food components like water, carbohydrates, protein, lipids, enzymes and their analyticaltechniques.	2

Course Title: Food Chemistry

Course Code: FTC – 201 (PR)

Course Prerequisite: Chemistry-I, Physics and Thermodynamics-I

Course Objectives:

1. To provide practical knowledge of food chemistry competent to industrial requirement for analysis of foodstuffs.
2. To make competent to work for qualityassurance.

Course content:

1. Quality evaluation of water. (pH, Hardness, TDS, Turbidity ofwater).
2. Proximate analysis of foodsamples.
3. Qualitative test for carbohydrates, Proteins &Fats.

Text/ Reference Books

1. Analysis of fruits and vegetables products: S. Ranganna, McMillan Co. Ltd., London, 2nd edition.
2. Official Methods of Analysis Association of Official Analytical Chemist: Benjamin Franklin Station, Chapman and Hall, N.York.
3. Manual of Analysis of Fruits & Vegetables Products: S. Tata, McMillan Co. Ltd., London, 1st edition.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	The students can quantitatively **estimate** proteins, fats, carbohydrate, moisture, ash, crude fiber and acidity in food samples in foodindustries.	5
2.	They can **evaluate** water quality parameters used in foodindustries.	5

Course Title: Indian Constitution Course

Code: NC-202

Course Objectives:

To percolate & disseminate knowledge about constitution of India for imbibing & understanding importance of fundamental rights & duties so as to aware the students towards justice, equality & liberty.

Course Content:

- **Introduction to the Indian Constitution:** History and Making of the Constitution, Constituent Assembly, Salient features, The preamble
- **Fundamental Rights & Duties:** Meaning and types of fundamental rights; Fundamental duties, the Right to Equality, the Right to Freedom, the Right against Exploitation, the Right to Freedom of Religion, Cultural and Educational Rights and Right to Constitutional Remedies

- **Directive Principles and Human Right:** Meaning of Directive Principles; difference between of Fundamental Rights and Directive Principles of State Policy – Implementation of Directive Principles of State Policy
- **Union Government & Administration:** Structure of Indian union, Loksabha, Rajyasabha, Powers and Functions of the President, the Prime Minister, Council of Ministers; composition, powers and functions of the Parliament, organisation of judiciary; jurisdiction of the Supreme Court; independence of judiciary, Election Commission

- **State Government & Local Administration:** Powers and Functions of Governor, Chief Minister and Council of Minister; composition, powers and functions of State Legislature, Local administration and constitution: Panchayati, Municipalities.

Suggested Books/ Readings:

1. M. V. Pylee – An Introduction to Constitution of India, Vikas Publications, New Delhi-2005.
2. Subhash C. Kashyap – Our Constitution: An Introduction to India's Constitution & Constitutional Law, National Book Trust, New Delhi-2000.
3. Durga Das Basu – Introduction to the Constitution of India, PHI, New Delhi-2001.
4. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
5. J. C. Johari – Indian Government & Politics, Sterling Publishers, Delhi-2004.
6. V. D. Mahajan – Constitutional Development & National Movement in India, S. Chand & Company, New Delhi.
7. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
8. Granville Austin – Working of a Democratic Constitution: The Indian Experience, Oxford University Press, New Delhi-1999.
9. A. P. Avasthi – Indian Government & Politics, Naveen Agarwal, Agra-2004.
10. S. A. Palekar – Indian Constitution, Serials Publication, New Delhi-2003.

Course Outcome:

Upon successful completion of the course students will be able to

CO No.	Course Outcome	Cognitive level
1.	**Understand** various constitutional rights &fundamental duties.	2
2.	**Understand** the implementation of Directive &Principles of State Policy.	2
3.	Get **Knowledge** of powers and function of Central Government, Parliament, Supreme Court and Election commission.	2
4.	Get**Awareness** of powers & functions of Governor, State Government, Chief Minister and Council of Minister.	2

SEMESTER-IV
Course Title: Engineering and Solid Mechanics
Course Code: ESL – 205

Course Pre-requisite: Physics, Mathematics and Engineering Graphics

Course Objective:

- Students would be introduced to fundamentals of Engineering Mechanics with emphasis on force systems, axioms, dynamics of rigid bodies.
- Second part of the course would be an introduction to Solid Mechanics, and students would be introduced to basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and applications to one/two dimensional problems.

Course Contents:

Unit - I

Coplanar forces: Introduction, basic concepts, composition & resolution of forces. Resultant forces. Moment of forces, couples, equivalent force systems, free body diagrams, distributed forces. Equilibrium of coplanar force system, conditions of equilibrium. Types of supports. Support reactions for determination of beams. Problems on above topics.

Analysis of structure: Plane trusses, method of joints, cables subjected to part loads. (10)

Unit – II

Centroid &Centre of gravity of composite plane figures. Principal Moment of Inertia, Moment of Inertia of various geometry.

Friction: Laws of friction, Application of friction on horizontal & inclined planes, belt friction.

Introduction to point Kinematics: Curvilinear Motion: Moving point in various coordinate systems (Cartesian, cylindrical, path), Equation of motion.

Kinetics & Kinematics of Rigid body: Translation & Rotation motion, Linear and Angular velocity, momentum. (10)

Unit – III

Concept of stress & strain, classification, Hooke's law, Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Bulk modulus, relation between elastic constants, Problems on stresses & strains for prismatic, linear varying & composites sections.

Introduction to thermal stresses & strains. Problems on simple & composite sections. (10)

Unit – IV

Concept & definition of shear force & bending moment in determinate beams due to concentrated loads, UDL, UVL, Shear force & Bending moment diagrams for cantilever & simply supported beams (with or without overhang). Theory of bending. Concept of shear stress distribution. (10)

Unit – V

Thin Cylinder: Hoop stress, longitudinal stress, riveted cylindrical vessels, wire bound thin pipes. Thin spherical shells, cylinder with hemispherical ends.

Torsion of a circular shaft: Theory of pure torsion, Assumptions. Simple problems on torsion & power transmission. Short & long columns & struts. Standard cases with axial load. (10)

Text/Reference Books

1. I. B. Prasad, "Applied Mechanics & Strength of Materials", Khanna Publishers.
2. Timoshenko, "Mechanics of Materials", CBS Publisher
3. Ramamruthan S., "Strength of Material", Dhanpat rai Publications
4. Bear & Johnson, "Mechanics of Materials", 7th edition, McGraw-Hill Education, 2015

5. R. K. Rajput, “Strength of Materials”, S Chand Publications
6. R S Khurmi, “Strength of Materials”, S Chand Publications

Course Outcome:

Upon successful completion of the course students will be able to-

CO No.	Course Outcome	Cognitive level
1	**Solve** basic concept in structural members like column, beams, trusses, and concept in laws of frictions and various types of stresses and strains.	3
2	**Solve** shear forces and bending moment and plot diagrams.	3
3	**Analyze** various parameters on torsion in transmission system.	4

Course Title: Chemistry-II

Course Code: BSC-206

Course Prerequisite: Chemistry-I

Course Objectives:

1. To develop the arts and culture of organic chemical reactions and its significance in chemical and technology process industry.
2. To study how chemical reactions takes place differently in different environments i.e., reaction mechanism.
3. To study and apply the basic reactions mechanism to design synthesis of some classes of molecules.
4. To study industrially important chemical reactions, substrate and some reagents.
5. To study interconversion of functional group and their applications.
6. To study methods of determination of structure of molecules.

Course Contents:

UNIT- I

Aromatic molecules: Huckels rule of aromatic molecules, different classes of aromatic molecules, resonance.

Aromatic Electrophilic Substitution bimolecular reactions (ArSE2 reactions): Mechanism of ArSE2 reaction, Orientation of ArSE2 reaction in monosubstituted benzene, Mechanism and synthetic application of Nitration, Friedel-Craft’s alkylation and acylation reactions, Gatterman-Koch reaction, Vilsmeier-Haack’s reaction. (10)

UNIT-II

Aromatic amines: Methods of Preparation – benzyne mechanism, reduction of nitro aromatics, properties-basicity and application in synthesis.

Diazonium Salts: Preparation-diazotization reaction, chemical properties and reactions such as

coupling, synthesis of azo dyes, replacements-Sandmeyer's reaction and deamination. Ullman's reaction and Benzidine rearrangement. (10)

UNIT-III

Reagents and Green solvents in organic synthesis:

Complex Metal hydride-DIBAL-H, Lithium dimethyl cuprate, applications in synthesis. Introduction to organoboron-diborane, organosilicon-silane. H2O2 and O3(Ozone) application in organic synthesis. Introduction to Green reactions, Green and hazardous solvents. (10)

UNIT-IV

Sulphonic acids: Methods of preparation, application of sulphonic acids in synthesis.

Heterocyclic compounds: Introduction, Methods of synthesis and ArSE2 reactions such as nitration, sulphonation, halogenations, acylation and mercuration of Furan, Pyrrole and Pyridine. (10)

UNIT-V

Spectroscopy: Basic principles and applications of IR, UV-VIS and ^{1}H NMR spectroscopy to structure determination of small molecules. (10)

Text/ Reference Books:

1. S. H. Pine, Organic Chemistry, Tata McGraw-Hill Education India, 5th Revised edition-1987
2. M. B. Smith, Jerry March, March's Advanced Organic Chemistry: Reactions, Mechanism and Structure, Wiley-Interscience, 6th Edition2007.
3. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, Pearson, 7th Edition 2011.
4. Jonathan Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, 2000.
5. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, Cambridge University Press, 4th Edition 2012.
6. P. S. Kalsi, Spectroscopy of Organic Compounds, New Age International Pvt Ltd Publishers, 6th Edition, 2006.
7. Elementary Organic Spectroscopy, Y. R. Sharma, S. Chand & Co. 4th Edition 2007.

Course Outcome:

Upon successful completion of the course students will have-

S.No.	CO	Cognitive Level
1.	Clear basic **concepts** of different classes of organic molecules, their important reactions and functional group interconversions.	1
2.	They would know how organic reactions are takes place, how to **design** the desired product and factors to take care of it	6
3.	They will understand how to **apply** different concepts of reactions to workup/separation of product, to improve yields and to study structure of molecules.	3

4.	This course provides the knowledge of organic **concept** to undergraduate engineering students, and is designed to strengthen the fundamentals so that they can build their own interface of applied organic chemistry concept with their industrial applications in the branch of chemical engineering and Technology.	1

Chemistry-II Lab Course

Code: BSC-206 (PR)

Course Prerequisite: Chemistry-I practical

Course Objectives:

1. To develop the arts and culture of organic chemical reactions and its significance in chemical and technology process industry.
2. To study how chemical reactions are takes place differently in different environments i.e., reaction mechanism.
3. To inculcate the laboratory skills.

Course content:

1. Qualitative analysis of organic binary mixture through type determination, separation. Elemental analysis, functional group determination and physical constant of any one component (at least Two mixtures)
2. Single step preparation involving greener approach, purification and characterization (m.p.) of product (at least Three)
   - i) Preparation of dibenzalpropanone using NaOH or LiOH as base
   - ii) Preparation of p-nitro aniline from p-nitroacetanilide
   - iii) Bromination of acetanilide by CAN, KBr in water
   - iv) Preparation of Osazone from Glucose
   - v) Preparation of Sudan-I from aniline
   - vi) Preparation of p-nitrobenzoic acid from p-nitrotoluene
   - vii) Oxidation of alcohol to ketone by sodium hypochlorite (NaOCl)
3. Determinations/Estimations (Any Two)
   - i) Determination of total hardness of water
   - ii) Determination of Molecular Weight of a monobasic/ dibasic acid by volumetric method.
   - iii) Estimation of amide by hydrolysis
   - iv) Study of kinetics of hydrolysis of methyl acetate
4. Laboratory Techniques (any Three)
   - i) Thin Layer Chromatography (TLC)
   - ii) Hydrogenation of organic compound-a demonstration

iii) Interpretation of IR and UV-VIS Spectra

iv) Interpretation of 1H NMR spectra

Text/ Reference Books

1. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, Pearson, 5th Edition 2005.
2. R. K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Limited, 5th Revised Edition 2008.

Course Outcome:

Upon successful completion of the course students will have-

S.No.	CO	Cognitive Level.
1.	Clear basic **concepts** of different classes of organic molecules, their important reactions with developed laboratory skill andawareness.	1
2.	Basic concepts in preservation of environment by **adaptation** of Green Chemistry concepts.	6

Course Title: Thermodynamics II

Course Code: CHL – 201

Course Pre-requisite: Thermodynamics I

Course Objective: To introduce the concepts of fugacity, activity and their coefficients, Phase equilibria and Chemical reaction equilibria.

Course Contents:

Unit - I

Review of basic laws of thermodynamics, intensive and extensive properties, state and path function, calculation for work, enthalpy and entropy changes. Efficiency calculation to heat engine, heat pumps. Refrigeration cycle & Carnot cycle, Throttling Process. (10)

Unit – II

Properties of pure substances: T-V, P-V, P-T diagram. Ideal gas law, compressibility factor, Van der waals equation, Viral equation, Redlich Kwong equation, Redlich Kwong Soave equation of state. P-V-T relation for isothermal, isobaric, isochoric, adiabatic & polytropic processes. (10)

Unit – III

The Maxwell relations, method of Jacobians, Gibbs &Helmotz relations, the Clapeyron equation. The general relations for du, dh, C_v, & C_p; Mayer relation. Isothermal compressibility, volume expansivity, coefficient of linear expansion, adiabatic compressibility & adiabatic bulk modulus. The Joule Thomson Coefficient. (10)

Unit – IV

Phase Equilibria: Chemical potential, Kay's rule, Phase rule for reacting system, Duhem's theorem, boiling point and equilibrium diagram, fugacity and activity coefficient, activity coefficient equations (Wohl's three-suffix equations; Margules equation; Van Laar equation; Wilson equation; Non-random two-liquid (NRTL) equation; Universal quasi-chemical (UNIQUAC) equation; Universal functional activity coefficient (UNIFAC)), Azeotropes, consistency tests for VLE data, modified Roult's law, liquid-liquid equilibria. (10)

Unit – V

Chemical Reaction Equilibria: Chemical equilibrium criteria, Equilibrium constant, chemical equilibria for simultaneous reactions, Feasibility of a reaction, Effect of temperature and pressure on equilibrium constant, Heterogeneous reaction equilibria. (10)

Text/ Reference Books

1. J.M.Smith, H.C.Van Ness and M.M.Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, McGraw-Hill International Edition, 2005.
2. K.V.Narayanan, "A textbook of Chemical Engineering Thermodynamics" PHI, New Delhi, 2010.
3. Y.V.C.Rao, "Chemical Engineering Thermodynamics" , University Press, Hyderabad,1997.

S.Sandler, " Chemical, Biochemical and Engineering Thermodynamics" , 4th edition, Wiley, India,2014.

Course Outcome:

Upon successful completion of the course students will be

CO No.	Course Outcome	Cognitive level
1	Familiar with Basics of thermodynamics.	1
2	Familiar with various thermodynamics relations.	1
3	Able to **solve** problems of phase equilibria	3
4	Able to **solve** problems of chemical equilibria	3

Course Title: Mechanical Operation

Course Code: CHC-207

Pre-requisites: Material and energy balance computations, Fluid Mechanics

Course Objectives

The objective of this course is to make student well acquainted with basic principles of various mechanical operations, construction and working of the equipment.

Course Contents:

UNIT- I

Properties & Handling of Particulate Solids: Particle size, shape; mixed particle size & size analysis, specific surface of mixture, average particle size; properties of particulate masses; storage of solids. Size Reduction: Size reduction equipment for coarse, intermediate & fine size reduction; energy & power requirement; open & closed loop circuit. (8)

UNIT - II

Screening: Equipment, ideal screen. Screen analysis methods & std. screen series; capacity & effectiveness of screen. Mixing of Solids & Pastes: Mixers for coasive solids, free flowing solids, paste & plastic masses, power requirement, mixing effectiveness by mixing index calculation, rate of mixing. Mixing & Agitation of Liquids: Agitation equipment & flow pattern; circulation velocities & power consumption in agitated vessel; blending & mixing. (8)

UNIT -III

Flow Past Immersed Bodies: Drag coefficient, Stokes law, Cozeny- Carman equation. Flow of Solids Through Fluids: maximum settling velocity, free & hindered settling conditions. Fluidization: Minimum fluidization velocity, types of fluidization, application of fluidization in catalytic cracking, drying, etc.; fixed bed, spouted bed system. (8)

UNIT - IV

Classification & Sedimentation: Clarification & thickening, separation ratio; equipment for centrifugal & gravity classification; cyclone separator & design; hydrocyclones; principle of jigging, tabling, magnetic & electrostatic separation. Gravity sedimentation; laboratory batch & continuous sedimentation, centrifugal sedimentation. (8)

UNIT -V

Filtration: Filter aids, classification of filters, selection of filter media. Principle of batch filtration: constant pressure & constant rate filtration, factors affecting filtration. Continuous, centrifugal,

vacuum, gravity filtration & related equipment. Washing of filter cake. (8)

Text/ Reference Books

1. Mc Cabe W. L. & Smith J. C. " Unit Operation for Chemical Engg." 5th Edition.
2. Coulson J. M. &Rechardson J. F. " Chemical Engg. - Vol. II"
3. Badger W. L. &Banchero J. T. " Introduction to Chemical Engg."
4. Narayan &Bhatacharya " Mechanical Operation in Chemical Engg."
5. P. Chattopadhaya " Unit Operation in Chemical Engg. Vol. I "
6. G. G. Brown " Unit Operations"

Course Outcome:

Upon successful completion of the course students will be

CO No.	Course Outcome	Cognitive level
1.	To build basic knowledge of various mechanical operations.	2
2.	To **review** the practical importance and relevance of unit operations used for crushing, grinding and size separation in chemical industry.	2
3.	To **define** the properties of solid and to select suitable size reduction equipment.	1
4.	To **understand** fluid particle system, solid liquid separation process.	2
5.	To **analyze**mixing processes and solid-solid separation method	4

Mechanical Operation Lab

Course Code: CHC – 207 (PR)

Course Contents:

1. Study of the properties of solid.
2. Calculation of critical speed of ball mill and grinding of given sample.
3. Calculation of power consumption for crushing operation in Hammer mill.
4. Study of relationship between drag coefficient and modified Reynolds number for spherical body falling through fluid for Stokes law region.
5. Study of Batch sedimentation process.
6. Calculation of efficiency of cyclone separator.
7. Study of sigma mixture.
8. Study of filtration process in basket centrifuge.

Text/ Reference Books

1. Mc Cabe W. L. & Smith J. C. " Unit Operation for Chemical Engg." 5th Edition.
2. Coulson J. M. &Rechardson J. F. " Chemical Engg. - Vol. II"
3. Badger W. L. &Banchero J. T. " Introduction to Chemical Engg."
4. Narayan &Bhatacharya " Mechanical Operation in Chemical Engg."
5. P. Chattopadhaya " Unit Operation in Chemical Engg. Vol. I "
6. G. G. Brown " Unit Operations"

Course Outcome:

Upon successful completion of the course students will be

CO No.	Course Outcome	Cognitive level
1	Ability to **calculate** the properties of solid	3
2	**Analysis** of the performance of size reduction equipment.	4
3	Ability to **analyze** separation process for solid liquid system.	4
4	Ability to **analyze** separation process for Gas solid system.	4

Course Title: Engineering Workshop

Course Code: ESC – 206

Course Objective:

In workshop practice, students will get familiar with use of different workshop practices like fitting, welding, tin smithy, black smithy, foundry and computer hardware workshop. Students will also get familiar with different tools, machines, equipment, and job holding devices, job drawing, job material, job manufacturing operations and processes in different workshops.

Course Contents:

Unit - I

Manufacturing Methods: Casting: Pattern Making, pattern materials, pattern allowances, Types of sand. Moulding hand tools, defect in casting.

Forming: Hot working and Cold working, forging, Drawing, Rolling, Extrusion

Machining: Lathe machine, Its major parts & operations (5)

Unit – II

Joining: Welding: (Arc welding, TIG, MIG & Gas welding, types of flames), Brazing, riveting & fastening

Advance manufacturing methods: Electrical discharge machine(EDM), laser beam welding(LBM)CNC machining: Introduction.

Fitting operation: Marking, measuring, filling, drilling, tapping, Power tool: Power hacksaw machine, Bench grinder Machine. (5)

Unit – III

Carpentry: Timber, Measuring & Marking tools, cutting tools, planning tools, boring tools, striking tools, holding tools. Use of plastics & composites as engineering materials.

Plastic Moulding: Injection moulding.

Metal casting: die casting, its advantages & dis advantages, (5)

Text/Reference Books

1. ’Elements of Workshop Technology Vol I & Vol II: Hajara Chaudhari S. K, Hajara Chaudhari A. K, Nirjhar Roy S. K, Media promoters & publishers pvt. Ltd., Mumbai
2. Manufacturing Engineering &Technology: Kalpakjin S. & Steven S. Schmid, 4th addition Pearson education India. Edition,2002
3. ’Manufacturing Technology: Gouri E. Hariharan & A. Suresh Babu, I Pearson education 2008
4. ’Processes & Material of manufacture’s: Roy A. Lindber, 4th edition, Prentice hall India 2008
5. Manufacturing Technologies I & II: Rao P. N. Tata McGraw-Hill house 2017

Course Outcome:

Upon successful completion of the course

CO No.	Course Outcome	Cognitive level
1	Students will gain knowledge of the different manufacturing processes which are commonly employed in industries, to fabricate components using different materials.	2

Course Title: Engineering Workshop Lab

Course Code: ESC – 206

Workshop Practice: (Any Five)

1. Machine Shop: Turning- Facing, plain turning, Step turning & Taper turning.
2. Fitting: Filling, Drilling & Tapping
3. Carpentry: (Halving, Mortise & Tenon, Bridle, Butt, Dowel, Dovetail) any one.
4. Electrical & Electronics: Common house wiring connection
5. Welding Shop: (Butt, Lap, Corner, T) Any one
6. Piping (Any Joint)
7. Plastic Moulding: Injection moulding

Examination could involve the actual fabrication of simple components, utilising one or more of the techniques covered above.

Course Outcomes:

Upon successful completion of the course

CO	Course Outcome	Cognitive

No.		level
1	Students will be able to **fabricate** components with their ownhands.	6
2	They will also get practical knowledge of dimensional accuracies &dimensional tolerances possible with different manufacturing processes.	2
3	By assembling different component, they will be able to **produce** small devices of their interest.	6

Course Title: Food Biochemistry and Nutrition
Course Code: FTC – 202 (TH)

Course Prerequisite: Chemistry-I, Physics, Thermodynamics-I and Food Chemistry
Course Objectives: The purpose is to provide industry based basic knowledge of food biochemistry and nutrition.

Course Contents:

Unit I

Enzymes: Specificity of enzymes, Enzyme kinetics, Activation and inhibition and their different types, Technique of enzyme immobilization. (6)

Unit II

Cell membrane, Structure and transport mechanism, Bioenergetics: Generation of energy phosphates. Different biochemical pathways and their significance (6)

Unit III

Digestion, Absorption and metabolism of carbohydrates, lipids and proteins, Toxic compounds, basic introduction to allergens. (6)

Unit IV

Nutrition: Function of food, energy value of food, Food groups, BMR and its measurements, Energy requirement for individual, Recommended dietary allowances of proteins, fats and carbohydrates. Nutritive value of foods, Balanced diet, enrichment and fortification, effect of processing on nutrients.(6)

Unit V

Vitamins: Definition, Classification, chemistry, Sources, function, deficiency symptoms of Vitamins Minerals: Definition, Classification, Sources, function and deficiency symptoms of macro and micro minerals, Recommended dietary allowances of Vitamins and minerals. (6)

Text/ Reference Books:

1. Outline of Biochemistry: Conn and P. Stumpf, Willy, 5th edition.
2. Food Biochemistry: Estin and Henderson, Wiley-Blackwell, 2nd edition.
3. Food Science and Nutrition: M. Swaminathan, Bappco, 2010
4. Food Science: Srilaxmi, New Age International Private Limited, 6th edition
5. Applied Nutrition: R. Rajlaxmi, Oxford & IBH, 4th edition.
6. Lehninger Principle of biochemistry: David L.Nelson, Worth publishing, 3rd edition.
7. Fundamentals of biochemistry: Dr.J.L.Jain, S.Chandpublibation, Revised edition.
8. Biochemistry: Donald Voet, Wiley John & sons, 3rd edition.
9. Food & Nutrition: Don Ross, Oxford book, 2010

10. Food facts and principles: N. Shakuntala Manay, New age international publications, 3rd edition.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	The students can **understand** enzymes kinetics, Techniques for enzymeimmobilization.	2
2	The students can **understand** enzyme assay techniques, Isolation of enzymes from natural sources and theirapplications.	2
3	The students can **understand** identify Anti-nutritional factors in food and controlthem.	2

Food Biochemistry and NutritionLab
Course Code: FTC – 202 (PR)

Course Prerequisite: Chemistry-I, Physics, Thermodynamics-I and Food Chemistry
Course Objectives: The purpose is to provide industry-based knowledge of food biochemistry and nutrition.
Course content:
1. Effect of pH, temperature and substrate concentration on activity of enzymes
2. Quantitative evaluation of enzyme action
3. Quantitative estimation of sugars, proteins
4. Estimation of vitamin and minerals
5. Planning and preparation of diet for different age group individuals

Text/ Reference Books
1. Fundamental Biochemistry: S. Chand, S. Chand Publishing, 7th edition.
2. Biophysical techniques: Manikam and Sadashivam, New Age International (P) Ltd, 3rd edition.
3. Introductory Practical Biochemistry: S.K. Sawhney and R. Singh, Narosa Publishing House, January 2001.
4. Biochemistry: Satyanarayana, Elsevier, 5th edition.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	The students can **understand** enzymes kinetics, Techniques for enzymeimmobilization.	2
2	The Students can **understand** carry out assay of vitamins, minerals proteins and sugars in food samples by different techniques.	2

SEMESTER-V

Course Title: Mass Transfer Operations

Course Code: CHL-314

Course objectives:

Objective of this subject is to expose students to understand the basic mass transfer operation like diffusion, absorption, drying, humidification distillation, liquid-liquid extraction, adsorption, leaching and crystallization and its application to chemical engineering.

Pre-requisites:

Material and energy Balances Computations (CHL-206)

Course Content:

Unit-I

Constitutive laws of diffusion: Equimolecular counter diffusion and diffusion in stationary gas; Diffusivities in liquid, vapor and gases; Local and average overall mass transfer coefficients

Interphase mass transfer process: Mass transfer equilibrium, Mass transfer theories, Mass transfer and chemical reaction

Material balance: Steady state co-current and counter current processes, stage wise and differential contacts, Number of theoretical stages, Stage efficiency, Height of transfer units.

Unit-II

Distillation of binary mixtures: Vapor–liquid equilibria, Raoult's law, X-Y, T-X-Y & H-X-Y diagrams, Boiling point diagram and azeotropes

Types of distillation, Fractionating column and multistage column,MaCabe-Thiele method, Operating and feed lines, feed conditions, reflux ratio, minimum and optimum reflux ratio, Tray and column efficiency.

Unit-III

Absorption: Solubility, choice of solvent, concept of driving force and mass transfer coefficient, Material balance for transfer of one component -counter current and concurrent flow, minimum gas-liquid ratio for absorber. absorption with & without chemical reaction. Determination of height of columns, transfer units and HETP.

Packed towers: General construction & working, types of packing merits & demerits, operational difficulties, pressure drop & limiting G-L flow rates.

Plate towers: General construction & working, types of plate, merits and demerits, operational difficulties

Unit IV

Liquid-Liquid Extraction: fundamentals, solvent selection, triangular diagram representation, Single stage extraction- maximum and maximum solvent, Equipment for liquid-liquid extraction. (Mixer settler, Rotating Disc Contractor, Packed column, spray column) equipment selection criteria.

Solid–Liquid Extraction fundamentals, Solvent selection, equilibrium relationship, triangular diagram representation, single stage operation,

Unit-V

Crystallization: Theory of solubility and crystallization, phase diagram (temp/solubility relationship),methods of achieving Supersaturation, phenomenon of crystal formation, crystal structure. Material & heat balance over crystallizer & related problems.

Drying: Drying mechanism, Constant rate and falling rate periods, drying rate curves, estimation of drying time, moisture contents, drying equipments- rotary dryers, drum dryers, vacuum dryers, Spray dryer, fluidized bed dryers.

Text/ Reference Books

1. Dutta, Binay K. *Principles of mass transfer and seperation processes*. PHI Learning Pvt. Ltd., 2007.
2. Treybal, Robert E. "Mass transfer operations." *New York* 466 (1980).
3. Cussler, Edward Lansing, and Edward Lansing Cussler. *Diffusion: mass transfer in fluid systems*. Cambridge university press, 2009.
4. Foust, Alan S., Leonard A. Wenzel, Curtis W. Clump, Louis Maus, and L. Bryce Andersen. *Principles of unit operations*. John Wiley & Sons, 2008.
5. Geankoplis, Tansport. "Processes and unit Operations, 3rd Editions Prentice hall." *Englewood Cliffs, NJ* (1993).

Course Outcome:

Upon completion of the course students will be able to:

CO No.	Course Outcome	Cognitive level
1	**Recognize** laws of diffusion, **apply** them in mass transfer operation and **estimate** the number of stages in distillation.	1
2	**Interpret** the fundamentals of gas absorption and **evaluate** the height of packed column for absorption.	4
3	**Analyze**liquid–liquid extraction and **solve** problems on single stage extraction.	2
4	**Understand** the basics of crystallization and drying technology.	5

Course Title : Mass & Momentum Transfer Operations
Course Code: CHP-315

Course objectives:
To provide the hand-in-hand experience of lab-scale experiments on various types of equipment based on the theoretical understanding and its application learned in theory course.

Experiments:

1. Determination of diffusivity of Acetone in air; Acetic acid in water.
2. Determination of rate of drying of given sample.
3. Determination of Mass transfer coefficient in wetted wall column.
4. Determination of loading and flooding point in packed column.
5. Validation of Rayleigh equation (Differential distillation).
6. Determination of distribution coefficient of Single stage liquid -liquid extraction for Acetic acid- water-benzene system.
7. Determination of Reynolds Number & prediction of flow behavior.
8. Determination of coefficient of discharge of Venturimeter and Orifice Meter.
9. Determination of the coefficient of discharge for Triangular, Rectangular and Trapezoidal Notch.
10. Study of characteristics of pumps & compressors (Centrifugal & Reciprocating)

Reference Books

1. Departmental Practical Manual.

Course Outcome:

Upon completion of the course students will be able to:

S.No.	CO	Cognitive Level
1.	**Develop** the ability regarding analytical and data interpretation skills.	6
2.	**Understand** the scaling approach of understanding from Experimental to Industry applications.	2
3.	**Plan** an appropriate approach to experiment work and justify plans in the light of preliminary findings.	4
4.	**Demonstrate** safe working in the choice of method and apparatus.	2

Course Title: Process Design and Project Management
Course Code: CHL-312

Course objectives:
The objective of the course is to provide students with a firm grasp of the essential principles ofmanagement,projectidentificationprojectfeasibilityandprojectschedulingtechniquewith suitable examples. Students will able to understand HAZOP design and read the PID of the plant. Students will able to understand economics for chemicalprocesses.

Prerequisites:
Industrial Management and Economics (HML-202)

Course Content:

Unit -I
Project identification and its feasibility; project testing based on viability, risk & cost estimation; evaluation of project by different methods on the basis of visibility i) Net present valuemethod,ii)Methodofrateofreturnoninitialinvestment,iii)Payoutperiod,iv)Method ofdiscountcashflow,v)Capitalizedcostmethod,vi)Internalrateofreturnmethod,vi)Break evenchart;evaluationofprojectbydifferentmethodsonthebasisofriski)Profitabilityindex,
ii) Demand fore casting, iii) Standard deviation approach; evaluation of project by different methods on the basis of cost i) Preparation of cost sheet and statements, ii) Preparation of profit loss statement.

Unit –II
New developments in management, CPM & PERT, principle and objective of CPM and PERT network diagram for calculation time duration.
Linear programming problem (Numerical based on each method) i) General simplex method ii) Primary& dual technique method iii) Direct simplex method iv) Graphicalmethod.

Unit –III
Cost analysis, fixed capital, working capital, preparation of store ledger account by pricing issue methods, LIFO, FIFO, simple average, weighted average.
Depreciation, significance of inadequacy and obsolescence, and depreciation methods.

Unit -IV

Layout and location, objective, principle; layout and location factors, equipment layout diagram (ELD); tank firm cum utility block diagram for different processes.

Unit -V

HAZOP: Introduction and guide word, application of HAZOP to processes with examples. PID: Basic symbols for various piping and instruments; development of PFD, P&ID, PDS for different processes.

Text/ Reference Books

1. S.D. Dawande*Process equipment Design*. Denett and Co FifthEdition
2. B.V.Pathak&M.S.Mahajan*IndustrialOrganization&Management*, NiraliPrakashan First Edition 1986
3. Peters, Max Stone, Klaus D. Timmerhaus, Ronald Emmett West, Klaus Timmerhaus, and Ronald West. *Plant design and economics for chemical engineers*. Vol. 4. New York: McGraw-Hill,1968.
4. Shreve,RandolphNorris,andJosephA.BrinkJr.*ChemicalProcessIndustries*.No.4th Edition. McGraw-Hill Book Co.,1977.
5. Drydens*Outlines of Chemical Process Technology*, Third Edition,1997
6. D.B.Dhone*PlantUtilities*NiraliPrakashan, First Edition2008.

Course Outcomes:

Upon successful completion of the course, students will be able to-

CO No.	Course Outcome	Cognitive level
1	To **evaluate** feasibility of project.	5
2	To **apply** various methods of profitability evaluation.	3
3	To **identify** the new development in project management and optimization techniques.	2
4	To **apply** HAZOP analysis for safety of the process.	3

Course Title: Principles of Food Preservation
Course Code: FTC-301

Course Objectives:

1. To study causes of foodspoilage.
2. To study newer technology of Thermal / Nonthermal processing of food.
3. To study drying and dehydration offoods.
4. To study freezing and cold storage of food.

Course Content:

Unit –I:

Food Spoilage: Intrinsic and Extrinsic factors affecting food spoilage. Basic principles and methods of food preservation

Preservation by chemicals, bio-preservative, antimicrobial, hurdle technology.

Unit-II:

Thermal processing of Foods: Newer techniques in thermal processing- Retort processing, UHT, Extrusion hot and cold.

Newer techniques of Non thermal processing: high pressure processing, Ohmic heating, pulse electric field, dielectric heating, infrared, microwave heating.

Unit – III:

Dehydration: Water activity for food and its significance in food preservation, dehydration and drying of foods, different dryers - Cabinet dryer, fluidized bed dryer, Spray dryer, Microwave dryer. Osmo-air dehydration ,IM food.

Unit-IV:

Concentration: Freeze concentration, open pan vacuum concentration, freeze drying, membrane concentration.

Irradiation: Preservation by ionizing radiation;Ultrasonic

Preservation by fermentation:curing, pickling; smoking.

Unit-V:

Low Temperature preservation of foods: Planks equation for predicting rate of freezing. FreezingandColdStorage,includingcryogenicfreezing,propertiesoffrozenfoods,IQF,Blast freezing, Types of thawing and their effect on food.

Textbooks

1. Potter, Norman N., and Joseph H. Hotchkiss. Food Science. Gaithersburg, MD: Aspen Publishers, 1998.
2. Owens R. Fenemma, Principles of Food Science: Physical Methods of Food Preservation Part II, Taylor & Francis Inc,1975
3. Owen R. Fennema, Principle of food science, New York ; Basel : Dekker,1975.
4. Grandison, Alistair S., and J. G. Brennan. Food Processing Handbook. Weinheim: Wiley-VCH,2012

Reference Books

1. Fruits and vegetable processing bycruss.
2. Desrosier, Norman W. Technology of Food Preservation. Place of publication not identified: ED-TECH,2018.
3. Radiation Technology by Desrosier, N.W. AVI Publishing Co. Inc, 1960.
4. Board, Niir. Modern Technology on Food Preservation. Delhi: Asia Pacific Business Press,2004
5. Food processing Technology: Principle and practice- Fellow P. J. , CBS publishers2005.
6. Srivastava, RP, and Sanjeev Kumar. Fruit and Vegetable Preservation: Principles and Practices. New Delhi: CBS Publishers & Distributors Pvt. Ltd.,1994..
7. Fellows, P. Food Processing Technology: Principles and Practice,2000.
8. Lal, Girdhari, G. S. Siddappa, and G. L. Tandon. Preservation of Fruits and Vegetables. New Delhi: Publications and Information Division, Indian Council of Agricultural Research,2011.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Student**discriminate** and categorized the causes of food spoilage and theircontrol	5
2.	Students can **justify** newer technology in thermal processing and non-thermal processing ofFoods	5
3.	Students will be able to **explore** newer techniques dehydration offoods.	3
4.	Students can **predict** rate offreezing.	3

Course Code: FTC-301

Course Title: Principles of Food Preservation

Course Objectives:

1. To study various thermal processing techniques for foodpreservation.
2. To study about various chemical preservatives to increase shelflife.
3. To study drying and dehydrationtechniques
4. To study effect of low temperature for foodprocessing.

Course Content:

Demonstration of food processing equipment's
To study the adequacy of blanching treatment of fruits and vegetables
Preservation of fruits squash by chemical preservation
Phosphatase test of pasteurized milk
Concentration of fruits juices
Dehydration of fruits and vegetables
To study the effect of low temperature on quality of fruits (Chilling injury)
Cutout analysis of Canned fruits.

Reference Books:

1. Chemical analysis of food and food product by Pearson D, J.E.A Churchill, 104, Gloucester place, Londan, sixth edition1970.
2. Rangana, S. Manual of Analysis of Fruit and Vegetable Products. New Delhi: Tata McGraw-Hill,1979
3. Official Methods of Analysis of the Association of Official Analytical Chemists, The Association, 2000
4. Lal,Girdhari,G.S.Siddappa,andG.L.Tandon. *PreservationofFruitsandVegetables*. New Delhi: Publications and Information Division, Indian Council of Agricultural Research, 2011.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students will be able to **Recognize** food preservation by dehydration,	6

	concentration, low temperature and chemicalpreservation	
2.	Studentscan**Explore**canning,pasteurization,blanchingforhightemperaturepreservation.	6
3.	Student can **Demonstrate** food processingequipment's	5
4.	Student can **prepare** cutout analysis of cannedfruits	3

Course Code: FTC-302

Course Title: Microbiology and Molecular Biology

Course Objectives:

1. To study basics of microorganism, importance of foodmicrobiology.
2. To study composition of nutrient media, isolation and enumeration ofmicroorganism.
3. To study various techniques of controllingmicroorganisms.
4. To study occurrence of food intoxication and their preventive and controlmeasures.

Course Content:

Unit I:

Historical background of microbiology. Scope and importance of food microbiology, classification and terminology of microorganism, study of morphology and physiology of bacteria, yeast, mold and occurrence of viruses in foods.

Unit II:

Nutritional requirement of micro-organism, composition of nutrient media, Enumeration of microorganism.Maintenance and preservation of industrially important microbial cultures.

Unit III:

Effect of temperature, dehydration, irradiation, and chemicals on growth of micro-organisms, controlofmicroorganismbyhighandlowtemperature,controlofmicroorganismsbyphysical and chemical methods. Determination of TDT curve,D, Z and Fvalue.

Unit IV:

Food borneinfection,Foodmycotoxintheirsources,toxicity,symptoms,preventiveandcontrol measures.

Unit V:

Contamination: Source of microbial contamination and spoilage of fresh and processed food products and their prevention. Spoilage of Canned foods, Bakery and confectionary products, milk and milk products, meat and meat products.

Text Book

1. Prescott, Samuel Cate, C. G. Dunn, and G. Reed. Industrial Microbiology. New York: MacMillan,198
2. Pelczar, Michael J., Eddie C. S. Chan, and Noel R. Krieg. Microbiology. New Delhi: Tata

McGraw-Hill,2010.
3. Frazier, William C., and Dennis C. Westhoff. Food Microbiology. London: McGraw-Hill, 1988

Reference Books:

4. Food Processing Operation By M.A. Joslyn and J.L.Held, The AVI publishing co. Inc. Westport.
5. The Micrbiological Safety of Food Edited by B. C. Hobs. J. H. E.Christian(1972), AcademicPress.
6. George, Borgstrom. Principles of Food Science. New York: Mackillan Co.,1968.
7. Desrosier, Norman W. Technology Of Food Preservation. Place of publication not identified: ED-TECH,2018.
8. Balachandar, D., and R. Thamizh. Vendan. Introductory Microbiology. New Delhi: New India Publishing Agency,2007.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students will be able to **prepare** media for microbial growth, isolation and characterization ofmicroorganisms.	6
2.	Student can **outline** the techniques of control of micro-organisms by physical, high temperature and chemicalmethods.	2
3.	Students will able to **diagnose** food infection/ intoxication and theircontrol.	2
4.	Students can **access** spoilage of fresh and processedfood.	6

Course Code: FTC-302
Course Title: Microbiology and Molecular Biology (PR)

Course Objectives:

1. To study composition of nutrient media growth, isolation and characterization of microorganism.
2. To study enumeration of microorganisms.
3. To study isolationtechniques.
4. To study microbiological examination of water and processedfoods.

Course Content

Staining Techniques
Isolation of microbes from food sample by Streak Plate, Pour Plate, Spread Plate
CFU, yeast and mold count
Measurement of antimicrobial activity
Evaluation of microbial quality of specific Fruit& Vegetable product and water sample.
Study of milk microbiology.

Reference Books:

1. Jay, James M. Modern Food Microbiology. New York: Springer,2005.
2. Ward, Owen P. Fermentation Biotechnology: Principles, Processes and Products. Chichester: John Wiley & Sons Ltd.,1995.
3. Comprehensive Biotechnology by Murvay&Mooyonng academicpress.
4. Aneja, K. R. Modern Food Microbiology. Noida: Medtech A division of scientific international,2018.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students will be able to **interpret** micro-organisms by stainingtechniques.	2
2.	Students will be able to **analyze**various isolation techniques ofmicroorganisms.	4
3.	Students can **estimate** CFU count infoods.	4
4.	Students will be able to **examine** microbial quality of water and processedfoods	3

Elective-I (Open Elective)

Course Code: FTL-305

Course Title: Advanced Technology in Food Packaging

Course Objectives:

1. To study basic packaging materials, their properties, types of packaging, sealingand laminationprocess.
2. To study newer packaging technologies used for food products.
3. To estimate shelf life of packagedproducts.
4. To study packaging of soft drink and alcoholicbeverages.

Prerequisites: ----Not Applicable----

Course Content:

Unit –I

Packaging as a method for conservation and protection of foods, different packaging material and their properties including barrier properties, strength properties, optical properties etc.Glass, Aluminium, tin, paper, plastic and composites. Sealing of metallic and plastic containers. Types of food packaging

Unit –II

Flexible packaging, laminated packaging and retortable pouches and biodegradablepackaging material. Concept and calculation of shelf life of laminate, wine in PET, glass bottle; shelflife based on browning, vitamin loss and microbial count in food container. Safety and testing of packagingcontainers.

Unit –III

Active packaging system: - Packaging requirement for different moisture level food products, Aseptic processing and packaging of fruits & vegetables, milk and milk products

Unit – IV

Product-Packagecompatibility:-MicrowavablePackaging,MAPoffreshfruitandvegetable, vacuum and MAP of meat and meat products. Packaging of breakfast cereals, bakery and confectionaryproducts

Unit –V

Packagingofsoftdrink,alcoholicbeverages,distilledspirits,frozenfood,futuretrendsinfood packaging: intelligent/ smart packaging.

Text/ Reference Books

1. HandbookoffoodpackagingbyF.APaineandH.Ypaine.,Publisher:BlackisandSonLtd London (1983)
2. Food Packaging Principles and Practice: Gordon L. Robertson
3. Modern processing and distribution system for food edited by F. APaine
4. Food and packaging interaction by Risch. S. H., Publisher: American chemical Society, Washington(1991)

5. PackagingmaterialsandcontainersbyPaineF.A.,Publisher:BlackisandsonsLtd,London (1983)
6. Mathlouthi, M. Food Packaging and Preservation. Gaithersburg: Aspen,1999
7. Paine F. A . Packaging media Publisher: Blackis and son Ltd; Bishop Briggs(1977)
8. Bureau, G., and J. L. Multon. Food Packaging Technology. New York, n.d. (1996)
9. Chemistry of Food Packaging by Swalam C.M., American Chemical Society, Washington D. C. 1974.
10. Packaging. Rockport, MA: Rockport Publishers,1995.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Recognize** and **classify** food packaging materials and theiruse.	6
2.	**Differentiate** active packaging, aseptic packaging, MAP, vacuum packaging, smart packaging, microwave ablepackaging.	2
3.	**Estimate s**helf life of foodpackaged.	2
4.	**Device** packaging of, soft drink, alcoholic beverages, and frozenfood.	6

Course Title: Technology of Perfumery and Cosmetics (Open Elective-I)

Course Code: OTL– 305 (Open Elective-I)

Course objectives: This course provides a thorough knowledge about different essential oil, perfumery synthetics and cosmetic ingredients. Students shall acquire various extraction methodologies in recovery of essential oils, their physio-chemical properties and applications. Also, the course will cover raw material for different cosmetic preparations.

Course Contents:

Unit I:

Essential oils: Chemistry, source materials, production methods

Production, properties and applications of essential oils (Rose, Jasmine, Khus, Sandalwood, Palmarosa, Lemongrass, Peppermint, Orange).

Unit II:

Physio-chemical properties of essential oils: Colour, specific gravity, refractive index, optical rotation, solubility, congealing point, evaporation residue, acid value and ester value.

Analysis of essential oils: Alcohol, Aldehyde, Ketones and Phenol content.

Unit III:

Grading and standardization of essential oils; common adulterants and their detection.

Perfumery: History and its function, mechanism of smelling, classification & blending of perfume ingredients, perfumery isolates (Menthol, Geraniol and Musk).

Unit IV:

Synthetic perfumery materials and fixatives (Camphor, Thymol, Citral, Vanillin, Cumarin, Benzyl acetate, Benzyl benzoate)

Production, properties and applications: Hair oil & dyes, Shaving creams and Depilatories.

Unit V:

Production, function and properties of cosmetic products: Face cream, Face powder, Talcum powder, Toothpaste/powder, Shampoo, Lipsticks and Nail polish.

Text/Reference Books:

1. Valerie Ann Worwood "The Complete Book of Essential Oils and Aromatherapy"
2. Ernest Guenther"The Essential Oils" Volume-I
3. Sonia Malik "Essential Oil Research" Springer International Publishing
4. "Hand Book of Perfumes with Formulations" Engineers India Research Institute.
5. Nigel Groom"The Perfume Handbook" Springer
6. Steffen Arctander"Perfume and Flavor Materials of Natural Origin"
7. S.K. Singh "Handbook on Cosmetics (Processes, Formulae with Testing Methods)"
8. H. W. Hibbott. "Handbook of Cosmetic Science" 1st Edition

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Understand** the fundamental of essential oils and **propose** methods of their production.	2
2	**Differentiate**the principles behind the physio-chemical analytical techniques in the estimation of quality parameters of essentialoils.	2
3	**Devise**the concepts of perfumery, blending of perfumes and **outline**the use of synthetic perfumerymaterials.	6
4	**Propose**the production techniques and **illustrate**the functions of	6

	ingredients in cosmetics products.	

Course Title: Specialty Pigments and Additives in Coatings (Open Elective-I)

Course Code: PTL-305 (Open Elective-I)

Course objectives:

The Paint Technocrat will have in depth exposure to Specialty Pigments and Additives in Coatings.

1. The student will learn about the metallic and pearl effect and changes in pigmentary properties in reference to nano size.
2. The Technocrat will have exposure to Mechanism, dosing and Trade information of coating additives and surfactants.

Course Contents:

Unit I:

Metallic, Interference and Cholesteric Pigments

Aluminum, copper, zinc dust, bronze, nickel stainless steel, lead powders and pastes, Nacreous, luminescent (fluorescent/phosphorescent) pigments-optical principles, substrate free pearlescent pigments, Special effect pigments based on mica (pigments formed by coating of substrates), pigments based on liquid crystal polymer

Unit II:

Functional and Nano Pigments

Antifouling pigments-cuprous oxide, other copper compounds, mercuric oxide, barium metaborate, organotin pigments, Manufacture and properties of nanopigments: alumina, silica, titanium dioxide, iron oxides, zinc oxides, silver, $CaCO_3$, etc. on Nano scale; variables affecting particle size aggregation and crystal structure. Their use as spacing extenders / functional pigments in paints, reinforcing agent in polymers, heat & wear resistant materials, etc.

Unit III:

Surfactants and Surface Additives

Anionic, cationic, non-ionic and amphoteric surfactants; polymeric surfactants, Gemini surfactants, HLB value, CMC, Kraft point. Role of surfactants as- emulsifier, wetting agents, dispersing agents. Surface additives, role of silicone and Fluro surfactants as surface additives flow and levelling control agents, slip additives

Unit IV:

Specialty additives in Solvent Borne CoatingsAntisettling agents, additives for rheology control, adhesion promoters, antiskinning agents, light stabilizers (UV absorbers, antioxidants, HALS), moisture scavengers, hammer and wrinkle finish additives, conductivity control additives etc.

Unit V:

Specialty additives for Water Borne Coating

Auxiliary and coalescing solvents, neutralization agents, thickeners, antifoam, antifreeze-thaw, Preservatives (In- can/film)-fungicides, mildew agents, corrosion inhibitors etc.

Text/Reference Books:

1. Jones, Frank N., Mark E. Nichols, and Socrates Peter Pappas. *Organic Coatings: Science and Technology*. John Wiley & Sons, 2017.
2. Swaraj, Paul. *Surface Coatings: Science and Technology*. J. Wiley & sons, 1985.
3. Karsa, D. R.; Davies, W. D., Eds., *Waterborne Coatings and Additives*, Royal Society of Chemistry,Cambridge, 1995.
4. Buxbaum, Gunter, ed. *Industrial inorganic pigments*. John Wiley & Sons, 2008.
5. Berte, J. N. "*High Performance Pigments*, ed Smith HM." (2002): 27-40.
6. Bieleman, Johan, ed. *Additives for coatings*. John Wiley & Sons, 2008.
7. Herbst, Willy, and Klaus Hunger. *Industrial organic pigments: production, properties, applications*. John Wiley & Sons, 2006.
8. Calbo, Leonard J. *Handbook of coatings additives*. 1987.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Optical effects and **evaluation** of Metallic, Interference and Cholesteric Pigments in coatings.	5
2	**Synthesis**, properties and applications of Functional and Nanopigments.	5
3	**Constructive**, corrective and **comparative**role of various additives in solvent borne, waterborne and othercoatings.	5
4	Dosing and trade information of Additives inCoatings.	2

Elective-I (Open Elective)

Course Code: PLL-304

Course Title: Polymer Rheology

Course Objectives:

1. To understand the flow properties of polymers in terms of various models to study viscoelastic behavior of thepolymers.
2. To know the thermo viscoelastic behavior of polymers during processing andselection of design of processingdevice.
3. To understand the processing of various types of polymers, selection of device for processing on the basis of flowproperties.

Prerequisites: ----Not Applicable----

Course Content:

Unit -I

Rheological Principles: Rheological Parameters, relationship between rheological parameters, Rheological systems: purely elastic, viscous, Types of fluids: Newtonian and Non Newtonian fluids, Viscoelastics fluids, Rheological or Constitutive equations.

Unit -II

Viscoelastic Nature of Polymers: Elasticity moduli and their time dependence, static and dynamic experiments to understand the time dependence , tan, its significance and methodof determination, models of viscoelasticity, mechanical models such as Maxwell, voight, combinationsofMaxwellandvoightmodelstosimulateviscoelasticbehavior,salientfeatures of molecular theories ofviscoelasticity.

Unit -III

Glass Transition, Theories to determine the glass transition i.e. Dillatometric, Heat capacity, measurement, Thermomechanical, Measurement of modulus of elasticity, effect of Tg on molecular mass, kinetic chain flexbility and chemical constituent, Importance of Tg and Tm.

Unit -IV

Viscoelastic behavior of Polymer solution and melts stress-strain curves for Polymers, creep curves of Polymeric material, elastic deformation, irrecoverable followdeformation.
Rubber like deformation, Time-temp superposition (WLFEquation)

Unit -V

Methods to determine shear viscosity by capillary, parallel plate and cone and plate Rheometer, Measurement of normal stresses, Application of rheology to polymer processing.

Text/ Reference Books

1. P.N.Cogswell, Polymer Melt Rheology, A guide for Industrial Practice, George Godwin, Second Edition,1981.
2. RichardC.Progelhof and James L. Throne, Polymer Engineering Principles, Hanser Publishers, New York,1993.
3. John M. Dealy and Kurt F. Wissburn, Melt rheology and its role in plastics processing, Chapman, London,1995.
4. R.S. Lenk, Polymer Rheology, Applied Science, London,1978.

5. J.D. Ferry, Viscoelastic Properties of Polymers, john Wiley & Sons, New York,1986.
6. Chang Dae Han. Rheology in Polymer Processing, Academic Press, New York,1976.
7. R.J. Crawford, Plastics Engineering, Butterworth - Heinemann, Oxford,1998
8. B.R. Gupta, Applied Rheology in Polymer Processing, Asian Books Pvt. Ltd. 1st Edition, 2005.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Flow behavior of the polymers and various models used for **determination** of flow properties.	3
2	**Design** features of the processing device on the basis of processing parameter as temperature, pressure, shear rate.	6
3	Proper **selection** of processing equipment with respect to change in polymer, polymer flow properties.	4

Elective-I (Open Elective)
Course Code: CHL-320
Course Title: Nanoscience and Nanotechnology

Course Objectives:

The objective of the course is to introduce students about emerging field of Nanoscience and Technology. Students will learn about properties of nanomaterials and their applications.

Prerequisites: ----Not Applicable----

UNIT-I

Quantum chemistry, Solid state Physics, Nanomaterial & Manufacturing, Renewable energy generation, Nanotechnology in drug delivery, Nanotechnology in cosmetics, Bio-nanotechnology, Nanotechnology & information technology, Nanotechnology in agriculture and food industry, Environmental nanotechnology, Nanotechnology Health risk.

UNIT-II

Synthesis methods of nanostructures: Top-Down and Bottom-up approach of synthesis, Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation andco-precipitation; Sol-gel synthesis; Microemulsions or reverse micelles; Solvothermalsynthesis.

UNIT-III

Nanostructures and its applications: Carbon Nanotubes (CNT), Graphenes, Fullerenes, Nano Peapods, Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide, Silver, Copper Nanoparticles) Nanowires Polymer-based Nanostructures including dendrimers, nanofillers like clay, $CaCO_3$, $CaSO_4$.

UINT-IV

Nanocatalysis: Nanomaterials as catalysts for a variety of homogeneous and heterogeneous catalysis applications. Impact of the intrinsic properties of nanomaterials on catalysis,Various methods like Chemical Reduction Method, Thermal, Photochemical and Sonochemical Reduction Method, Applications of Nanocatalysis in ChemicalIndustry.

UNIT-V

Characterization techniques in analysingNanomaterials: Scanning/transmission electron microscopy (SEM/ TEM), XRD, Atomic Force Microscopy, Particle size analyser (PSA) and their applications.

Text/ Reference Books

1. Nanochemistry: A Chemical Approach to Nanomaterials, Geoffrey A. Ozin, Andre C. Arsenault, Royal Society of Chemistry, Cambridge, UK, 2005.
2. Chemistry of Nanomaterials: Synthesis, Properties and Applications C. N. R. Rao, Achim Muller, A. K Cheetham, Wiely-VCH,2004.
3. Metal Nanoparticles: Synthesis Characterization & Applications, Daniel L. Fedlheim, Colby A. Foss, Marcel Dekker,2002.
4. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong, Ying Wang, World Scientific,2011.
5. Nanoparticles and Catalysis, Didier Astruc (Editor), Wiley-VCH Verlag GmbH & Co. KGaA,2008

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Choose** appropriate synthesis technique to synthesize nanostructures of desired size, shape and surface properties.	3
2	**Correlate** properties of nanostructures with their size, shape and surface characteristics.	4
3	**Select** appropriate analytical tools for characterization of nanomaterials.	4
4	**Appraise** on application of nanomaterials as catalyst.	5

Course Code:NC-303

Course Title: Essence of Indian Traditional Knowledge

Course Objectives:

1. The course aims at imparting basic principles of thought process, reasoning with emphasis on sustainability connecting society and nature.
2. TofacilitatethestudentswiththeconceptsofIndiantraditionalknowledgeandtomake them understand the importance of roots of knowledgesystem.
3. To focus on Indian Knowledge System, Indian perspective of modern scientific

worldview and basic principles of Yoga and holistic health caresystem.

Prerequisites: ----Not Applicable----

Course Content:

Unit-I
Introduction to traditional knowledge: Traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, physical and social contexts in which traditional knowledge develop, historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, western knowledge. Indian personalities in traditional knowledge, linking science and the rural

Unit-II
Protection of traditional knowledge: Need for protecting traditional knowledge (TK), significance of TK protection, global mechanisms of protection and sharing, recognition and protection value of TK in global economy, role of government to harness TK.

Unit-III
Legal framework and TK: Scheduled Tribes and Other Traditional Forest Dwellers (RecognitionOfForestRights)Act(2006);PlantVarietiesProtectionandFarmer'sRightsAct (2001) (PPVFRAct); Biological Diversity Act (2002) and Rules (2004); Protection of Traditional Knowledge Bill (2016); Geographical Indicators Act(2003).

Unit-IV
Traditionalknowledgeandintellectualproperty:SystemsofTKprotection,Legalconcepts for the protection of TK, Certain non IPR mechanisms of traditional TK, Patents and TK, Strategies to increase protection of TK, Global legal fora for increasing protection of Indian TraditionalKnowledge.

Unit-V
Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Food and healthcare needs of Traditional societies, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Text/ Reference Books

1. Sengupta, Nirmal, Nirmal Sengupta, and Ghosh. *Traditional Knowledge in Modern India*. Springer India, 2019.
2. Jha, Amit. *Traditional knowledge system in India*. Atlantic Publishers & Distributors, 2009.
3. Basanta Kumar Mohanta and Vipin Kumar Singh *Traditional Knowledge System and Technology in India*, Pratibha Prakashan2012.
4. Kapoor, Kapil, and Michel Danino. "Textbook of" Knowledge Traditions and Practices of India"." *Ancient Science of Life* 32, no. 1 (2012):59.

E-Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Ability to **understand**, connect and explain basics of Indian Traditional knowledge modern scientific perspective	2
2	Know the need and importance of protecting traditional knowledge.	2
3	Know the various enactments related to the protection of traditional knowledge.	2
4	**Understand** the concepts of Intellectual property to protect the traditional knowledge.	2

SEMESTR-VI

Course Code: CHL-316

Course Title: Chemical Reaction Engineering

Course objectives:

1. This course will highlight basic concepts of kinetics and rate laws along with interpretation of ratedata.
2. Thecoursewilldealwithproblemsinvolvingdesign&ratingofidealreactorsincluding heat effects, multiplereactions.
3. The course will also provide basic understanding of catalysts and their applications to industrialprocesses.

Pre-requisites:

Material and Energy Balance Calculations (CHL-206)
Chemistry-I (BSC-103)

Course Content:

Unit –I

Reactions and reaction rates - stoichiometry, extent of reactions, conversion, Selectivity Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory.

Unit –II

Analysis and correlation of experimental kinetic data - data collection & plotting, linearization of rate equations, differential and integral method of analysis**.**

Unit –III

Ideal reactors - generalized material balance, design equations, graphical interpretation. Sizing and analysis of ideal batch, mixed (CSTR), plug flow and recycle reactors – solving design equations for constant and variable density systems, reactors in series and parallel.

Unit –IV

Multiple reactions - conversion, selectivity, yield, series, parallel, independent and mixed series-parallel reactions.

Unit –V

Introduction to Catalysis, homogeneous and heterogeneous catalysis. Preparation and characterization of catalysts. Physical and chemical adsorption, Adsorption isotherms, Determination of BET surface area and pore volume of the Catalyst .

Text/Reference Books

1. H. Scott Fogler*Elements of Chemical Reaction Engineering* 2nd Edition, Prentice Hall 2001.
2. OctaveLevenspiel*ChemicalReactionEngineering*by,3rdEdition,JohnWiley&Sons 2001

Course Outcome:

Upon completion of the course the students will be able to:

S.No.	CO	Cognitive Level
1.	**Design** chemical reactors involving heat effects optimally using minimum amount of data.	6
2.	Fix some problems related to operability and productivity.	2

3.	**Apply** methods of Catalysts' synthesis and catalyst characterization.	3
4.	**Understand** and **interpret** kinetics data.	2

Course Code: HML-309
Course Title: Psycho-Social Dimensions of Industrial Management

Course Objectives:

1. To prepare and develop the students for successful career that meets the global Industrial and Corporate requirements.
2. To guide the students about perception and attitude development to excel in organisation setting
3. To provide an environment for students to work on Multidisciplinary projects as part of different teams to develop their team building capabilities like leadership, motivation, teamwork etc.
4. To introduce professional ethics and codes of professional practices in Industry.

Pre-requisites:

Industrial Management and Economics (HML-202)

Course Content:

Unit –I

Concept and meaning of organisationbehaviour, Features & foundations of organisationbehaviour,Role of organisationbehaviour, Theories of organisationbehaviour, Behaviour Process, Innovation & creativity in organization

Unit –II

Perception: Meaning and definition, Factors influencing perception process, Perception Process, Perception and individual decision making, Nature of attitudes, Components of attitude, Formation of attitudes, Functions of attitudes, Work related attitudes: Job satisfaction & organizational commitment, Attitudes, values & organization behaviour

Unit –III

Motivation: Nature & Importance, Theories of Motivation, Content Theories and Process theories: Evaluation & criticism, Self motivation

Unit –IV

Leadership: Nature, Leadership and management, Importance, Leadership styles and their implications, Trait and behavioural approach of leadership, Decision making: Nature, types &conditions of decisions,Decision making process & styles

Unit –V

Nature and sources of ethics, Ethical dilemmas, Resolving dilemmas, Ethical decision making, Ways of managing ethics, Corporate social responsibility

Text/ Reference Books

1. Aswathappa, Kalupally, and G. Sudarsana Reddy. *Organisationalbehaviour*. Vol. 20. Himalaya Publishing House, 2009.
2. Martin, John. *Organizational behaviour and management*. Cengage learning EMEA, 2005.
3. Saiyadain, Mirza S. *Organisationalbehaviour*. Tata McGraw-Hill Education, 2003.
4. Mishra, MahaNarain. *Organisationalbehaviour*. Vikas Publishing House Pvt Ltd, 2001.
5. Robbins, Stephen P. *Organisationalbehaviour: global and Southern African perspectives*. Pearson South Africa, 2001.
6. Stoner, *Management-II*. Pearson Education India.

Course Outcome:

Upon completion of the course the students will be able to:

S.No.	CO	Cognitive Level
1.	**Develop** the process of individual behaviour and perpetual process along with conditioning of thinking process.	6
2.	**Identify** the concept and process of motivation and leadership.	2
3.	**Correlate** human behaviour, social skills, innovations, and creativity to improve workplace dynamics.	4
4.	**Develop** the knowledge of ethical considerations and administrative regulations by applying the theories and principles of Management in practice to improve performance of individual employee at a workplace.	6

Course Code: FTL-303
Course Title: Food Biotechnology

Course Objectives:

1. To study r-DNA technology, application in foodindustry.
2. To study production of baker's yeast, mushroom, SCP, organic acid, alcoholic beverages, vitamin
3. To study preparation of soya based orientalfoods.

Course Content

Unit I:

Screening of microorganisms for biotechnological process, chemistry and biology of DNA, RNA and Proteins, DNA replication, transcription and translation in prokaryotes. r-DNA technology and its application for GM food and its safety issues.

Unit II:

Enzymatic Production of glucose, fructose, starch, SCP. Cultivation technology of mushroom and production of baker's yeast. Microbial culture for food fermentation, its maintenance.

Unit III:

Production of organic chemicals: production of industrial alcohol, lactic acid, citric acid, vinegar

Unit IV:

MicrobialProductionofvitamins(B_2,B_{12}),flavorandfragrance,polysaccharidesandenzyme. Introduction to tissueculture.

Unit V:

Production of Alcoholic beverages: beer, wine and distilled beverages such as whisky, Rum Vodka.

Fermented Dairy products, Idli

Oriental fermented food: Soya sauce, Tempeh, Tofu,

Textbook:

1. Casida, L. E. J. R. Industrial Microbiology. Place of publication not identified: New Age International Pvt.,2015
2. Prescott, S. C., and Cecil G. Dunn. Industrial Microbiology. Jodhpur: Agrobios (India), 2011
3. Singh, B. D. Biotechnology. Ludhiana: Kalyani Publishers,2016..
4. Handbook of Hydrocarbon and Lipid Microbiology. Berlin: Springer,2010.
5. Joshi V. K., Technology of handling, Packaging, Processing, Preservation of fruits and vegetables, New India Publication agency New Delhi ,India,2019

Reference Book:

1. Underkoffler L.A, R. J. Hickey,Industrial fermentation vol 1 and 2, Chemical publishing co. Inc. 212, fifth Avenue New York, 1954.
2. Peppler, H. J Ed. Microbial Technology. New York: Academic Press,2004.
3. Joshi V. K, Ashok Pande, Biotechnology: food fermentation Educational Publishers & Distributors, 1999

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	The students will able to **produce** Baker's yeast, mushroom, organic acids, alcoholic beverages, vitamin,SCP	6
2.	The students will able to **recognize**r-DNA technology and its application in food industry	6
3.	Students can **outline** the microbial production of glucose, fructose,	2

	starch, and **use** of microbialculture	
4.	Student can **outline** the process of making soya fermentedproducts	2

Course Code: FTP-304
Course Title: Food Processing and Biotechnology

Course Objectives:

1. To produce, baker's yeast, mushroom, citric acid, ethanol andwine.
2. To prepare idli, soya, cheese and yoghurtproducts
3. To prepare bakery and chocolateproducts
4. To prepare jam, jelly chikki and extrudedproducts

Course Content:

Preparation of biscuits, bread and cake
Preparation of chocolate
Preparation of chikki
Preparation of jam, jelly and extruded product
Fermentative production & estimation of ethanol from suitable substrate.
Production of baker's yeast
Citric acid production
Preparation of idli/tofu/ soy sauce by fermentation process
Preparation of cheese and yoghurt
Preparation of wine

Reference Book:

1. Jayaraman,J.,andJ.Jayaraman.LaboratoryManualinBiochemistry.NewDelhi:New Age International (P) Ltd. Publishers,2005.
2. Aneja K. R., Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom Production Technology, New Age International Limited,2001
3. Srivastava, RP, and Sanjeev Kumar. Fruit and Vegetable Preservation: Principlesand Practices. New Delhi: CBS Publishers & Distributors Pvt. Ltd.,1994
4. Srilakshmi, B. Food Science. New Delhi: New Age International Pvt,2015.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students will able to **produce** baker's yeast, mushroom, citric acid andwine.	6
2.	Students will able to **prepare** idli and soya sauce, cheese andyoghurt	6
3.	Students can **prepare** bakery and confectionaryproducts	6
4.	Students can **prepare** jam, jelly and extrudedfood	6

Elective-II (Open Elective)

Course Code:FTL-306

Course Title: Treatment and Disposal of Food Industrial Waste

Course Objectives:

1. To study composition, sources, permissible and health hazards of industrialwastewater pollutants
2. To study various techniques of wastewater treatment by physical chemical and biologicalmethods
3. Tostudy,designandoperationalproblemsofbiologicaltreatmentandvalueadditionto waste
4. Estimation of kinetic coefficients for treatment with designproblem.

Prerequisites: ----Not Applicable----

Course Content:

Unit-I

Physical, chemical and biological characteristics of food industry waste. Composition of typical industry waste. BOD /COD and characterization of effluent. Typical BOD of some food industrialeffluentsandtheirdischargelimit,typesandpointsourcesofindustrialpollutantsand adverse effect by theirdischarge.

Unit-II

Primary treatment, secondary and tertiary treatments by physical, chemical and biological methods. Process design criteria. Sanitary disposal of sludge.

Unit-III

Role of micro-organisms in food industry waste. Application of kinetics to biological treatment. Determination of kinetic coefficients with some design problems.

Unit -IV

Activated sludge process and modified activated sludge process. Nitrification and denitrification, Aerobic lagoons, aerated aerobic lagoons, aerated facultative lagoons, Design criteria for A.S.P and stabilization ponds

Unit-V:

Trickling filters, Rotating biological contactors, design criteria and problem on RBC and trickling filter design.By product recovery and value addition to the waste.

Text/ Reference Books

1. Rao, C. S. Environmental Pollution Control Engineering. New Delhi: New Age Internat., 2011
2. Arceivala Sol J., AsolekarShyamR. Wastewater Treatment for Pollution Control and Reuse Tata McGraw-Hill Education,2006
3. Green, John H., and AmihudKramer. Food Processing Waste Management. Westport, Conn: AVI Pub. Co,1979
4. Bartlett,RonaldErnest.WastewaterTreatment:PublicHealthEngineeringDesInMetric., Applied Science Publishers Ltd,1971

5. Metcalf, L., H. P. Eddy, and Georg Tchobanoglous. Wastewater Engineering: Treatment, Disposal, and Reuse. New Delhi: McGraw-Hill,2010
6. Waldron Keith W.,Handbookof Waste Management and Co-Product Recovery in Food Processing, Elsevier,2007
7. Herzka, A., and R. G. Booth. Food Industry Wastes, Disposal and Recovery. London: Applied Science Publishers,1981
8. Bhattacharyya Bimal C., Banerjee Rintu, Environmental Biotechnology; Oxford University Press, 2007

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	**Explore** composition of industrial effluent and health hazards of pollutants in effluent.	6
2.	**Recognize** primary, secondary and tertiary treatment for industrial effluent treatment and designparameters.	6
3.	**Access** principle, design and working of fixed film biological reactorefficiency Students can **prepare** bakery and confectionaryproducts	6
4.	**Manage** industrial effluent for recovery of biological as value addition towaste.	6

Elective-II (Open Elective)
CourseCode:OTL-306
Course Title: Biochemistry & Biotechnology of Lipids

Course Objectives:
This course is designed to gain the insights about various bio-simulated reactions, pathways, and mechanisms in natural way. Also, the use of enzymes for synthetic modification and applications several fatty products will be studied. Environmental issues from bio-technological industries will also be discussed.

Prerequisites: ----Not Applicable----

Course content:

Unit-I
Biosynthesisoffattyacidsandphospholipids;Mechanismofchainelongationanddesaturation of acyl chains; Regulation of lipid metabolism; Biological role of fat in human nutrition; Atherosclerosis.

Unit-II
EFA, MUFA, PUFA –Sources and biological activities in human health; Biochemical aspects of vitamins in nutrition; Toxic constituents in oilseeds and oils: Sources, structures, toxicological effects and methods of detoxification.

Unit-III

Microbial production of fats and other lipids; Biotransformation of fats and lipids usingwhole microbial cells; General aspects of Microbial Lipases: Sources, isolation and purification and industrialapplications

Unit-IV

Enzymatic Interesterification: Chemistry, reaction in (aqueous/organic) solvent systems, immobilizationofenzymes,factorsaffectingenzymeactivity,enzymekinetics,reactordesign.

Unit-V

Structured lipids: Synthesis, analysis and applications
Genetically modified lipids: Physical, chemical and nutritional functionality modifications.
Environmental biotechnology concept: Principles in bioremediation and biological water & waste treatment.

Text/ Reference Books

1. Lehninger'sPrinciplesofBiochemistrybyDavidLNelson;A.L.LehningerandMichael M. Cox, 5th edition, Worth Publishing.
2. Outline of Biochemistry by Eric.E. Conn and P.K. Stumpf, 5thedition, WileyIndia.
3. Lipids: Biochemistry, Biotechnology and Health, 6th Edition by Michael I. Gurr,John L. Harwood, Keith N. Frayn, Denis J. Murphy, Robert H. Michell, Wiley-Blackwell
4. Fatty Acids in Fish Oğuz Taşbozan and Mahmut Ali Gökçehttp://dx.doi.org/10.5772/68048
5. FoodLipidsChemistry,Nutrition,andBiotechnology,FourthEditionEditedCasimir C. Akoh Taylor & Francis Group

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Acquire the fundamental knowledge of scholarly discourse in fatty acids and other lipid synthesis.	1
2.	Able to understand the biological roles of important fatty and non-fattycomponents.	2
3.	Identify and describe the toxicity effects and method ofremediation.	2
4.	Apply the theories and concepts of microbial lipase in industrialapplications.	3

Elective-II (Open Elective)
Course Code: PTL-306
Course Title: Technology of Printing Inks

Course Objective: The Paint Technocrat will have in depth exposureto

1. Formulation and manufacture of PrintingInks.
2. Various techniques of printingprocesses.
3. Different applications of printing inks

Prerequisites: ----Not Applicable----

Course Content:

Unit-I
NatureofPrintingink,Visualcharacteristicsofinks,Majorprintingsystems,classificationand characteristics of printing inks, mechanism of ink drying, adhesive nature of printing inks, resistancepropertiesofprintinginks,physicalchemistryofprintinginks,rheologicalproperties of inks principles ofprinting

Unit- II
Description and schematic diagram of printing processes, it‟s press configuration and applications e.g. Flexographic, lithographic, gravure, letterpress, planographic, screen, Inkjet printing, substrate selection principles of ink formulations, colour matching and process printing.

Unit-III
Manufacture of inks, manufacturing process, mixing equipments such as High speedimpeller, butterfly mixer, Rotar and stator high speed mixer and milling equipments such as three roll mill, bead mill etc. handling, storage and manufacture of UV ink, news paper inks, modern production trends and future ofinks.

Unit-IV
Inksforvarioussubstrates:paper,plastic,fabric,leather,glassandmetal.Testing&Evaluation of finished ink and raw materials for ink manufacture. Inks for News paper (rotary and well offset), publication work, posters, labels, and packaging materials, heat set and quick set inks for multicolourprinting.

Unit-V
Metaldecoratinginks,afterprintvarnishesandlacquers,magneticinks,ceramicinks,inksfor printed circuit boards, inkjet printing, laser printing, dot-matrix printing, and other miscellaneous inks. Identification of various ink troubles and remedialmeasures

Text/ Reference Books

1. Jones, Frank N., Mark E. Nichols, and Socrates Peter Pappas. *Organic Coatings: Science and Technology*. John Wiley & Sons, 2017.
2. Leach, Robert. *The printing ink manual*. Springer Science & Business Media,2012.
3. Thompson, Robert. *Printing materials: science and technology*. Pira International, 2004.

4. Flick, Ernest W. *Printing ink and overprint varnish formulations*. William Andrew, 1999.

Course Outcomes:

Upon successful completion of the course, the students will learn about

CO No.	Course Outcome	Cognitive level
1	Nature, characteristics and classification of printing inks.	4
2	Principles of ink **formulations** and manufacture of Inks for various substrates	6
3	Press configuration and **applications** of printing inks	3
4	**Comparison** and selection of various printing processes	4

Elective-II (Open Elective)
Course Code: PLL-305
Course Title: Plastics Waste Management

Course Objective:

1. To understand the concept of plasticsrecycling.
2. To understand about various sources of plasticswaste.
3. To understand various identification and separation method for wasteplastics.
4. To learn about different recycling methods for plasticsrecycling.

Prerequisites: ----Not Applicable----

Course Content:

Unit- I

Introduction, Sources of plastics waste (Industrial waste, post-consumer waste, scrap waste andnuisancewaste),PlasticidentificationandSeparationtechniques–(density-floatsinkand froth floatation methods, optical, spectroscopic, electrostatic, sorting by melting temperature, sortingbysizereduction,sortingbyselectivedissolutionandothermethods),recyclingcodes.

Unit- II

Plastics Waste Management - 4R‟s approach (reduce, reuse, recycle – mechanical and chemical, recover), recycling classification- - primary - secondary - tertiary - quaternary recycling with examples. Energy from waste – incinerators-pyrolysis, factors affecting incineration.

Unit- III

Recycling of polyolefins - PVC, PET, polystyrene, polyamides-nylon-6 and nylon-6,6, polyurethanes, mechanical process, applications of recycled materials.

Unit- IV

Recycling of rubber – comparison of thermoset and thermoplastic composites, reclaiming of rubber – fuel source – pyrolysis, Depolymerisation of scrap rubber, tyre retreading, uses of recycled rubber – asphalt and other uses.

Unit- V

Recycling of plastics by surface refurbishing - coating application, influence on plastics

properties by coating, polishing of the plastics surface, commercial process. Plastics aging - environmental aging, thermal aging, weathering of plastics, mechanical degradation,chemical degradation and environmental stress cracking, wear and erosion, influence of plastic aging in recycling, energy from waste -incinerators

Text/ Reference Books

1. John Scheirs., - "Polymer Recycling Science, Technology and applications" John Wiley and Sons,1998
2. Nabil Mustafa – "Plastics Waste Management Disposal Recycling and Reuse" Marcel Dekker Inc., First Edition1993.
3. Steven Blow, Handbook of Rubber Technology, Galgotia Publications Pvt. Ltd., New Delhi,1998.
4. Chandra R. and Adab A., Rubber and Plastic Waste, CBS Publishers & Distributors, New Delhi,1994.
5. Muna Bitter, Johannes Brandup, Georg Menges "Recycling and Recovery of plastics" 1996
6. Attilio.L.Bisio, Marino Xanthos, "How to manage plastics waste: Technology and Market Opportunities" Hanser Publishers,1994
7. Francesco La Mantia., "Handbook of Plastics Recycling" Chem TecPublishing,2002

Course Outcomes:

Upon successful completion of the course, students will have knowledge of

CO No.	Course Outcome	Cognitive level
1	Sources of plastics waste, its identification and separation methods.	2
2	Approaches of plastic waste management	2
3	Mechanical and chemical recycling of polymers.	2
4	Recycling of plastics by surface refurbishing.	2

Elective-II (Open Elective)

Course Code: CHL-321

Course Title: Water Conservation and Management

Course objectives:

The Objective of this course is to:

1. Understand current waterscenarios
2. Need for water conservation andmanagement
3. Strategies for water conservation from source to sink in differentsector.

Prerequisites: ----Not Applicable----

Course Content:

Unit- I:

Introduction: water cycle, water storage, water quality. Water conservation, Current Demand of water for Domestic, Irrigation and Industries.

Current supply available, Shortage of water, water conservation process and ways to conserve water.

Unit -II:

Understanding water conservation and water quality parameter like TDS, pH, etc. Water

management-water quality, controlling use and quality of water, water flow management, water quality control, testing water salinity, preserving water quality. Managing water quality in different sectors.

Unit- III:
Water conservation in agriculture-Reuse of wastewater for irrigation (Methods, Precautions), Irrigation system (Components) and Water user's participation in irrigation system management. Current Supply, utilization and shortage of water

Unit- IV:
Water conservation in construction industry: Importance of saving water in the construction industry in India, reduce and recycle water at construction sites, saving water during wall construction.

Unit- V:
Water Conservation in process industry: Water treatment, recycling, and reuse
Water saving equipment, economics of water, minimising evaporation, water audits.

Text/Reference Books

1. IrrigationEngineering-R.K.SharmaandT.K.Sharma,S.Chand&CompanyLtd.,New Delhi.
2. Water Resources Systems: Modeling Techniques and Analysis Vedula, S.and Mujumdar, (2005); Tata McGraw Hill, NewDelhi.
3. Economics of Water Resources Planning, James, L.D., and Lee, R. R., Mc GrawHill.
4. Agriculture and water management, P.Verma, Amiga PressInc.
5. Industrial water treatment process technology, Parimal Pal, ElsevierScience.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students would able to **understand** the importance of water conservation and management in different sectors.	2
2	Students would able to **identify** the thrust area for water conservation and develop management strategies to achieve it.	2
3	Students would able to effectively **implement** the developed strategies.	2

Elective-III (Professional Core Elective)
Course Code:FTL-307
Course Title: Food Processing-I

Course Objectives:

1. To study milling technology of wheat, rice, corn,starch
2. To study milling technology of legumes processing and & oil seeds (oil extraction, refining,hydrogenation)
3. To study process technology for baked and confectionery products To study process technology for preparing convenience and fast foods, Snack foods and special foods, IM foods and instantfoods

Course Content
Unit-I

Process Technology of cereals grains: Types, grading and quality. Milling technology of wheat, riceandwetmillingofcorn.Isolationandprocessingofstarch,Byproductsofmillingindustry. Malting ofcereal.

Unit-II

Classification, types and Milling technology of legumes and oil seeds, extraction, refining & hydrogenation of oil. Manufacture of margarine.

Unit-III

Role of ingredients and chemistry of bakery products, Rheology of dough, changes during dough formation. Manufacturing of bread, biscuit, cookies, cracker and cakes. Bread andcake improvers. Quality control in bakedgoods

Unit IV

Manufacturing of breakfast cereals, puffed cereals, extrusion process and extruded products, baked snack foods. Fast foods & convenience foods. Speciality foods: weaning & baby foods, IM foods, & instant food.

Unit-V

History of Cocoa beans and origin and quality selection. Technology of cocoa processing. Manufacturing of dark and white chocolate & milk chocolate.
Confectionary technology: manufacturing of hard-boiled candies, caramel, chikki.

Text Books

1. Kent-Jones,D.W.,andA.J.Amos.ModernCerealChemistry.Liverpool:theNorthern Publishing, 1967
2. Matz,SamuelA.SnackFoodTechnology.Placeofpublicationnotidentified:Springer, 2013
3. Daniel Albert R., Bakery Materials and Methods: A Book for Every Baker and Confectioner, Maclaren,1963.
4. Sultan, William J. Practical Baking,1976.
5. Harper, Judson M. Extrusion of Foods. Boca Raton: CRC Press,2019.
6. LeesR.,SugarConfectioneryandChocolateManufacture,SpringerScience&Business Media,2012

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Thestudentswillbeableto**interpret**themillingtechnologyofwheat,rice,corn,maltingof grains and byproducts ofmilling.	2
2.	The students can **describe** milling of legumes and hydrogenation of crudeoil.	2
3.	Student can **explore** baked products and various chocolates	6
4.	Student can **outline** of special foods, Convenience, fast food, Snack foods, instant mixes, hard boiledcandies.	2

Elective-III (Professional Core Elective)
Course Code: FTL-308
Course Title: Fruits and Vegetable Processing Technology

Course Objectives:

1. To study quality assessment of fruit & vegetables, and their post-harvesttechnology
2. To study outline of fruit and vegetable processing for finished product and their machines
3. To study process technology for Fruit and vegetable products: concentrate, puree, jam, jelly, marmalade, preserves, candid fruits, pickles, chutneys, RTS, and carbonated beverages
4. To understand FSSAI, international standards WHO, FAO, Codex Alimentarius Specification of various Fruit and vegetable products of Fruit and vegetable products, good manufacturing practices(GMP).

Course Content:

Unit I:
Quality assessment of fruit & vegetables. Physiology of plant tissue, Plant pigments. Effect of processing on colour and texture, Post-harvest technology of fruit and vegetables.

Unit II:
Instruments for Fruits and vegetable processing; washing, grading, peeling, extraction, thermal processing and canning of food products.

Unit III:
Process technology for concentrate, puree, jam, jelly, marmalade, candid fruits, pickles, chutneys, RTS, and carbonated beverages and their packaging.

Unit IV:
Dehydrated and speciality products and by-products of fruits and vegetables. Tomato processing, honey and sugar processing.

Unit V:
Specification of various fruits and vegetable products, FSSAI, international standards WHO, FAO, Codex Alimentarius standards for fruits and vegetables processed products, good manufacturing practices (GMP).

Textbooks:

1. Girdharilal, G. S. Siddappa, and G. L. Tandon. Preservation of Fruits andVegetables. New Delhi: Publications and Information Division, Indian Council of Agricultural Research,2011
2. Desrosier, Norman W., Technology of Food Preservation.: ED-TECH,2018.

3. Tressler, Donald Kiteley, Van Arsdel Wallace B., Michael J. Copley, and Willis Raymond Woolrich. The Freezing Preservation of Foods. Westport (Conn.): Avi Publishing, 1968.

Reference Books:

1. Charm, Stanley E. Fundamentals of Food Engineering. Westport, CT: Avi publishing, 1981.
2. Karel, Marcus. Physical Principles of Food Preservation. New York: MarcelDekker, 2003.
3. Desrosier Norman W., Rosenstock Henry M. Radiation technology in food, agriculture, and biology Avi Pub. Co.,1960
4. Bennet, Gregory S. Modern Technology on Food Preservation. Delhi, India: Asia Pacific Business Press,2008

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students will be able to **define** quality aspects and post-harvest handling of fruit & vegetables.	1
2.	Students will be able to **recognize** and use various unit operations and equipment's fruit & vegetablesprocessing.	6
3.	Students can **design** different Fruits and vegetables processedproducts.	6
4.	Students will be able to **express and apply** various rules and regulations like FSSAI, international standards WHO, FAO, Codex Alimentarius Specification for fruits and vegetables.	3

SEMESTER-VII

Course code:FTP-401

Course Title: Industrial Training/ Project

Course Objectives:

1. To provide on hand training with subject knowledge they have acquired earlier
2. To create interest in research with subject knowledge they have acquired earlier
3. To learn recent industrial practices and technological development in food processing
4. To prepare report on industrial inplant training and its presentation

Research Project at Department: The entire semester will be devoted for the detail experimental work on a research problem from the field of Food Technology selected by the student and specially approved by the faculty member/s designated as research guide/s. The student will present his/her findings in the form of neatly typed and bound thesis and will have to appear before panel of experts for defending his/her Thesis.

OR

Research Project/ Training at Industry: The student will undertake research work/ Training at selected reputed Institute / Industries for six months on a topic allotted by the concerned institute / Industry Management and approved by the Department. His/her progress will be jointly reviewed by the Department and the concerned Institute / Industry Management. The student will present his/her findings in the form of neatly typed and bound thesis, which will carry approval and attendance certificate issued by the concerned Industry Management and will have to appear before panel of experts for defending his/her Thesis.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Develop skills and good practices related to technology of food processing	2
2.	Carry out research independently as per the need of society	3
3.	Analyze raw material and quality control	3
4.	Formulate various food products and prepare it.	
5.	Examine food products and identify their defects and report their causes and state their control measures	6
6.	Provide engineering solutions in a global, economic, environmental, and societal context.	6
7.	Identify career opportunities in food technology sector	3

Course Code: FTP-402

Course Title: Technical Seminar

Course Objective:

1. To develop necessary skills in understanding current technological trends in the field of Food Technology.
2. To prepare the students more skilled and technically qualified through learning from literature survey, preparing technicalreview report.
3. To improve technical presentation skills of the graduates.

Technical seminar report : Student will be required to prepare a critical review of selected topics in Food Technology andallied subjects and submit the same in the form of a standard typed report under thesupervision of designated Guide. The student will also be required to make an oral presentation of the review before panel of experts.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Develop knowledge of recent and emerging trends in the field of Food Technology.	3
2.	Identify, formulate, and solve technical problems..	1
3.	Capable for preparation and presentation of Technical Reports.	6
4.	Recognition of the need for, and an ability to engage in life-long learning.	1

SEMESTER-VIII

Course Code: CHC-416

Course Title: Process Dynamics & Control

Course Objective:

To study the chemical process control and dynamics of automatic, advanced chemical processes and to study the response of various forcing functions for first, second order control system by studying the various types of control mechanisms for chemical process and to examine stability analysis and application .

Course Content :

Unit-I

Dynamic Behaviourof First Order Control System. Study of forcing functions Step, ramp,impulse, sinusoidal etc. Transfer functions of Continuous Stirred Tank Reactor, mercury in glass thermometer, mixing process, liquid level single tank system and problems with practical approach, response of first order control systems, step response, ramp or linear response, impulse response, sinusoidal response equations and problems. (08Hrs)

Unit-II

Interacting and Non-Interacting liquid level Control Systems. Step response for non-interacting, interacting control system, Transportation lag, the dynamic behaviour of second order control systems. Transfer function derivation for U tube Manometer and Damped vibrator system, Concept of underdamped, critically damped and overdamped systems, Step response equation for under damped second order system.Problems on under damped second order control system.(08Hrs)

Unit-III

Second order step response equations of critically and over damped control systems and derivations. Step response Characteristics of an Underdamped second order control systems for step function. Decay ratio,overshoot,rise time, response time and numerical. Mechanism of Control System and Block Diagram RepresentationControl aspects, negative verses positive feedback control systems, servo and regulator control problems. (08Hrs)

Unit-IV

Proportional, proportional plus derivative, proportional plus integral and Proportional plusDerivative plus Integral controller their input output relationship, transfer functions of different controllers, advantages and disadvantages and their applications.StabilityAnalysis of Control System. Stability for linear control system, Rouths stability criteriaand problems based on stability of control system. (08Hrs)

Unit-V

Root locus analysis, procedure for plotting root locus diagram for negative feedback control systems. Various numerical and graphical problems based on Root locus analysis.Frequency response analysis of linear systems, procedure for plotting the Bodediagram, problems on Bode stability criteria, basics of open loop poles and zeroes at origins, first order poles and zeroes, corner frequency, concept of phase and gain margins, phase crossover and gain crossover frequencies. (08Hrs)

Reference Book:

1. Coughanowr, Donald R., Process Systems Analysis and Control, McGraw Hill.ThirdEdition,2009.

2. Stephanopoulos George, Chemical Process Control Prentice Hall Inc.First Edition.

3. Harriott Peter, Chemical Process Control, Tata McGraw Hill.T.M.H.Edition

4. Process Dynamic and Control,S.S.Bhagade and G,D,Nageswar First Edition 2011.

Course Outcomes:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	From the course contents, the students will be able to know the complete dynamics of the chemical process and understand the different kinds of forcing function and responses.	3
2	The students understand the method for obtaining the transfer function, responseequation and physical behaviour of first, second and higher order control system.	2
3	Students understand various types of control actions like ON OFF, P, PI, PD, PID andapplications and usefulness in the different chemical process and Industries.	5
4	Students able to know stability of chemical process control system by solving the problems of graphical methods and analysis of rootlocus, frequency response analysis.	3

Course Code : CHC-416 (PR)

Course Title: Process Dynamics & control

Course Objective:

To carry outan experiment of Process Dynamics and Control, the students come to know how the equations developed from physical system, their response studies and actual application to chemical process Industries during automatic process control.

Course Content :

1. Study of dynamic behaviour and response of Mercury thermometer forstep change during heating.
2. Determination of time constant of mercury in glass thermometer ,thermocouple, or bimetallic thermometer etc.
3. To study the dynamic behaviour of U tube manometer representing second order control system by giving impulse input.
4. Determination of damping coefficient and time constant of second order system.
5. ToStudythe pneumatic control valve and Valve characteristics.
6. To Study the two tank liquid level non-Interacting systems in series by giving step change and study the overall response.
7. To study the step response of single tank liquid level system.
8. Study of dynamic behaviour and step response of Mercury thermometer during cooling.
9. To study the impulse response of single tank liquid level system.
10. Study of Mixing process in single tank liquid level system and determine time constant.
11. Study of two tank liquid level Interacting systemsin series by giving step change and study the overall response.

At least any seven experiment to be conducted.

Course Outcome:

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome	Cognitive level
1	The students are capable to know about the basic theory of various physical systems and to know the actual responses for different inputs for first, second and Interacting non interacting control system.	3
2	Students able to determine mathematically and graphically time constant, transfer function and response equation by carried out an experiment.	2
3	Students come to know how the system behaves with different disturbances and how it can be optimized for stable control system	5
4	The order of the physical system like first, second and interacting non interacting control system is determined experimentally.	3

Course code : CHC-417
Course Title : Process equipment design and drawing

Course Prerequisite:
Engineering Graphics, engineering and solid mechanics, heat transfer, mass transfer operations, mechanical operations

Course Objectives:

1. To learn the design procedure for designing chemical equipment and selection of proper material of construction by considering different mechanical and physical properties.
2. To know the behaviour of material under stresses.
3. To understand the designing of pressure vessels, high pressure vessels, supports,
4. To do the process design calendria evaporator, shell and tube heat exchanger, sieve tray and bubble cap tray for distillation column, agitators.

Course Contents:

Unit –I
General design procedure for designing chemical equipment, protective coating, corrosion causes and prevention.. The material behaviour under stresses. (**5hrs**)

Unit –II
Unfired pressure vessel subjected to internal and external pressure. Design of shell, nozzle, different types of head.Vessels for high pressure operation, constructional features, multi shell construction, Types of support for vertical and horizontal vessels. (**5hrs**)

Unit-III
Agitators, selection, types application, power required for agitation, , Process design for short tube calendria Evaporator, shell and tube heat exchanger construction and design in detail. Design for sieve tray and bubble cap tray for distillation column, (**5hrs**)

Reference Books:

1.Sinnott, R. K. Coulson & Richardson's "Chemical Enginering: Volume 6/ChemicalEngineering Design", Elsevier Butterworth Heinemann,
2. Joshi, MansukhlaVrajlal, and V. V. Mahajani. Process Equipment Design. MacmillanIndia, .
3. Dawande, S. D. "Process design of equipments." Central Tecno Publication, Nagpur
4 Bhattacharya, B. C. "Introduction of Chemical Equipment Design." Mechanical Aspects.

Course Outcome:

Upon successful completion of the course, students will be able to:

CO No.	Course Outcome	Cognitive level
1	Exhibit how to design and draw in a competitive manner various process equipment with proper scale and each component with detail dimensions.	5
2	Learn how to design Pressure vessels, Reaction vessels, Shell and Tube HeatExchanger, Short Tube Calendria Evaporator.	5
3	Understands the constructional features of high-Pressure vessels, Detail arrangementof Sieve tray and bubble cap trays. .	3
4	Be aware of how to read drawings to know details about process equipment, fabrication, maintenance, assembling and dismantling.	3

Course Code : FTL-403
Course Title : Food Processing - II

Course objectives:

Aim of this subject is to expose students to learn the processing technology of perishable foods with following objectives:

1.To learn basics of fruits and vegetables tissues, storage and post-harvest changes
2. To know the process technology of various fruits and vegetable products.
3. To understand the process technology of meat, fish, poultry and eggs
4. To gain the knowledge of process technology of milk and milk products.
5. To learn the process technology of tea, coffee and spices, & carbonated soft drinks (CSD).

Pre-requisites:

Principles of Food Preservation (FTC-301), Food Processing I (FTL-307)

Course Content:

Unit-I
Introduction to Fruits & Vegetables Processing

Fruits & Vegetables structure, Chemistry & physiology of plant tissues, Ripening of fruits, climacteric & non-climacteric fruits, plant colour pigments, effect of processing on fruits and vegetable texture, CA & MA Storage, Dehydration of Fruits and vegetables, Canning

Unit –II

Process Technology of Fruits & Vegetables Products

Processing Technology of fruits & vegetable purees, concentrates, jams, jellies, marmalades, squash, cordials, crush, nectar, preserves, candied fruits, pickles, chutney, sauce & ketchup, RTS beverages, AsepticProcessing

Unit –III

Process Technology of Meat and Fish

Structure & chemical composition of muscle proteins, meat colour, Post mortem changes in muscle, rigor mortis, various cuts of meat, preservation processing and packaging of meat, By products in meat processing industry, preservation processing and packaging of fish

Unit –IV

Process Technology of Milk & Milk Products

Composition of milk, standards of milk & milk products, storage & distribution of milk, processing of milk, manufacture of cream, butter, ghee, condensed milk, whole & skimmed milk powder. Preparation of Indian milk products like khoa, channa, curd & their products

Unit –IV

Processing for Beverages and Other Products

Composition of tea and coffee & processing of tea and coffee, Flavour and aroma development and evaluation. Carbonated beverages (Soft Drink), Processing of spices. Processing of poultry, processing of eggs

Reference:-

1. Girdharilal&Sidappa G. S, Preservation of fruits and vegetables, ICAR., New Delhi, (6th reprint, 2nd edition, 2013).
2. Tressler D. K. & Joslyn M. A., Fruits & vegetables juice processing technology, AVI publishing Co. Westport, Connecticut, (2nd edition, 1980).
3. Leviea , The meat & book, AVI publishing Co., Connecticut(1970).
4. Price J. F. &Schweigrt B. S., W. H. Freeman, The scientist of meat & meat products San Francisco, (2nd edition, 1971).
5. Mountney G. J., Poultry product technology, AVI publishing Co. Inc. Westport Connecticut, 1976. (2ndedition,vol. 5,1988)
6. Ashok Kumar Agrawal, Megh R. Goyal, 2017, Processing Technologies for Milk and Milk Products Methods, Applications, and Energy Usage, ISBN 9781771885485
7. EIRI Board, Engineers India Research Institute, Hand Book of Milk Processing, Dairy Products and Packaging Technology, ISBN Number: 9788186732960
8. H. Panda, 2016, The Complete Book on Cultivation and Manufacture of Tea (2nd Revised Edition), ISBN: 9788178331683
9. EIRI Board, Engineers India Research Institute, Coffee Processing Book
10. NIIR Board of Consultants & Engineers, 2013, The Complete Book on Spices & Condiments (with Cultivation, Processing & Uses) 2nd Revised Edition, Asia Pacific Business Press Inc., ISBN: 9788178330389
11.Sharangi, Amit (Ed.), 2018, Indian Spices, The Legacy, Production and Processing of India's Treasured Export, Springer
12. David Steen, Philip R. Ashurst, 2006, Carbonated Soft Drinks: Formulation and Manufacture, Blackwell Publishing Ltd
13 Mitchell**,** A.J., 1991, Formulation and Production Carbonated Soft Drinks, ISBN 978-0-442-30287-0

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Assess the quality of fruits and vegetables, preserve the fruits andvegetables in the form of various finished products, develop the process technology and formulate new products for manufacturing fruits and vegetables based products	6
2.	Preserve and process meat, fish, poultry and eggs and design or develop the process technology for manufacturing meat and fish products of high quality	3
3.	Assess the quality of milk, preserve the milk in the form of various milk products, develop the process technology and formulate new products for manufacturing milk based food products	6
4.	Manufacture food beverages, process spices, develop the process technology and formulate new products for manufacturing food beverages and spices or their blends	3

Course Code: FTL-404
Course Title: Food Quality

Course objectives

Aim of this subject is to impart knowledge of food quality and it's control to students with following objectives:

1. To study the sensory evaluation techniques and quality control.
2. To gain knowledge of latest food analysis instrumental techniques.
3. To learn the control of Food quality by fortification, food standards, food laws and regulation.
4. To learn the control of microbial quality of food and food safety system HACCP
5. To learn the defects in foods and it's rectification to maintain their quality.

Pre-requisites:
Food Biochemistry and nutrition (FTC-202), Food Microbiology (FTC 302), Food Processing I (FTL-307)

Course Content:

UNIT-I
Food Quality & Sensory Evaluation:
Food quality, quality control and quality assurance, Sensation of color, flavor& texture by human organ, taste panel, sensory evaluation techniques, Undesirable and anti-nutritionals in processed food products.

UNIT-II
Quality Evaluation & Food Analysis Instruments

Qualityevaluation by chemical parameters, calorific values, browning reaction, non nutritive sweeteners. Techniques used in food analysis (Spectrophotometer, chromatography, Scanning electron microscopy, Electrophoresis, Texurometer).

UNIT-III

Food Nutrition Quality and Food Laws

Essential fatty acids, polyunsaturated Fat, Trans fat, omega 3 fatty acid, protein quality, essential amino acid, available lysine, Food Fortification/Enrichment of vitamins and minerals. Food standard, food law & regulation. FSSAI, AGMARK, BIS, Codex alimentary commission.

UNIT-IV

Food Hazards and their Control

Sources of microbial contamination, Microbiological quality of foods & their control., pest control, GHK, GMP, history of HACCP, concept of HACCP, various types of hazard and their control, Principles of HACCP.

UNIT-V

Food Products Defects

Food products defects, their cause and remedies during harvesting, processing, storage and packaging of various food products like fruits and vegetables, milk and milk products, bakery and confectionary products.

Reference Books:

1. L. H. Meyer, Food chemistry, Published van Nostrand Reinhold co. New York (5th edition, March 2017).
2. Owen R. Fennema, Principle of food science, food chemistry, publisher Marcel Dekker inc New York, (3rd edition, 1996).
3. Morries B. Jacobs, The chemical analysis of food and food products, published Van Nostrand Company Priceton New Jersey (3rd edition, 2006).
4. Pierson, Merle D., 1992, HACCP Principles and Applications, Springer
5. Harry T. Lawless, 2010, Sensory Evaluation of Food: Principles and Practices (Food Science Text Series) 2nd Edition, Kindle Edition, Springer.

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Students will be able to **prepare** various fruit juices, jam, jelly,pickles.	4
2.	Students can **process** the spices.	5
3.	Students will be able to **evaluate** the quality parameters of processedfoods.	6

Course Code: FTL-405

Course Title: Food Processing & Quality

Course objectives:

Aim of this subject is to provide practical knowledge of food products processing and their quality analysis with following objectives:

1) To practically prepare and process various fruits and vegetable/ milk products
2) To practically prepare and process spices
3) To learn the chemical analysis of various food products

Pre-requisites:

Food Chemistry (Pr) (FTC-201), Food Processing and Biotechnology (Pr) (FTP-304)

Course Content:

Processing of squash/ Cordial/ Crush, jam/ jelly, RTS beverage/ Nectar, tomato sauce/ tomato ketchup, Preparation ofButter/ Ghee, sweetened condensed milk/ Milk powder, Shrikhand, Processing of spices
Analysis of finished products Quality like biscuits, squashes/Cordial/ Crush, jams/ jelly, Milk products like paneer/Shrikhand, Condensed milk/ Milk powder, sensory evaluation of various food products as per sensory evaluation techniques

Reference Books:

1. Jacob M.R., D.Van Nostrand Co. Inc., The analysis of foods & food products, Princeton,- New jersey, New york, (1958).
2. Ranganna S, Manual of analysis of fruits & vegetable products, McGraw Hill publishing Co., New Delhi, (2ndedition, 2005)
3. Official Methods of Analysis of the association of Official Analytical chemists, Pub. Assoc. Office, Anal chemists. Washington D.C., (11th edition, 1970).
4. Food Analysis :Theoryand practice IS:6273(Part-1&Part-2) Y.Pomeranz (3rd edition)
5. BIS and AOAC Methods of Food analysis (17thedition, 2000).
6. M.A. Amerine, Principles of Sensory Analysis of Food (1st edition, 1965)
7. Ranganna S., Hand Book of analysis and quality control for fruit and Vegetable Products", McGraw-Hill Publishing Company Ltd. New Delhi(2ndedition, 2001)
8. Morris B. Jacobs, The Chemical Analysis of Foods &Food Products (Publication Date: February 1939)

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Evaluate sensory quality for acceptance of food products.	6
2.	Analyze quality parameters by different analytical techniques.	4
3.	Design and formulate the food standards as per food laws and regulations.	5
4.	Develop the process as per the microbial safety.	5
5.	Rectify the various defects of food products	6

Course code:FTL-406
Course Title: Biochemical Engineering (Professional Core Elective –IV)

Course Objective:
1. To study energy and mass balance of biosystem.
2. To learn formulation of media and techniques of sterilization by thermal process and filtration3. To learn various bioreactors their design parameters and process control.
4.To study various downstream techniques of isolation and purification of fermentation products
5. To study the immobilized enzyme & their industrial application**.**

Pre-requisites:

Food Biotechnology (FTL-303), Food microbiology (FTC-302)& Chemical engineering (Material and Energy Balances Computations CHL-206)

.

Course Content

UNIT I:

Microbial growth&kinetics,Mass& energy balance and Thermodynamics of biosystem, kinetics of substrate utilization & product formation. Application of material balances to bioprocess.

UNIT II:

Sterilization: Importance of sterilization, batch sterilization of liquid, continuous sterilization of liquid and sterilization of air. Design, Preparation &sterilization of fermentationmedia.

UNIT III:

Oxygen transfer & microbial respiration, bubble aeration and mechanical agitation. Oxygen mass transfer in bioreactor, measurement of oxygen transfer coefficient (Kla), operating variables, effect of bubble size and temperature, impeller, surface active agents, mycelium and types of sparger on mass transfer coefficient.

UNIT IV:

Types of reactor, continuous stirred tank reactor (CSTR), packed bed bioreactor, bubble column bioreactor, fluidized bed bioreactor, trickle bed bioreactor and air lift bioreactor, design of Fermenter. Scale up of bioreactor systems. Bioprocess control.

UNIT V:

Downstream processing &bio separation, recovery of intracellular product from fermentation broth by disruption of cell, mechanical methods and celllysis.
Techniques of Immobilization of enzymes and their industrial application

Reference Books:

1. GhoseT.K.,Bioprocess Computations in Biotechnology, Published by Ellis Horwood Ltd. (2nd edition, 1990).
2. GhoseT.K. & Fletcher A, Advances in biochemical Engineering, Springer verlag Berlin, Heidelberg, New York, (vol 1 to 6, 1971).
3. Blake Brough, Biochemical Engineering Science, Academic press,London, (vol 1& 2, 1968).
4. Weetal H.H., ,Immobilised enzymes, Antigens, antibodies & Peptides , Marcel Dekkar, New York, (vol,2,3& 4, 1975).
5. Bailey James E. &Ollis D.F., Biochemical Engineering fundamentals, McGraw Hill Book Co., (1977).
6. Peter Stanbury, Allan Whitaker, Stephen Hall ; Principles of Fermentation Technology, (3rd edition, 2016)

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	To assess energy and mass balance of bioprocess.	6
2.	To sterilize formulate fermentation medium and sterilize it by using heat and filtration techniques.	5
3.	Describe various aspects of designing bioreactor vessel	2
4.	Isolate pure fermentation product from fermentation broth	3
5.	To prepare immobilize enzyme using insoluble carrier and use it for product formation	4

Course code:FTL – 407
Course Title: Dairy Technology (Professional Core Elective-IV)

Course Objectives:
1. To study various dairy products
2. To study various techniques of milk preservation.
3. To study packaging technology of milk products.
4. To study techniques of concentrating milk and dairy products
5. To study the cleaning & sanitization of dairy products and dairy equipments

Pre-requisites:

Food Biochemistry and Nutrition (FTC-202), Food Biotechnology (FTL-303), Food Microbiology (FTC-302), Principles of Food Preservation (FTC-302)

Course Content:

Unit I:

Milk chemistry, storage and distribution, Important manufacturing steps of packed milk, butter, ghee, evaporated, condensed, Whole and skimmed milk powder.

Unit II:

Use of bio-protective factors for preservation of raw milk: effects on physicochemical, microbial and nutritional properties of milk and milk products, present status of preservation of raw milk by chemical preservatives; thermal processing for preservation.

Unit III:
Status of current packaging; types of packaging materials; criteria for selection of proper packaging; testing of packaging materials.

Unit IV:
Dehydration: advances in drying of milk and milk products; freeze concentration, freeze dehydration: physicochemical changes during freeze drying and industrial developments.

Unit V:
Current trends in cleaning and sanitization of dairy equipment: biological; detergents; Automation; Ultrasonic techniques in cleaning; bio-detergents, development of sanitizers- heat; chemical; radiation, mechanism of fouling and soil removal; Bio-films, assessing the effectiveness of cleaning and sanitization of dairy products.

Reference Books:

1. Smit, G., Dairy Processing – Improving quality, CRC – Woodhead, Publishing, England (2003).
2. Gould, G. W., New Methods of Food Preservation, Academic & Professional Publication, London, (2nd edition,1995).
3. Gordon, L. Robertson, Food Packaging: Principles and Practice, CRC Press, Taylor & Francis Group, Florida, USA (2nd edition, 2006).
4. Raija, A.,Novel Food Packaging, Woodland Publishing Co., England. (1st edition, 2006).
5. Walstra, P., Geurts, T.J., Noomen, A., Jellema, A. and Van Boekel,M.A.J.S., Dairy Technology – Principles of Milk Properties and Processes. Marcel Dekker, New York (1999).
6. Burton, H., Ultra-high Temperature Processing of Milk and MilkProducts, Elsevier Applied Sciences Ltd., England (1998).
7. Roger, A., Food Biotechnology, Elsevier Applied Sci. Pub., UK (1989).
8. Lee ByongH.,Fundamentals of Food Biotechnology, VCH Publishers, New York, (2nd edition, 1996).
9. Wiseman Alan, Principles of Biotechnology, Surrey University Press, New York (1988).
10. Sukumar De, Outlines of Dairy Technology,Oxford University Press, (2nd edition, 1980).
11. Khan Q A and Padmanabhan, Technology of Milk Processing.
12. Warner J N, Principles of Dairy Processing, Wiley eastern Ltd, New Delhi (1976)
13. Henderson J L, The Fluid Milk Industry, AVI Publishing Co. West port, Conn. USA (3rd edition).

Course Outcome:

Upon successful completion of the course, students will be able to

CO No.	Course Outcome	Cognitive level
1	Prepare various milk dairy products	4
2.	Preserve the raw milk and their products for long term	5
3.	Pack the dairy products for extending their shelf life.	3
4.	Prepare concentrated milk dairy products by using thermal drying and freeze concentration.	4
5.	Clean and sanitize dairy equipments and dairy products.	5