Hindusthan College of Engineering And Technology
Approved by AICTE, New Delhi, Accredited with 'A' Grade by NAAC
(An Autonomous Institution, Affiliated to Anna University, Chennai)
Coimbatore – 641 032

DEPARTMENT OF FOOD TECHNOLOGY

REGULATION 2016
CURRICULUM

SEMESTER I

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16MA1101	Engineering Mathematics – I (Matrices and calculus)	3	2	0	4	25	75	100
2	16PH1101	Engineering Physics	3	0	0	3	25	75	100
3	16CY1101	Engineering Chemistry	3	0	0	3	25	75	100
4	16HE1101	Essential English for Engineers – I	3	2	0	4	25	75	100
5	16GE1103	Problem Solving and Python Programming	3	0	0	3	25	75	100
6	16GE1102	Engineering Graphics	2	0	4	4	25	75	100
PRACTICAL									
7	16PS1001	Physical Sciences Lab – I	0	0	2	1	50	50	100
8	16GE1004	Problem Solving and Python Programming Lab	0	0	4	2	50	50	100
9	16GE1002	Engineering Practices Lab	0	0	4	2	50	50	100
10	16GE1003	Value Added Course – Language Competency Enhancement Course - I	0	0	0	1	0	50	100
		TOTAL	**17**	**4**	**14**	**27**			**1000**

SEMESTER II

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16MA2101	Engineering Mathematics – II (Vector Calculus, Complex Variables and Laplace Transforms)	3	2	0	4	25	75	100
2	16PH2102	Physics of Materials	3	0	0	3	25	75	100
3	16FT2101	Fundamentals of Biochemistry	3	0	0	3	25	75	100

4	16HE2102	Essential English For Engineers - II	3	2	0	4	25	75	100
5	16GE2101	Engineering Mechanics	3	2	0	4	25	75	100
6	16CY2102	Environmental Science	3	0	0	3	25	75	100
PRACTICAL									
7	16PS2001	Physical Sciences Laboratory – II	0	0	2	1	50	50	100
8	16FT2001	Biochemistry Lab	0	0	4	2	50	50	100
9	16GE2001	Value Added Course – Language Competency Enhancement Course - II	0	0	0	1	0	50	100
		TOTAL	**18**	**6**	**6**	**25**			**900**

SEMESTER III

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16MA3111	Fourier Analysis and Z Transform	3	1	0	4	25	75	100
2	16FT3201	Fluid Mechanics	3	1	0	4	25	75	100
3	16FT3202	Food Process Calculations	3	1	0	4	25	75	100
4	16FT3203	Food Microbiology	3	0	0	3	25	75	100
5	16FT3204	Food Chemistry	3	0	0	3	25	75	100
6	16FT3205	Thermodynamics	3	0	0	3	25	75	100
PRACTICAL									
7	16FT3001	Food Microbiology Laboratory	0	0	4	2	50	50	100
8	16FT3002	Food Chemistry Laboratory	0	0	4	2	50	50	100
		TOTAL	**18**	**3**	**8**	**25**			**800**

SEMESTER IV

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16MA4112	Applied Statistics & Numerical Methods	3	0	2	4	25	75	100
2	16FT4201	Engineering Properties of Food Materials	3	0	0	3	25	75	100
3	16FT4202	Fundamentals of Heat and Mass Transfer	3	1	0	4	25	75	100
4	16FT4203	Food Process Engineering - I	3	1	0	4	25	75	100
5	16FT4204	Food Analysis	3	0	0	3	25	75	100
6	16HE4101	Total Quality Management	3	0	0	3	25	75	100
PRACTICAL									

7	16FT4001	Food Analysis Laboratory	0	0	4	2	50	50	100
8	16FT4002	Heat and Mass transfer Laboratory	0	0	4	2	50	50	100
		TOTAL	**18**	**2**	**10**	**25**			**800**

SEMESTER V

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16FT5201	Food Process Engineering - II	3	1	0	4	25	75	100
2	16FT5202	Food Quality Assurance and Control	3	0	0	3	25	75	100
3	16FT5203	Baking and Confectionery Technology	3	0	0	3	25	75	100
4	16FT5204	Milling Technology for Food Materials	3	0	0	3	25	75	100
5	16FT5205	Fruits and Vegetable Processing Technology	3	0	0	3	25	75	100
6	16FT53XX	Professional Elective – I	3	0	0	3	25	75	100
PRACTICAL									
7	16FT5001	Baking and Confectionery Technology Laboratory	0	0	4	2	50	50	100
8	16FT5002	Food Process Engineering Laboratory	0	0	4	2	50	50	100
		TOTAL	**18**	**1**	**8**	**23**			**800**

SEMESTER VI

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16FT6201	Dairy Engineering	3	0	0	3	25	75	100
2	16FT6202	Food Packaging	3	0	0	3	25	75	100
3	16FT6203	Poultry, Meat and Fish Process Technology	3	0	0	3	25	75	100
4	16FT6204	Refrigeration and Cold chain Management	3	1	0	4	25	75	100
5	16FT63XX	Professional Elective – II	3	0	0	3	25	75	100
6	16XX6401	Open Elective – I	3	0	0	3	25	75	100
PRACTICAL									
7	16FT6001	Food Packaging and Fruits & Vegetable Processing Laboratory	0	0	4	2	50	50	100
8	16FT6002	Dairy Engineering Laboratory	0	0	4	2	50	50	100
9	16FT6701	Industrial Training	0	0	0	1	0	100	100
		TOTAL	**18**	**1**	**8**	**24**			**900**

SEMESTER VII

S.No.	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16HE7101	Professional Ethics	3	0	0	3	25	75	100
2	16FT7201	Food Additives	3	0	0	3	25	75	100
3	16FT7202	Plantation crops & Spices Product Technology	3	0	0	3	25	75	100
4	16FT73XX	Professional Elective – III	3	0	0	3	25	75	100
5	16FT73XX	Professional Elective – IV	3	0	0	3	25	75	100
6	16XX7401	Open Elective – II	3	0	0	3	25	75	100
PRACTICAL									
7	16FT7001	Food Process Equipment Design Laboratory	0	0	4	2	50	50	100
8	16FT7801	Mini Project	0	0	4	2	50	50	100
		TOTAL	**18**	**0**	**8**	**22**			**800**

SEMESTER VIII

S.No	COURSE CODE	COURSE TITLE	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16FT83XX	Professional Elective – V	3	0	0	3	25	75	100
2	16FT83XX	Professional Elective – VI	3	0	0	3	25	75	100
PRACTICAL									
4	16FT8901	Project	0	0	20	10	100	100	200
		TOTAL	**6**	**0**	**20**	**16**			**400**

LIST OF PROFESSIONAL ELECTIVES	
COURSE CODE	**COURSE TITLE**
SEMESTER V	
16FT5301	Technology of Fats and Oils

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16FT5302	Food Storage and Infestation Control
16FT5303	Cereal Technology
16FT5304	Post-Harvest Technology
SEMESTER VI	
16FT6301	Fermentation Technology
16FT6302	Bioprocess Engineering
16FT6303	Cane Sugar Technology
16FT6304	Enzyme Technology
SEMESTER VII	
16FT7301	Biology and Chemistry of Food Flavours
16FT7302	Food Laws and Safety
16FT7303	Functional Foods and Nutraceuticals
16FT7304	Food Toxicology and Allergy
16FT7305	Instrumentation and Process Control
16FT7306	Technology of Snack and Extruded Foods
16FT7307	Beverage Technology
16FT7308	Food Process Plant Layout and Safety
SEMESTER VIII	
16FT8301	Drying Technology
16FT8302	Emerging Technologies in Food Processing
16FT8303	Modeling, Simulation and Soft Tools for Food Technologists
16FT8304	Analytical Instruments in Food Industries
16FT8305	Separation Techniques in Food Processing
16FT8306	Waste Management and By-Product Utilization in Food Industries
16FT8307	Economics and Management
16FT8308	Emerging non-thermal processing of foods

LIST OF OPEN ELECTIVES	
COURSE CODE	**COURSE TITLE**
SEMESTER VI	
16FT6401	Principles of Food Science
SEMESTER VII	
16FT7401	Food Product Development

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SYLLABUS
I SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.E/B.Tech	16HE1101	ESSENTIAL ENGLISH FOR ENGINEERS – I	3	1	0	4

Course Objective

- ✓ It fulfills the necessary skills needed in today's global workplaces.
- ✓ Student will be able to interpret and illustrate formal communication.
- ✓ It empowers students in choosing right lexical techniques for effective presentation
- ✓ It equips the learner to analyze and list out things in logical order
- ✓ The learner develops the ability to create and integrate ideas in a professional way.

Unit	Description	Instructional Hours
I	Getting to know people – Introduction – Talking about jobs (Present Simple) – Talking about working conditions(Adverb of Frequency) - Talking about company history and structure (Past simple, Prepositions of Time) – Talking about company activities (Connectors of addition and contrast, Present Continuous) – Focus on language – Parts of Speech – Gerund and Infinitives – Instruction-**General Vocabulary**.	12
II	Vocabulary practice – (Telephoning Leaving and taking messages) – requests and obligation – Describing trends (Adjectives and Adverbs) – Talking about company performance (present perfect and past simple, Reasons and consequences) – Reading Test Practice Describing products Dimensions, (Comparatives and Superlatives, Question formation) – Talking about product development (Sequencing words, Present continuous and going to) – Articles – Prepositions- Synonyms – Antonyms- Recommendations- **Interpretation of a chart**.	12
III	Talking about business equipment (Giving Instruction) – Letter Phrases- Writing Test Practice- Talking about facilities(Asking for and giving direction)- Presentation on a general topic -Talking about traffic and transport(making predictions)-**Discussion on current affairs**– Tenses- Present –Past-Future-Forms of verbs- Word techniques- Formation-Prefixes-Suffixes.	12
IV	Talking about conference arrangement(checking and confirming) – Talking about a conference before, after, when, until etc. – Listening Test Practice- talking about production process – passive- Talking about quality control Conditional 1 (real) (Making suggestions) – Itinery- Jumbled sentences- Paragraph writing- Essay writing – Checklist- Letter to Inviting Dignitaries – Accepting invitation- Declining Invitation.	12
V	Talking about call centers, insurance and changes in working practices (future possibility/probability)- Talking about banking- Speaking Test practice – Talking about delivery services (preposition of Time)- Talking about trading (Tense review)- Talking about recruitment conditional 2 (hypothetical) – talking about job applications (indirect questions) – Reading, Writing and Listening Test – Job application Letter and Resume Writing- Permission letters.	12
	Total Instructional Hours	**60**

Course Outcome

CO1 - Recognize different parts of speech for better usage.
CO2 - Interpret and illustrate formal communication
CO3 - Choosing right lexical techniques for effective presentation.
CO4 - Analyze and list out things in logical order.
CO5 - Create and integrate ideas in a professional way.

TEXT BOOKS:

T1 - NormanWhitby, Cambridge English: Business BENCHMARK Pre-intermediate to Intermediate – 2nd Edition. 2014.

T2 - Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2013.

REFERENCE BOOKS :

R1 - Meenakshi Raman and Sangeetha Sharma. "Technical Communication-Principles and Practice", Oxford University Press, 2009.

R2 - Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi.

2005R3 - KamaleshSadanan "A Foundation Course for the Speakers of Tamil-Part-I &II", Orient Blackswan, 2010.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E. / B.Tech	16MA1101	**ENGINEERING MATHEMATICS–I (Matrices and Calculus)**	3	1	0	4

Course Objective

1. Develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.
2. Find curvature, evolutes and envelopes using the concept of differentiation.
3. Solve ordinary differential equations of certain types using Wronskian technique.
4. Familiarize the functions of several variables which are needed in many branches of engineering.
5. Understand the concept of double and triple integrals.

Unit	Description	Instructional Hours
I	**MATRICES** Eigen valuesand Eigen vectorsofarealmatrix– PropertiesofEigen values andEigen vectors (without proof)– Cayley- Hamilton Theorem (excluding proof)– Orthogonal matrices–Diagonalization of matrices by orthogonal transformation–Reduction of a quadratic form to canonical form by orthogonal transformation.	12
II	**DIFFERENTIAL CALCULUS** Curvature incartesianco-ordinates – Radius and Centre of curvature - Circle of curvature – Involutes and Evolutes(parabola, ellipse, cycloid, asteroid) – Envelopes - single parameter and two parameter family of curves.	12
III	**ORDINARYDIFFERENTIALEQUATIONS** Second and higher order linear differential equations with constant coefficients and with RHS of the form e^{ax} , x^n, sinax or cosax , $e^{ax}f(x)$ and $xf(x)$ where $f(x)$ is sinbx or cosbx– Method of variation of parameters – Linear differential equations with variable coefficients (Euler's equation)	12
IV	**FUNCTIONS OF SEVERAL VARIABLES** Totaldifferentiation (excluding implicit functions) - Partial derivatives of composite functions - Taylor'sseries for functions of two variables- Maximaandminimaof functions oftwovariables - Lagrange's method of undeterminedmultipliers – Jacobians.	12
V	**MULTIPLEINTEGRALS** DoubleintegralsinCartesiancoordinates–Changeoforderofintegration–Area enclosed by the plane curves (excluding surface area)– Tripleintegrals in Cartesian co-ordinates – Volume of solids using Cartesian co-ordinates.	12
	Total Instructional Hours	**60**

Course Outcome

CO1: Calculate Eigen values and Eigen vectors for a matrix which are used to determine the natural frequencies (or Eigen frequencies) of vibration and the shapes of these vibrational modes

CO2: Apply the concept of differentiation to find the radius, centre and circle of curvature of any curve

CO3: Develop sound knowledge of techniques in solving ordinary differential equations that model engineering problems

CO4: Identify the maximum and minimum values of surfaces.

CO5: Computation of area of a region in simpler way by changing the order of integration and evaluation of triple integrals to compute volume of three dimensional solid structures

TEXT BOOKS:

T1- Ravish R Singh, Mukul Bhatt, "Engineeing Mathematics", McGraw Hill education (India) Private Ltd.,Chennai,2017.

T2- Veerarajan T, "Engineering Mathematics–I", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016

REFERENCE BOOKS :

R1-BaliN.P &ManishGoyal,"ATextbookofEngineeringMathematics",8th Edition, Laxmi Pub. Pvt. Ltd. 2011.

R2- Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.

R3- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning,2012.

R4-Sivarama Krishna Das P and Rukmangadachari E., "Engineering Mathematics" Vol I, Second Edition, Pearson publishing, 2011.

R5- Wylie &Barett, "Advanced Engineering Mathematics", McGraw Hill Education, 6th edition, 2003

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Programme	Course Code	Name of the Course	L	T	P	C
B.E. / B.Tech	16PH1101	**Engineering Physics**	3	0	0	3

Course Objective

1. Illustrate the fundamental knowledge in mechanical properties of matter and thermal physics.
2. Gain knowledge about laser and their applications.
3. Conversant with principles of optical fiber, types and applications of optical fiber.
4. Discuss the architectural acoustics and applications of Ultrasonics.
5. Extend dual nature of matter and the Necessity of quantum mechanics to explore the behavior of sub atomic particles.

Unit	Description	Instructional Hours
I	**PROPERTIES OF MATTER AND THERMAL PHYSICS** Elasticity – Hooke's law – Stress-strain diagram - Relation between three modulii of elasticity (qualitative) — Poisson's ratio – Bending moment – Depression of a cantilever – Derivation of Young's modulus of the material of the beam by Uniform bending – I-shaped girder. Modes of heat transfer – Thermal conductivity – Newton's law of cooling - Lee's disc method - Conduction through compound media (series and parallel).	9
II	**LASER AND APPLICATIONS** Spontaneous emission and stimulated emission – Population inversion – Pumping methods – Derivation of Einstein's coefficients (A&B) – Types of lasers – Nd:YAG laser, CO2 laser, Semiconductor lasers:(homojunction and heterojunction) – Laser Applications – Industrial applications: laser welding, laser cutting, laser drilling – Holography – Construction and reconstruction of images.	9
III	**FIBER OPTICS AND APPLICATIONS** Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index, modes and materials) – Crucible-crucible technique for fiber fabrication – Sources (LED and LASER) and detectors (p-i-n photodiode and avalanche photodiode) for fiber optics - Fiber optical communication link –Fiber optic sensors – Temperature and displacement sensors.	9
IV	**ACOUSTICS AND ULTRASONICS** Classification of sound – Weber–Fechner law – Sabine's formula (no derivation) - Absorption coefficient and its determination –Factors affecting acoustics of buildings and their remedies. Ultrasonic Production – Magnetostrictive generator – Piezoelectric generator – Determination of velocity using acoustic grating – Non destructive testing – Ultrasonic pulse echo system.	9
V	**QUANTUM PHYSICS AND APPLICATIONS** Black body radiation – Planck's theory (derivation) –Compton effect experimental verification only - Matter waves – Physical significance of wave function – Schroedinger's wave equations – Time independent and time dependent wave equations –Particle in a box (One dimensional) – Scanning electron microscope – Transmission electron microscope.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Enhance the fundamental knowledge in Properties of Matter and Thermal Physics.
CO2: Uunderstand the advanced technology of LASER in the field of Engineering and medicine.
CO3: Exposed the fundamental knowledge of Optical fiber in the field of communication Engineering.
CO4: Understand the production of ultrasonics and its applications in NDT.
CO5: Impart the fundamental knowledge on Quantum Physics.

TEXT BOOKS:

T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011.

T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, DhanpatRai Publications (P) Ltd., New Delhi, 2013.

REFERENCE BOOKS:

R1 - Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill, New Delhi – 2010

R2 - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi 2014

R3 - Dr. G. Senthilkumar "Engineering Physics – I" VRB publishers Pvt Ltd., 2013

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Programme	Course Code	Name of the Course	L	T	P	C
BE	16CY1101	ENGINEERING CHEMISTRY	3	0	0	3

Course Objective

1. The student should be conversant with boiler feed water requirements, related problems and water treatment techniques.
2. The student should be conversant with the principles of polymer chemistry and engineering applications of polymers and composites
3. The student should be conversant with the principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
4. To acquaint the student with important concepts of spectroscopy and its applications.
5. To acquaint the students with the basics of nano materials, their properties and applications

Unit	Description	Instructional Hours
I	**WATER TECHNOLOGY** Hard water and soft water- Disadvantages of hard water- Hardness: types of hardness, calculations, estimation of hardness of water – EDTA method - scales and sludges – boiler corrosion – priming and foaming – caustic embrittlement; Conditioning methods of hard water – External conditioning - demineralization process- Internal conditioning - domestic water treatment: screening, sedimentation, coagulation, filtration, disinfection – chlorine – UV method; desalination: definition, reverse osmosis.	9
II	**POLYMER & COMPOSITES** Polymerization – types of polymerization – addition and condensation polymerization – mechanism of free radical addition polymerization – copolymers – plastics: classification – thermoplastics and thermosetting plastics, preparation, properties and uses of commercial plastics – PVC, Teflon – moulding of plastics (extrusion and compression); rubber: vulcanization of rubber, synthetic rubber – butyl rubber, SBR; composites: definition, types of composites – polymer matrix composites – FRP.	9
III	**ENERGY SOURCES AND STORAGE DEVICES** Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator- classification of nuclear reactor- light water reactor- breeder reactor- solar energy conversion- solar cells- wind energy. Batteries and fuel cells: Types of batteries- alkaline battery lead storage battery- nickel-cadmium battery- lithium battery- fuel cell H_2 -O_2 fuel cell applications.	9
IV	**ANALYTICAL TECHNIQUES** Beer-Lambert's law – UV-visible spectroscopy and IR spectroscopy – principles – instrumentation (block diagram only) – estimation of iron by colorimetry – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – interferences - estimation of nickel by atomic absorption spectroscopy.	
V	**NANOMATERIALS** Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: definition, carbon nanotubes (CNT), types of carbon nano tubes – single walled and multi walled carbon nanotubes – synthesis of carbon nanotubes: chemical vapour deposition – laser ablation – arc-discharge method; properties of CNT: mechanical, electrical, thermal and optical properties; applications of carbon nanotubes in chemical field, medicinal field, mechanical field and current applications.	9
	Total Instructional Hours	**45**

Course Outcome

1. Illustration of the basic parameters of water, different water softening processes and effect of hard water in industries.
2. Knowledge on basic properties and application of various polymers and composites as an engineering material.
3. Summarize the various energy sources and energy storage devices
4. Analyze various analytical skills in handling various machines, instruments, apart from understanding the mechanism involved.
5. Describe the basic properties and application of nanomaterials.

TEXT BOOKS

T1 - P.C.Jain and Monica Jain, "Engineering Chemistry" DhanpatRai Pub, Co., New Delhi (2015).

T2 - O.G.Palanna, "Engineering chemistry" McGraw Hill Education India (2017).

REFERENCES

R1 - B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2008).

R2 - B.K.Sharma "Engineering Chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2005).

R3 - S.S.Dara "A Text book of Engineering Chemistry" S.Chand&Co.Ltd., New Delhi (2010).

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E/ B.Tech	16GE1103	PROBLEM SOLVING AND PYTHON PROGRAMMING	3	0	0	3

Course Objective

1. To know the basics of algorithmic problem solving
2. To read and write simple Python programs.
3. To develop Python programs with conditionals and loops.
4. To define Python functions and call them.
5. To use Python data structures – lists, tuples, dictionaries.
6. To do input/output with files in Python.

UNIT	DESCRIPTION	TOTAL INSTRUCTIONAL HOURS
I	**ALGORITHMIC PROBLEM SOLVING** Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudocode, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems:To find the greatest among three numbers, prime numbers,find minimum in a list, Towers of Hanoi.	9
II	**DATA, EXPRESSIONS, STATEMENTS** Python interpreter and interactive mode; values and types: int, float, boolean, string, and list;variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, compute Simple interest for a given amount, Factorial of a given number ,distance between two points.	9
III	**CONTROL FLOW, FUNCTIONS** Conditionals: Boolean values and operators, conditional (if), alternative (if -else), chained conditional (if –elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion; Strings: string slices,immutability, string functions and methods, string module; Lists as arrays. Illustrative programs:square root, gcd, exponentiation, sum an array of numbers, linear search,binary search.	9
IV	**LISTS, TUPLES, DICTIONARIES** Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing -list comprehension; Illustrative programs: selection sort, insertion sort,histogram.	9
V	**FILES, MODULES, PACKAGES** Files and exception: text files, reading and writing files, format operator; command line arguments,errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count,copy file.	9
	TOTAL INSTRCTIONAL HOURS	**45**

Course Outcome

Upon completion of the course, students will be able to
CO1:Develop algorithmic solutions to simple computational problems
CO2:Structure simple Python programs for solving problems.
CO3:Decompose a Python program into functions.
CO4:Represent compound data using Python lists, tuples, dictionaries.
CO5:Read and write data from/to files in Python Programs.

TEXT BOOKS:

T1 –Ashok NamdevKamthane ,Amit Ashok Kamthane ," Programming and Problem solving with Python" McGrawHill Education

T2-Sheetal Taneja, "Python Programming A Modular Approach With Graphics,Database,Mobile and Web Applications, PEARSON .

REFERENCE BOOKS:

R1 - ReemaThareja" Python Programming Using Problem Solvimg Approach " OXFORD.

R2-E.Balagurusamy, "Problem solving and Python Programming" McGrawHill Education.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	16GE2102	ENGINEERING GRAPHICS	2	0	4	4

Course Objective
1. To provide drafting skills for communicating the Engineering concepts and ideas.
2. To expose to BIS and International standards related to engineering drawings.

Unit	Description	Total Hours
I	**PLANE CURVES** Importance of engineering drawing, drafting instruments, drawing sheets – layout and folding, Lettering and dimensioning, BIS standards and scales. Geometrical constructions, Construction of ellipse, parabola and Hyperbola by eccentricity method, construction of cycloids and involutes of square and circle – Drawing of tangents and normal to the above curves.	15
II	**PROJECTIONS OF POINTS, LINES AND PLANE SURFACES** Introduction to Orthographic projections- Projection of points. Projection of straight lines inclined to both the planes, Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) inclined to both the planes by rotating object method (First angle projections only).	15
III	**PROJECTIONS OF SOLIDS** Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is perpendicular and inclined to one plane and objects inclined to both the planes by rotating object method.	15
IV	**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES** Sectioning of simple solids with their axis in vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other – Obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinder and cone. Development of lateral surfaces of truncated solids. Intersection of solids-cylinder vs cylinder.	15
V	**ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS** Isometric views and projections of simple and truncated solids such as - Prisms, pyramids, cylinders, cones-combination of two solid objects in simple vertical positions. Free hand sketching of multiple views from a pictorial drawing. Perspective projection of solids in simple position using visual ray method.	15
	Total Instructional Hours	**75**

Course Outcome
CO1: Draw the orthographic and isometric views of regular solid objects including sectional views.
CO2:Recognize the International Standards in Engineering Drawing practices.

TEXT BOOKS:

T1 - K.Venugopal, V.Prabu Raja, “Engineering Drawing, AutoCAD, Building Drawings”, 5th Edition New Age International Publishers, New delhi 2016.
T2 - K.V.Natarajan, “A textbook of Engineering Graphics”, Dhanalaksmi Publishers, Chennai.

REFERENCE BOOKS:

R1 - BasantAgrawal and C.M.Agrawal, “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited,New Delhi 2008.
R2 - K. R. Gopalakrishnan, “Engineering Drawing” (Vol. I & II), Subhas Publications, Bangalore, 1998.
R3 - M.B.Shah and B.C.Rana, “Engineering Drawing”, Pearson Education, India, 2005.
R4 - N.S. Parthasarathy, Vela Murali, “Engineering Drawing”, Oxford University press, India 2015.

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E	16PS1001	PHYSICAL SCIENCES LABORATORY – I	0	0	2	1

PHYSICS LAB - I

Course Objective

1. Evaluate the particle size of micro particles and acceptance angle of fibres.
2. Employ instrumental method to determine Young's modulus of a beam of metals.
3. Apply the concept of diffraction and getting ability to calculate the wavelength of the mercury spectrum

Expt. No.	Description of the Experiments
1.	Determination of Wavelength, and particle size using Laser
2.	Determination of acceptance angle and numerical aperature in an optical fiber.
3.	Determination of velocity of sound and compressibility of liquid – Ultrasonic Interferometer.
4.	Determination of wavelength of mercury spectrum – spectrometer grating
5.	Determination of thermal conductivity of a bad conductor – Lee's Disc method
6.	Determination of Young's modulus by Non uniform bending method
7.	Determination of specific resistance of a given coil of wire – Carey Foster's Bridge.
8.	Post office box Measurement of an unknown resistance

TOTAL PRACTICAL HOURS 30

Course Outcome

CO1: Point out the particle size of micro particles and acceptance angle of fibres using diode laser.
CO2: Assess the Young's modulus of a beam using non uniform bending methods.
CO3: Illustrate the concept of diffraction and getting ability to calculate the wavelength of the mercury spectrum Using spectrometer.
CO4: Identify the velocity of ultrasonic's in the given liquid.
CO5: Illustrate phenomena of thermal conductivity of a bad conductor.

CHEMISTRY LAB-I

Course Objective

1. Acquire practical skills in the determination of water quality parameters.
2. Acquaint the students with the determination of molecular weight of a polymer by viscometry.
3. Acquaint the students with the estimation of chemical substances using instrumental analysis techniques.

Expt. No.	Description of the Experiments
1.	Preparation of molar and normal solutions and their standardization.
2.	Estimation of total, permanent and temporary hardness of Water by EDTA
3.	Determination of chloride content of water sample by argentometric method.
4.	Determination of available chlorine in bleaching powder.
5.	Conductometric titration of strong acid vs strong base (HClvsNaOH).
6.	Conductometric titration (Mixture of weak and strong acids)
7.	Conductometric precipitation titration using $BaCl_2$ and Na_2SO_4
8.	Determination of molecular weight and degree of polymerization using viscometry.
9.	Estimation of iron content of the water sample using spectrophotometer.(1,10 phenanthroline / thiocyanate method).

Total Practical Hours 30

Course Outcome

CO1: Estimate the different types of hardness in a water sample.
CO2: Determine the chloride content of water sample.
CO3: Calculate the strength of acid using conductometric titrations.
CO4: Calculate the strength of strong and weak acid using conductometric titrations.
CO5: estimate the amount of salt using conductometric precipitation titrations.

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E	16GE1004	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY (EFFECTIVE FROM THE ACADEMIC YEAR 2018-2019)	0	0	4	2

Course Objective

1. To write, test, and debug simple Python programs.
2. To implement Python programs with conditionals and loops.
3. Use functions for structuring Python programs.
4. Represent compound data using Python lists, tuples, dictionaries.
5. Read and write data from/to files in Python.

Ex.No	DESCRIPTION	TOTAL INSTRUCTIONAL HOURS
1	Compute the GCD of two numbers.	3
2	Find the square root of a number	3
3	Exponentiation (power of a number)	3
4	Find the factorial of a given number	3
5	Print prime numbers from 1 to n numbers	3
6	Find the maximum of a list of numbers	3
7	Linear search , Binary search	3
8	Selection sort, Insertion sort	3
9	First n prime numbers	3
10	Multiply matrices	3
11	Programs that take command line arguments(word count)	3
12	Find the most frequent words in a text read from a file	3
13	Simulate bouncing ball using Pygame	3
	TOTAL INSTRCTIONAL HOURS	**45**

Course Outcome

CO1: Write, test, and debug simple Python programs.
CO2: Implement Python programs with conditionals and loops.
CO3:Develop Python programs step-wise by defining functions and calling them.
CO4:Use Python lists, tuples, dictionaries for representing compound data.
CO5:Read and write data from/to files in Python.

PLATFORM NEEDED: Python 3 interpreter for Windows/Linux

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	16GE1002	ENGINEERING PRACTICES LAB	0	0	4	2

Course Objective	To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

Expt. No.	Description of the Experiments

I CIVIL ENGINEERING PRACTICE

Study of plumbing and carpentry components of Residential and Industrial buildings.

(A) PLUMBING WORKS:

1. Study on pipe joints, its location and functions: Valves, taps, couplings, unions, reducers, elbows in household fittings.
2. Study of pipe connection requirements for pumps.
3. Preparation of plumbing line sketches for water supply and sewage works.

Hands-on-exercise:

4. ➢ Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
5. Demonstration of plumbing requirements of high-rise buildings.

(B) CARPENTRY USING POWER TOOLS ONLY:

1. Study of the joints in roofs, doors, windows and furniture.
2. Hands-on-exercise in wood works by sawing, planning and cutting.

IIMECHANICAL ENGINEERING

(A) Welding:

1. Preparation of arc welding of Butt joints, Lap joints and Tee joints

(B) Machining:

1. Practice on Simple step turning and taper turning
2. Practice on Drilling Practice

(C) Sheet Metal Work:

1. Practice on Models– Trays, cone and cylinder.

DEMONSTRATION

(D) Smithy

- ➢ Smithy operations: Upsetting, swaging, setting down and bending.
- ➢ Demonstration of – Production of hexagonal headed bolt.

(E) Gas welding

(F) Foundry Tools and operations.

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GROUP B (ELECTRICAL & ELECTRONICS)

S.No	Description of the Experiments
	ELECTRICAL ENGINEERING PRACTICES
1	Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2	Fluorescent lamp wiring
3	Stair case wiring.
4	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5	Measurement of energy using single phase energy meter.
	ELECTRONICS ENGINEERING PRACTICES
1	Study of Electronic components and equipments – Resistors - colour coding
2	Measurement of DC signal - AC signal parameters (peak-peak, RMS period, frequency) using CRO.
3	Study of logic gates AND, OR, NOT and NAND .
4	Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5	Measurement of average and RMS value of Half wave and Full Wave rectifiers.
	Total Practical Hours **45**

Course Outcome	CO1: Fabricate wooden components and pipe connections including plumbing works. CO2: Fabricate simple weld joints. CO3: Fabricate electrical and electronics circuits.

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II SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.E/B.Tech	16HE2102	ESSENTIAL ENGLISH FOR ENGINEERS – II	3	1	0	4

Course Objective

- ✓ The learner will be introduced to global corporate culture and professional communication.
- ✓ It helps the students to focus on organizing professional event and documentation.
- ✓ The student will be able to describe the events and process in an effective way.
- ✓ It trains the student to analyze the problems and to find solution to it.
- ✓ The learner will be familiar with business communication.

Unit	Description	Instructional Hours
I	Introduction- talking about teamwork- Making arrangements- Improving Communication in spoken language – Taking and leaving Voice mail messages (present Tense, Past Tense and Present Perfect) Talking about Business Hotel- (Speaking Activity) Talking about Corporate Hospitality- Formal and Informal Language – Making accepting and declining invitations (Auxiliary Verb, Countable or Uncountable Nouns) – Focus on Language – Definitions and Extended Definitions-**Reading comprehension.**	12
II	Talking about orders – Clarity Written Language – Phone and Letter Phrases – Talking about Company Finances – Conditional 1 and 2 – Managing Cash Flow (Intention and Arrangements Conditional 1 and 2) – Talking about Brands and Marketing – Ethical Banking- Talking about Public Relations – Organizing a PR Event – Describing Duties and Responsibilities – (Future Tense and Articles) – Reported Speech – Modal Verbs and Passive, Impersonal Passive Voice-**interpretation of posters or advertisements.**	12
III	Talking about relocation – Report Phrases – Talking about Similarity and difference- Giving Directions- Asking for Information and Making Suggestions – Talking about Location (Comparatives and Superlatives, Participles) – Talking about Company Performances- Describing Trends – Describing Cause and Effect – Talking about Environmental Impact – Discussing Green Issues – Language of Presentations (Adjectives and Adverbs, Determiners)- Homophones – Homonyms- Acronyms-Abbreviations- British and American words.	12
IV	Talking about Health and Safety – Expressing Obligation- Discussing Regulations- Talking about personnel Problems – Passives – Talking about Problem at Work (modal Verbs, Passives)- Talking about Expenses Claims- Talking about Air Travel (Relative Pronoun, Indirect Questions) – **E-mail Writing - Note completion-** Transcoding.	12
V	Talking about staff Benefits- Talking about Appraisal Systems (gerunds and Infinitives, Reported Speech) – Talking about Marketing Disasters – Expressing hypothetical Situations- Talking about entering Foreign Market (Conditional 3, Grammar review) – Letter for calling quotations, Replying for quotations – Placing an order and Complaint and **reply to a complaint**.	12
	Total Instructional Hours	**60**

Course Outcome

CO1: Introduced corporate culture and professional communication.
CO2: It focused on organizing a professional event and its documentation.
CO3: Improved the ability to describe the events and process in an effective way
CO4: Trained to analyze the problems and to find solution to it.
CO5: Practiced to make business communication.

TEXT BOOKS:

T1 - NormanWhitby, Cambridge English: Business BENCHMARK Pre-intermediate to Intermediate – 2nd Edition. 2014.
T2 - Ian Wood and Anne Willams. “Pass Cambridge BEC Preliminary”, Cengage Learning press 2013.

REFERENCE BOOKS :

R1 - Communication Skills for Engineers, SunithaMisra&C.Murali Krishna, Pearson Publishers
R2 - Technical Communication, Daniel G. Riordan, Cengage learning publishers.
R3 - KamaleshSadanan “A Foundation Course for the Speakers of Tamil-Part-I &II”, Orient Blackswan,2010.

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Programme	Course Code	Name of the Course	L	T	P	C
BE	**16PH2102**	**Physics of Materials**	3	0	0	3

Course Objective

1. Gain knowledge about conducting materials.
2. Provide fundamental knowledge of semiconducting materials which is related to the engineering program.
3. Extend the properties of magnetic materials, applications and super conducting materials.
4. Defend the various types of dielectric materials and their uses.
5. Expose the students to smart materials and the basis of nano technology.

Unit	Description	Instructional Hours
I	**CONDUCTINGMATERIALS** Introduction – Conductors – Classical free electron theory of metals – Electrical and thermal conductivities – Wiedemann–Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi function – Density of energy states – Carrier concentration in metals.	9
II	**SEMICONDUCTING MATERIALS** Introduction – Intrinsic semiconductor – Compound and elemental semiconductor (direct and indirect band gap of semiconductors). carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – Extrinsic semiconductor - derivation of carrier concentration in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration — Hall effect –Determination of Hall coefficient – Applications.	9
III	**MAGNETIC & SUPERCONDUCTING MATERIALS** **Magnetic Materials**: Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti ferromagnetic materials – Ferrites and its applications. **Superconducting Materials :** Superconductivity : properties(Messiner effect, effect of magnetic field, effect of current and isotope effects) – Type I and Type II superconductors – BCS theory of superconductivity(Qualitative) - High Tc superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.	9
IV	**DIELECTRIC & COMPOSITES MATERIALS** Introduction – Electrical susceptibility – dielectric constant – polarization - electronic, ionic, orientation and space charge polarization –internal field – Claussius – Mosotti relation (derivation) – dielectric loss and dielectric breakdown (qualitative) Introduction to composites materials – types of composites materials – polymer, metallic and ceramic matrix composites (qualitative). Application in surgery, sports equipment.	9
V	**SMART MATERIALS AND NANOTECHNOLOGY** **New Engineering Materials:** Metallic glasses – preparation, properties and applications – shape memory alloys (SMA) – characteristics, properties of NiTi alloy applications. **Nano Materials**: Synthesis - plasma arcing – Chemical vapour deposition – properties of nanoparicles and applications. – Carbon nano tubes – fabrication – pulsed laser deposition - Chemical vapour deposition - properties & applications.	9
	Total Instructional Hours	**45**

Course Outcome

CO1:Illustrate the electrical / thermal conductivity of conducting materials.
CO2: Understand the purpose of the acceptor or donor levels and the band gap of a semiconductor.
CO3: Interpret the basic idea behind the process of magnetism and applications of magnetic materials in every day life
CO4: Identify and compare the various types of dielectric polarization and dielectric breakdown.
CO5: Evaluate the properties and applications of various advanced engineering materials and develop the new ideas to synthesis Nanomaterials.

TEXT BOOKS:

T1 - S.O.Pillai “Solid State Physics” New Age International Publishers, New Delhi – 2011
T2- Rajendran V “Materials Science” McGraw-Hill Education” New Delhi -2016.

REFERENCE BOOKS:

R1 – William D Callister, Jr “Material Science and Engineering” John wiley and Sons, New York, 2014.
R2 -Raghavan, V. “Materials Science and Engineering – A First Course” Prentice Hall of India, New Delhi 2016.
R3 -Dr. G. Senthilkumar “Engineering Physics – II” VRB publishers Pvt Ltd., 2013

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Programme	Course Code	Name of the Course	L	T	P	C
B.E. / B.Tech	16MA2102	ENGINEERING MATHEMATICS–II (Vector Calculus, Complex variables and Laplace transforms)	3	1	0	4

Course Objective

1. Learn the basics of vector calculus comprising gradient, divergence, Curl and line, surface, volume integrals.
2. Understand analytic functions of complex variables and conformal mappings.
3. Know the basics of residues, complex integration and contour integration.
4. Apply Laplace transform techniques to solve linear differential equations.
5. Know the effective mathematical tools for the solutions of partial differential equations that model several physical problemsin mathematical physics

Unit	Description	Instructional Hours
I	**VECTORCALCULUS** Gradient,divergenceandcurl–Directionalderivative–Irrotationalandsolenoidalvector fields– Vectorintegration – Green'stheoreminaplane,Gauss divergencetheoremandStokes' theorem (excludingproofs)– Simpleapplicationsinvolvingcubesandrectangular parallelopipeds.	12
II	**ANALYTIC FUNCTIONS** Analytic function -Cauchy-Riemann equations -sufficient conditions (excluding proof) – Harmonic - conjugate harmonic functions– Constructionofanalytic functions (Milne-Thompson method)–Conformal mapping:w= z+c,cz,1/z and bilinear transformation without problems related to the concept of conformal mapping.	12
III	**COMPLEX INTEGRATION** Complexintegration–StatementsofCauchy'sintegral theorem – Taylor's and Laurent's series expansions - Singular points–Residues–Cauchy'sresidue theorem – Evaluation of real definite integrals as contour integrals around unit circle.	12
IV	**LAPLACETRANSFORM** Laplacetransform–Basic properties –Transforms ofderivatives andintegrals offunctions-Transformsofunitstepfunctionandimpulsefunction–Transformofperiodic functions. InverseLaplacetransform-Convolutiontheorem (with out proof) – Solutionof linear ODE of second order with constant coefficientsusing Laplace transformation techniques.	12
V	**PARTIAL DIFFERENTIAL EQUATIONS** Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions-Solution of standard types of first order partial differential equations of the form f(p,q) = 0, Clairaut's type: z = px + qy + f(p, q) – Lagrange's linear equation- Linear homogeneous partial differential equations of second and higher order with constant coefficient.	12
	Total Instructional Hours	**60**

Course Outcome

CO1: Know the gradient, divergence and curl of vectors useful for engineering application like fluid flow, electricity and magnetism.
CO2: Test the analyticity to construct the analytic function and transform complex functions from one plane to another plane graphically.
CO3: Evaluate real and complex integrals over suitable closed paths or contours.
CO4: Know the applications of Laplace transform and its properties and to solve certain linear differential equations using Laplace transform technique.
CO5: Solve the engineering problems using Partial Differential Equations.

TEXT BOOKS:

T1- Ravish R Singh, Mukul Bhatt, "Engineeing Mathematics", McGraw Hill education (India) Private Ltd.,Chennai,2017.
T2- Veerarajan T, "Engineering Mathematics–II", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016

REFERENCE BOOKS :

R1-BaliN.P &ManishGoyal,"ATextbookofEngineeringMathematics",8th Edition, Laxmi Pub. Pvt. Ltd. 2011.
R2- Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.
R3- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning,2012.
R4-Sivarama Krishna Das P and Rukmangadachari E., "Engineering Mathematics" Vol II, Second Edition, Pearson publishing, 2011.
R5- Wylie &Barett, "Advanced Engineering Mathematics", McGraw Hill Education, 6th edition, 2003

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Programme	Course Code	Name of the Course	L	T	P	C
BE	16CY2102	ENVIRONMENTAL SCIENCE	3	0	0	3

Course Objective

1. To gain knowledge on the importance of environmental education, ecosystem and biodiversity.
2. To acquire knowledge about environmental pollution – sources, effects and control measures of environmental pollution.
3. To find and implement scientific, technological, economic and political solutions to environmental problems.
4. To study about the natural resources, exploitation and its conservation
5. To be aware of the national and international concern for environment and its protection.

Unit	Description	Instructional Hours
I	**ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY** Importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers- energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.	9
II	**ENVIRONMENTAL POLLUTION** Definition – causes, effects and control measures of: Air pollution – Air pollution standards – control methods- Water pollution – Water quality parameters- Soil pollution - Marine pollution - Noise pollution- Thermal pollution - Nuclear hazards–role of an individual in prevention of pollution – pollution case studies**.**	9
III	**NATURAL RESOURCES** Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and Desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.	9
IV	**SOCIAL ISSUES AND THE ENVIRONMENT** From unsustainable to sustainable development – urban problems related to energy- energy conversion – electrical energy calculations- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- Current Environmental issues at Country level – management of municipal sewage, municipal solid waste, Hazardous waste and Bio-medical waste – Global issues – Climatic change, Acid rain, greenhouse effect and Ozone layer depletion. Disaster management: floods, earthquake, cyclone and landslides.	9
V	**HUMAN POPULATION AND THE ENVIRONMENT** Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- GIS-remote sensing-role of information technology in environment and human health – Case studies.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the natural environment and its relationships with human activities.
CO2: Characterize and analyze human impacts on the environment
CO3: Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes
CO4: Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
CO5: Understand and implement scientific research strategies, including collection, management, evaluation, and interpretation of environmental data.

TEXT BOOKS:

T1- AnubhaKaushik and C. P. Kaushik, "Environmental Science and Engineering", Fourth edition, New Age International Publishers, New Delhi, 2014.

T2 – Deeksha Dave and S.S.Katewa, "Textbook of Environmental Studies", Second Edition, Cengage Learning, 2012.

REFERENCES:

R1 - Trivedi R.K. "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol. I and II, Enviro Media.

R2 - G.Tyler Miller, Jr and Scott E. Spoolman"Environmental Science" Thirteenth Edition, Cengage Learning, 2010.

R3 - Gilbert M. Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH	16FT2201	FUNDAMENTALS OF BIOCHEMISTRY	3	0	0	3

Course Objective

1.To enable students learn the fundamentals of Biochemical Processes and Biomolecules.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BIOMOLECULES** Basic principles of organic chemistry, role of carbon, types of functional groups, biomolecules, chemical nature of water, pH and biological buffers.	9
II	**STRUCTURE AND PROPERTIES OF IMPORTANT BIOMOLECULES** Carbohydrates (mono, di, oligo& polysaccharides) mutarotation, glycosidic bond, reactions of monosaccharides and reducing sugars Starch, glycogen, cellulose and chitin. Proteoglycans, glycosaminoglycans. hyaluronic acid, chondroitin sulfate. Lipids**:** Fatty acids, glycerol, triacylglycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids. Inherited metabolic disorders of Lipid-metabolism-Tay-Saach's disease, Niemann-Pick's disease and Gaucher's disease. Cholesterol, steroids, Bile acids and salts, Gluco-and Mineralo-corticosteroids. Aldosterone, cortisone and synthetic derivative-prednisolone. Androgens-testosterone, Estrogens- estrone, estradiol and progesterone. Prostaglandins and their functions. LDL, HDL and VLDL. Cardiovascular disease and correlation with circulating lipid and lipoprotein concentration Amino Acids, Peptides, and Proteins.Classification based on side-chain properties. Structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determination of primary structure.Nucleic acids: Purines, pyrimidines, nucleosides, nucleotides, Chargaff's Rules. Base pairing, A-T and G-C, mRNA, rRNA and tRNA., Watson-Crick structure of DNA. reactions, properties, Tm and hypochromicity, Measurement of DNA and RNA. Nucleoprotein complexes.	9
III	**METABOLISM CONCEPTS** Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Interconnection of pathways and metabolic regulation.	9
IV	**INTERMEDIARY METABOLISM AND REGULATION** Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt, glyoxalate shunt, fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.	9
V	**CASE STUDIES** Case study on overproduction of primary and secondary metabolites - glutamic acid, threonine , lysine, methionine, isoleucine, propionic acid and ethanol.	9
	Total Instructional Hours	**45**

Course Outcome

1. To ensure students have a strong foundation in the structure and reactions of Biomolecules.
2. To introduce them to metabolic pathways of the major biomolecules and relevance to clinical conditions.
3. To correlate Biochemical processes with Biotechnology applications

TEXT BOOKS

T1 - Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox

T2 - Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.

T3 - Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.

T4 - Conn, E.E., etal., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.

T5 - Outlines of biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp 693. John Wiley and Sons, New York. 1987.

REFERENCES

R1 - Berg, Jeremy M. et al. "Biochemsitry", 6th Edition, W.H. Freeman & Co., 2006.

R2 - Murray, R.K., etal "Harper's Illustrated Biochemistry", 27th Edition, McGraw-Hill, 2006.

R3 - Voet, D. and Voet, J.G., "Biochemistry", 3rd Edition, John Wiley & Sons Inc.,2004.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	16PS2001	PHYSICAL SCIENCES LABORATORY – II	0	0	2	1

PHYSICS LAB-II

Course Objective

1. Evaluate the band gap of a semiconductor.
2. Apply the concept of interference and calculate the thickness of thin wire.
3. Acquire the practical skills in Young's modulus by uniform bending method.

Expt. No.	Description of the Experiments
1.	Determination of Young's modulus by uniform bending method
2.	Determination of band gap of a semiconductor
3.	Determination of Coefficient of viscosity of a liquid –Poiseuille's method
4.	Determination of Dispersive power of a prism – Spectrometer
5.	Determination of thickness of a thin wire – Air wedge method
6.	Determination of Rigidity modulus – Torsion pendulum
7.	Magnetic hysteresis experiment
8.	Calibration of ammeter using potentiometer

TOTAL PRACTICAL HOURS 30

Course Outcome

CO1: Experiment involving the physical phenomena of the Rigidity modulus of wire.
CO2: Determine the band gap of a semiconductor and variation of Energy Gap (E_g) with temperature.
CO3: Assess the Young's modulus of a beam using non uniform bending method.
CO4: Explain the concept of interference and calculate the thickness of thin wire and other fine objects.
CO5: Experiment provides a unique opportunity to validate Dispersive power of a prism using Spectrometer.

CHEMISTRY LAB – II

Course Objective

1. Acquire practical skills in the quantitative analysis of water quality parameters.
2. Acquire practical skills in the instrumental methods for quantitative estimation of metal ion content.
3. Gain knowledge in determination of rate of corrosion.

Expt. No.	Description of the Experiments
1.	Determination of Dissolved Oxygen in water by Winkler's method.
2.	Estimation of alkalinity of water sample by indicator method.
3.	Estimation of hydrochloric acid by pH metry.
4.	Estimation of ferrous iron by Potentiometry.
5.	Estimation of Copper by EDTA
6.	Determination of sodium by flame photometry
7.	Determination of corrosion rate of mild steel by weight loss method.

Total Practical Hours 30

Course Outcome

CO1: Determine the level of DO in a water sample.
CO2: Identify and estimate the different types of alkalinity in water sample.
CO3: Estimate the acidity of water sample using pH metry.
CO4: Estimate the amount of copper in a brass sample.
CO5: Determine the metal ion content using instrumental methods.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH	16FT2001	BIOCHEMISTRY LAB	0	0	4	2

Course Objective To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids, metabolites etc.,) and laboratory analysis of the same in the body fluids.

Expt. No.	Description of the Experiments
1.	General guidelines for working in biochemistry lab (theory)
2.	Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices.
3.	Accuracy, precision, sensitivity and specificity (theory)
4.	Preparation of buffer –titration of a weak acid and a weak base.
5.	Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.
6.	Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from imino acid.
7.	Protein estimation by Biuret and Lowry's methods.
8.	Protein estimation by Bradford and spectroscopic methods.
9.	Extraction of lipids and analysis by TLC.
10	Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect (demo)
11	Enzymatic assay: phosphatase from potato.
12	Enzymatic assay: estimation of glucose by GOD-POD method after hydrolysis of starch with acid and specificity of the enzymatic method.
	Total Practical Hours **60**

Course Outcome

Analyze the biomolecules qualitatively and quantitatively in the body fluids

Estimate the biomolecules qualitatively and quantitatively in the body fluids

TEXT BOOK

T1 - Practical Biochemistry by R.C. Gupta and S. Bhargavan.

T2 - Introduction of Practical Biochemistry by David T. Phummer. (II Edition)

REFERENCE BOOK

R1 - Harpers Biochemistry Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W.Rodwell, Appleton and Lange ,Stanford ,Conneticut.

R2 - Textbook of Biochemistry with clinical correlations. Ed. Thomas M. Devlin. Wiley Liss Publishers

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III SEMESTER

Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16MA3111**	**FOURIER ANALYSIS AND Z TRANSFORMS**	3	1	0	4

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**FOURIER SERIES** Dirichlet's conditions- General Fourier Series – Odd and Even Functions – Half range sine and cosine series Change of Interval - Parseval's Identity - Harmonic analysis.	12
II	**BOUNDARY VALUE PROBLEMS** Classification of PDE - Solutions of one dimensional wave equation - One dimensional equation of heat conduction (excluding insulated edges).	12
III	**TWO DIMENSIONAL HEAT EQUATIONS** Steady state solution of two dimensional equation of heat conduction in infinite plate and semi circular plate.	12
IV	**FOURIER TRANSFORMS** Fourier Transform Pairs - Fourier sine and cosine transforms – Properties - Transforms of Simple functions – Convolution Theorem – Parseval's identity.	12
V	**Z - TRANSFORMS AND DIFFERENCE EQUATIONS** Z- Transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem(excluding proof)– Solution of difference equations using Z – transform.	12
	Total Instructional Hours	60

COURSE OUTCOMES

- Understand the principles of Fourier series which helps them to solve physical problems of engineering.
- Apply Fourier series in solving the boundary value problems.
- Understand Fourier series in solving the two dimensional heat equations.
- Summarize the knowledge of Fourier transform techniques which extend its applications.
- Illustrate the Z- transforms for analyzing discrete-time signals and systems.

TEXT BOOKS:

1. Veerarajan. T.,"Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., Second reprint, New Delhi, 2012.
2. Bali. N.P and Manish Goyal& Watkins, "Advanced Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007

REFERENCE BOOKS :

1. C.Roy Wylie " Advance Engineering Mathematics" Louis C. Barret, 6th Edition, McGraw Hill EducationIndia Private Limited, New Delhi 2003.
2. Kandasamy P., Thilagavathy K. and GunavathyK.,"Engineering Mathematics Volume III", S.Chand& Company Ltd., New Delhi, 1996.
3. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, Delhi,2018.
4. Ramana. B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2018.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT3201**	**FLUID MECHANICS**	3	1	0	4

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Fluid Statics and Dimensional Analysis:** Nature of fluids – physical properties of fluids, Compressible and incompressible. Types of fluids – Newtonian and Non – Newtonian fluids. Fluid static: Hydrostatic equilibrium. Application of fluid statics: manometers, continuous gravity decanter. Basics of dimensional analysis: Rayleigh's method and Buckingham's method.	12
II	**Basic Equations of Fluid Flow:** Bernoulli equation. Correction of Bernoulli equation for fluid friction. Application of Bernoulli equation for pump work. Shear stress and skin friction in pipes. Laminar and turbulent flow of fluids through closed conduits. Velocity profiles and friction factor for smooth and rough pipes. Friction loss due to sudden enlargement, contraction. Friction loss in fittings valves and coils.	12
III	**Flow Past Immersed Bodies:** Pressure drop for flow of liquids through porous media. Motion of particles through fluids: Equation for one dimensional motion of spherical particle through fluid, terminal velocity, Hindered settling. **Agitation of liquids:** Types of impellers, Flow pattern in agitated vessel. Power consumption in agitated vessels, blending and mixing.	12
IV	**Transportation of Fluids**: Fluid moving machinery. Performance – selection and specification. Positive displacement, centrifugal pump - characteristics. Gear pump, diaphragm pumps, vacuum pump, metering pump, peristaltic pump – working principle and application. Fans, blowers and compressors – Selection, types and applications.	12
V	**Metering of Fluids:** Variable head meter: Orifice meter, Venturimeter, Pitot tube. Variable area meter: Rota meter. Calibration of flow meters. Principles and applications of Doppler Effect in flow measurement. Principle of Magnetic flow meters, V-Notch, Turbine flow meters, and Thermal flow meters. Valves – Types, applications.	12
	TOTAL INTRUCTIONAL HOURS	60

COURSE OUTCOMES

- Classify fluids, apply hydrostatic equilibrium and dimensional analysis in fluid flow behaviour
- Derive and apply basic equations of fluid flow
- Analyze fluid flow through porous media and select suitable mixing equipment used in food industries
- Select and evaluate the performance of pumps
- Illustrate the principle and application of different flow measuring devices and valves

TEXT BOOKS

1. McCabe W.L., Smith J.C. and Harriot P., ―Unit Operations of Chemical Engineering‖, 7th Edition, McGraw Hill, New York, 2017.
2. Gavhane K.A., ―Unit Operations – I, 8th Edition, NiraliPrakashan Publications, Pune, 2017.

REFERENCE BOOKS

1. Coulson & Richardson's Chemical Engineering. 5th edition, vol. 2. Elsevier, 2006.
2. Mott, Robert L., and Joseph A. Untener. Applied fluid mechanics. Pearson, 2015.
3. Cengel, Yunus and Cimbala John M., ―Fluid Mechanics Fundamentals and Applications‖, 4th Edition, Tata McGraw Hill Publishing Company, 2017.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT3202**	**FOOD PROCESS CALCULATIONS**	3	1	0	4

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Units and Dimensions, Fundamental Calculations:** Basic and derived units, unit conversions, use of model units in calculations, methods of expression, compositions of mixture and solutions. Ideal and real gas laws – gas constant - calculations of pressure, volume and temperature using ideal gas law, Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.	12
II	**Material Balance and Stoichiometry:** Stoichiometric principles, Importance of material balance and energy balance in a process Industry, material balance with chemical reaction and without chemical reaction- application of material balance to unit operations like distillation, evaporation, crystallization, drying and extraction.	12
III	**Recycle Operations:** Recycle stream**,** block diagram, purging operations, purge ratio, recycle ratio and purge stream. **Humidity and Saturation:** Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity, wet and dry bulb temperature, dew point - Humidity chart usage.	12
IV	**Energy Balance:** Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems without chemical reaction.	12
V	**Combustion:** Combustion of solids, liquid and gas, determination of NHV and GHV. Determination of composition by Orsat analysis - Calculation of excess air, theoretical oxygen requirement	12
	TOTAL INTRUCTIONAL HOURS	60

COURSE OUTCOMES

- Apply different systems of units and dimensions, estimate compositions of mixtures and solutions
- Apply material balance for different unit operations
- Apply material balance for recycle operations and perform humidification calculations
- Perform energy balance calculations
- Determine the GHV, NHV and composition of fuels

TEXT BOOKS

1. Gavhane K.A., ―Introduction to Process Calculations (Stoichiometery), 1st Edition, NiraliPrakashan Publications, 2016.
2. Venkataramani V. and Anantharaman N., ―Process Calculations, 2nd edition, Prentice Hall of India, 2011.

REFERENCE BOOKS

1. Bhatt B.L. and Vora S.M., ―Stoichiometry, 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2004.
2. Himmelblau D.M., ―Basic Principles and Calculations in Chemical Engineering, 8th Edition, Prentice Hall of India, New Delhi, 2012.
3. Narayanan K.V. and Lakshmikutty B., ―Stoichiometry and Process Calculations, 2nd revised edition, Prentice Hall of India, New Delhi, 2016.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT3203**	**FOOD MICROBIOLOGY**	3	0	0	3

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Classification and Structure of Microorganisms:** Classification and Groups of microorganisms - Prokaryotes and Eukaryotes. Whittaker's five kingdom and three kingdom concept of living organisms. Microbial cell: Bacteria, Virus, Algae, Fungi- structure, reproduction and economic importance. Bacteriophage – structure, importance and life cycle (lytic and lysogenic cycle).	9
II	**Microscopy and Staining Techniques**- Principle, resolution, numerical aperture, magnification. Different types of microscopes – Light, UV, dark field, phase contrast and Electron microscope (Scanning and Transmission type). Stains – Auxochrome, chromophores, acidic and basic dyes. Staining techniques – Simple staining, Gram's staining, acid fast staining, endospore staining, capsule staining and flagella staining.	9
III	**Microbial Nutrition and Growth:** Primary nutritional requirements and nutritional classification – Phototrophs, autotrophs, organotrophs, lithotrophs, chemotrophs. Culture Media – components of media, design and preparation of media using common ingredients. Types of media - natural, synthetic, complex, selective, differential, enriched, assay, enumeration, transport and enrichment media. Growth curve – batch culture, continuous culture, synchronous culture. Physical factors influencing the growth – Temperature, pH, osmotic pressure and salt concentration.	9
IV	**Incidence of Microorganisms in Food:** Importance of microorganisms in food, primary sources of microorganisms in food, Intrinsic and Extrinsic parameters of food affecting / influencing microbial growth. Types of microorganisms in foods like meats, poultry, seafood, vegetables, dairy products, fruits and vegetables. **Microbial Load Assessment: S**ampling methods, SPC, MPN, spiral platter, DEFT, microcolonyHGMF, DMC, Dye reduction, swab/swab-rinse method, impedance, microcalorimetry, flow cytometry, ATP measurement, PCR, Fluorescent antibody, RIA, ELISA.	9
V	**Microbial Examination Of Foods:** Detection & Enumeration of microbes in foods; Indicator organisms and microbiological criteria;Rapid and automated microbial methods - development and impact on the detection of food bornepathogens; Applications of immunological, techniques to food industry; Detection methods for E.coli, Staphylococci, Yersinia, Campylobacter, B. cereus, Cl. Botulin0.1um& Salmonella, Listeriamonocytogenes Norwalk virus, Rotavirus, Hepatitis A virus from food samples.	9
	TOTAL INTRUCTIONAL HOURS	45

COURSE OUTCOMES

- Classify and identify the structure of microorganisms
- Interpret the different types of microscopes and staining techniques
- Formulate media for microbial growth
- Recognize the sources and factors influencing the microbial growth and identify the techniques used to assess the microbial load
- Examine the microorganism n food

TEXT BOOKS

1. Pelczar M.J., Chan E.C.S. and Krieg N.R., ―Microbiology, McGraw Hill, New York, 2004.
2. Powar C.B. and Daginawala H.F., ―General Microbiology, Volume I and II, 2nd edition, Himalaya Publishing House, New Delhi, 2010.

REFERENCE BOOKS

1. Wiley J., Sherwood L., and Woolverton C., ―Prescott's Microbiology, McGraw Hill, New York, 2013.
2. Harvey R.A., Cornelissen C.N. and Fisher B.D., ―Microbiology, 3rd Edition, Lippincott Williams &Wlakins, Philidelphia, 2013.
3. Black J.G., ―Microbiology – Principles and Explorations, 9th edition, John Wiley and sons Publications, USA, 2015.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT3204**	**FOOD CHEMISTRY**	3	0	0	3

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Food Groups:** Definition. Major food groups (basic 4, 5, 7) and their characterization. Food as a source of energy, Energy value of foods, energy requirement of the body - estimation. Water balance and recommended intakes; fluid/electrolyte balance, acid-base balance; Concept of water activity – Water binding in foods. **Nutrition:** Definitions – Malnutrition, obesity, balanced diets, Recommended Dietary Allowances (RDA).	9
II	**Minerals:** Major minerals – Calcium, Potassium, Sodium, Phosphorus. Minor minerals – Iron, Zinc, Iodine, Copper, Selenium. Functional role and deficiency. **Vitamins:** Definition, water soluble and fat soluble vitamins, sources, functions and deficiency symptoms.	9
III	**Changes during Cooking:** Cooking – objectives, methods – moist heat, dry heat and combination. Loss of nutrients and prevention, biochemical changes in carbohydrates - Gelatinization and retro gradation of starch, proteins and lipids; parboiling of rice; enzymatic browning reactions; non enzymatic browning reactions - caramelization, Maillard reaction.	9
IV	**Modification of Biomolecules:** Modified starches, resistant starch. Starch hydrolysates – Maltodextrins and dextrins. Modification of proteins – chemical and enzymatic methods. Modification of fats - Hydrogenation - cis and trans isomers, interesterification, winterization. Biochemical changes during processing of foods - pickling, malting, drying and baking.	9
V	**Food Preservation:** principles of food preservation. Preservation by high temperature – sterilization, pasteurization, blanching. Preservation by low temperature – Refrigeration and freezing – factors affecting the process and characteristics of foods. Preservation by irradiation, drying and chemicals. Biochemical changes during preservation.	9
	TOTAL INTRUCTIONAL HOURS	45

COURSE OUTCOMES

- Interpret the nutritional importance of foods and water
- Summarize the nutritional importance of vitamins and minerals
- Recognize the changes in food components during cooking, processing and storage
- Modify the carbohydrates, proteins and fats based on its functional properties
- Apply the different methods of food preservation

TEXT BOOKS

1. Belitz H.D., Grosch W. and Schieberle P., ―Food Chemistry, 4th revised and extended Edition, Springer, 2009.
2. Sivasankar B., ―Food Processing and Preservation, Prentice Hall of India, New Delhi, 2005.

REFERENCE BOOKS

1. Fennema, Owen R., Srinivasan Damodaran, and Kirk L. Parkin. “In Fennema’s Food Chemistry”, Fifth Edition, CRC Press, 2017.
2. Sri lLakshmi B., ―Nutrition Science, 6th Edition, New Age International Ltd., New Delhi, 2017.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT3205**	**THERMODYNAMICS**	3	0	0	3

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Basic Concepts and First Law:** Fundamental concepts of thermodynamics- microscopic and macroscopic approach – systems, properties, process, functions, units, energy, heat and work, zeroth law. First law - statement of first law for flow and non - flow process, internal energy, enthalpy, heat capacities (CV and CP) – steady state flow processes with reference to various thermal equipments - nozzle, throat, throttling process and compressors.	9
II	**Second Law:** Second Law of thermodynamics: Kelvin-Plank, Clausius statements and its equivalence, reversible cycle – Carnot cycle and theorem – thermodynamic temperature scale. Entropy, Clausius theorem, Clausius inequality, Entropy changes during processes – available and unavailable energies.	9
III	**PVT Behavior of Pure Fluids:** PVT surfaces: P-V, P-T, T-S and H-S Diagrams. Equation of state and the concept of ideal gas - Process involving ideal gases: constant volume, constant pressure, constant temperature, adiabatic and polytrophic process. Equation of state for real gases – Vander Waals equation, RedllichKwong equation, Virial equation of state. Principle of corresponding states – generalized compressibility charts.	9
IV	**Steam Properties:** Properties of steam, usage of steam tables. Determination of dryness fraction of steam. Calorimeters – Tank or barrel type, throttling, separating, separating and throttling. Steam distribution systems. Types of steam traps and their characteristics. Application of steam in food process industries.	9
V	**Boilers:** Types and classification of boilers - Cochran Boiler, Lancashire boiler, Locomotive Boiler, Fluidized Bed Boiler. Boiler mountings and Accessories. Performance and energy efficiency of boilers. Simple calculation of Boiler efficiency. Importance of boiler water treatment and blow down.	9
	TOTAL INTRUCTIONAL HOURS	45

COURSE OUTCOMES

- Outline the basic concepts and apply the first law of thermodynamics in selected processes
- Understand the principle of second law of thermodynamics and concepts of Carnot cycle
- Interpret the second law of thermodynamics and relate the properties of pure substance
- Estimate the properties of steam and measurement of quality of steam using calorimeters
- Integrate the use of simple calculation in gaining the working knowledge of different boilers

TEXT BOOKS

1. Narayanan K.V., ―A Text Book of Chemical Engineering Thermodynamic, 2nd revised edition, Prentice Hall of India, New Delhi, 2013.
2. Reeve Sidney Armor., ―"Thermodynamics of Heat Engines", Wentworth press 2019.

REFERENCE BOOKS

1. Smith J.M., Van Ness H.C. and Abbott M.M., ―Introduction to Chemical Engineering Thermodynamics, 7th Edition, McGraw Hill, New York, 2005.
2. Rao Y.V.C., ―An Introduction to Thermodynamics, Universities Press, 2004.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT3001**	**FOOD MICROBIOLOGY LAB**	0	0	4	2

Experiments:

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques; Culture Media-Types and Use; Preparation of Nutrient broth and agar
2. Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
3. Microscopy – Working and care of Microscope; Microscopic Methods in the Study of Microorganisms; Staining Techniques- Simple, Differential- Gram's Staining
4. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in food products TVC
5. Microbiological Quality of Water (MPN)
6. Microbiological quality of milk
7. Enumeration of Lactic acid bacteria from fermented foods
8. Yeast &Mould count from fruits
9. Enumeration of spores from pepper
10. Inhibitory effect of spices on microbial load in fish & flesh foods
11. Enumeration & Isolation of E. colifrom processed meat/chicken
12. Thermal destruction of microbes: TDT & TDP
13. Enumeration & Isolation of Staphylococci from ready to eat street foods
14. Effect of cleaning and disinfection on microbial load

Total Practical Hours 45

COURSE OUTCOMES

- Complete understanding of isolation, characterization of various microbes associated withfoods and food groups.
- Familiarize with microbiological techniques for the study of foods.
- Better understanding of methods to detect pathogens in foods.

REFERENCES

1. Yousef A.E. and Carlstrom C., ―Food Microbiology: A Laboratory Manual, Wiley Inter science Publications, 2003.
2. McLandsborough L., ―Food Microbiology Laboratory, CRC Press, 2004.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT3002**	**FOOD CHEMISTRY LAB**	0	0	4	2

Experiments:

1. Qualitative tests for monosaccharide, disaccharides, polysaccharides
2. Estimation of reducing sugar by dinitrosalicylic acid method
3. Estimation of starch by anthrone method
4. Estimation of amylase
5. Estimation of non-enzymatic browning in foods
6. Extraction and estimation of oil content
7. Determination of peroxide value and TBA value of oil
8. Isolation of protein from milk and egg
9. Estimation of moisture content, total ash and acid insoluble ash
10. Estimation of vitamins
11. Estimation of crude fibre
12. Extraction of natural colours - chlorophyll, lycopene and carotenoids.

Total Practical Hours 45

COURSE OUTCOMES

- Estimate the biomolecules in food samples
- Interpret the changes during storage of oil
- Extract and estimate pigments and bioactive compounds

REFERENCES

1. Manickam A., ―Biochemical Methods, New Age International, New Delhi, 2010.
2. Ranganna S., ―Handbook of Analysis and Quality Control for Fruit and Vegetable Products, 2nd Edition, Tata McGraw Hill, New Delhi, 2017.

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IV SEMESTER

Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16MA4112**	**APPLIED STATISTICS AND NUMERICAL METHODS**	3	0	2	4

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**MEASURE OF CENTRAL TENDENCY AND DISPERSION** Measure of central tendency – mean, median, mode –Measure of dispersion – range – Quartile deviation – Standard deviation – Coefficient of Variation.**Introduction to R programming, Application of descriptive statistics – Mean, Median, Mode, variance**	9+3
II	**HYPOTHESIS TESTING** Large sample test based on Normal distribution – test of significance for single mean and difference of means -Small sample test – t test for single mean and difference of mean - F distribution for variance, Chi – Square test for independence of attributes – Goodness of fit. **Application of Student t-test, Application of Chi – square test**	9+6
III	**ANALYSIS OF VARIANCE** Introduction, assumptions of analysis of variance, Completely randomized design, Randomized block design, Latin square design. **ANOVA – completely randomized design ,ANOVA – randomized block design**	9+6
IV	**INTERPOLATION** Interpolation: Newton's forward and backward difference formulae Lagrangian interpolation for unequal intervals – Divided difference for unequal intervals : Newton's divided difference formula.	9
V	**NUMERICAL DIFFERENTIATION AND INTEGRATION** Differentiation using interpolation formula – Newton's forward and backward interpolation formulae for equal intervals – Newton's divided difference formula for unequal intervals - Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules.	9
	TOTAL INTRUCTIONAL HOURS	60

COURSE OUTCOMES

- Familiar with Measures of Central Tendency and Measures of Dispersion.
- Understand the concepts of statistical methods for testing the hypothesis.
- Apply Design of Experiment techniques to solve various engineering problems
- Understand the concept of interpolation in both cases of equal and unequal intervals.
- Identify various methods to perform numerical differentiation and integration.

TEXT BOOKS

1. Gupta, S.C., & Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Reprint 2011.
2. M.K.Jain,S.R.K.Iyengar, R.K.Jain "Numerical methods for Scientific and Computation", Fifth Edition, New Age International publishers 2010.

REFERENCE BOOKS

1. Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.
2. Grewal B.S. and Grewal J.S. " Numerical Methods in Engineering and Science ", 6th Edition , Khanna publishers, New Delhi 2014.
3. S.K.Gupta, Numerical Methods for Engineers" , New Age InternationalmPvt.Ltd Publishers,2015.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT4201**	**ENGINEERING PROPERTIES OF FOOD MATERIALS**	3	0	0	3

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Physical Properties:** Physical properties of food materials- size, shape, density, porosity and surface area – definitions and measurements, moisture content and its determination, direct and indirect methods, units, Frictional properties –friction – types, coefficient of friction, angle of repose – types and its determination.	9
II	**Thermal Properties:** Thermal properties, Definition of specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient. Measurement of specific heat, thermal conductivity, thermal diffusivity. Cryogenics, Calorific value of food, Bomb calorimeter. Applications of thermal properties.	9
III	**Optical Properties:** Refractive index of food items, Abbe_srefractometer, Sorting of food material using optical properties , Optical activity, Polarimeter, Spectrophotometer, Gloss, color, translucency – Definitions, measurement and applications. **Electromagnetic Properties:** Electrical properties, dielectric heating, electrical conductivity, dielectric measurements, microwave heating and other Applications.	9
IV	**Rheological Properties**: Stress Strain behavior of Newtonian and Non-Newtonian fluids- Bingham and Non Bingham. Stress-strain relationships in solids, liquids and viscoelastic behavior- stress relaxation test, creep test and dynamic test, stress-strain diagrams, Emulsions and Colloids. Viscosity – Principle, Types- Capillary, Orifice, Falling and Rotational viscometers.	9
V	**Textural Properties**: Types of food textures, Texture measuring instruments- Compression, Snap Bending, Cutting Shear, Puncture, Penetration and TPA, Properties of food powders. **Colour**: Interaction of object with light, Colorimeter-Color order systems- Munsel color system, CIE color system, Hunter lab color space, Loviebond system.	9
	TOTAL INTRUCTIONAL HOURS	45

COURSE OUTCOMES

- Interpret the physical properties of agricultural materials
- Elaborate the thermal properties and its application
- Outline the optical and electromagnetic properties
- Recognize the rheological properties of food materials
- Infer textural properties and color measurements of food materials

TEXT BOOKS

1. Rao, M. Anandha, Syed SH Rizvi, Ashim K. Datta, and Jasim Ahmed. *Engineering properties of foods*. CRC press, 2014.
2. Heldman, Dennis R., Daryl B. Lund, and Cristina Sabliov, eds. *Handbook of food engineering*. CRC press, 2018.

REFERENCE BOOKS

1. Stroshine R., ―Physical Properties of Agricultural Materials and Food Products, West Lafayette, IN., Purdue University, 2000.
2. De Podesta, Michael. Understanding the properties of matter. CRC Press, 2002.
3. Singh R. Paul and Heldman Dennis R., ―Introduction to Food Engineering, 5th Edition, Gulf Publishing USA, 2013.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT4202**	**FUNDAMENTALS OF HEAT AND MASS TRANSFER**	3	1	0	4

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Heat Transfer – Conduction :** Basic transfer processes – heat, mass and momentum – heat transfer process - conductors and insulators - conduction – Fourier's fundamental equation – thermal conductivity and thermal resistance - linear heat flow – heat transfer through homogenous wall, composite walls, radial heat flow through cylinders and sphere – extended surfaces (fins) — solving problems in heat transfer by conduction.	12
II	**Heat Transfer – Convection :**NewtonRikhman's law – film coefficient of heat transfer - convection – free and forced convection - dimensional analysis and its application – factors affecting the heat transfer coefficient in free and forced convection heat transfer – overall heat transfer coefficient - solving problems in heat transfer by convection.	12
III	**Heat Transfer – Heat Exchanger :** Heat exchangers – parallel, counter and cross flow – evaporator and condensers – Logarithmic Mean Temperature Difference – overall coefficient of heat transfer – tube in tube heat exchanger, shell and tube heat exchanger, plate heat exchanger – applications of heat exchangers – solving problems in heat exchangers.	12
IV	**Heat Transfer: Radiation** Radiation heat transfer – concept of black and grey body - monochromatic total emissive power – Kirchoff's law – Planck's law - Stefan-Boltzman's law – heat exchange through non-absorbing media - solving problems in heat transfer by radiation.	12
V	**Mass Transfer:** Mass transfer – introduction – Fick's law for molecular diffusion - molecular diffusion in gases –equimolar counters diffusion in gases and diffusion of gas A through non diffusing or stagnant B - diffusion through a varying cross sectional area and diffusion coefficients for gases – molecular diffusion in liquids, biological solutions and gels.	12
	TOTAL INTRUCTIONAL HOURS	60

COURSE OUTCOMES

- To understand and apply the principles in heat transfer phenomena
- To understand andapply the principles in mass transfer phenomena
- To design heat and mass transferequipments.

TEXT BOOKS

1. Bellaney, P.L. "Thermal Engineering". Khanna Publishers, New Delhi, 2001
2. Pyle, D. Leo, Peter J. Fryer, and Chris D. Reilly. Chemical engineering for the food industry. Springer Science & Business Media, 2012.

REFERENCES

1. Holman, E.P. "Heat Transfer". McGraw-Hill Publishing Co. New Delhi, 2001
2. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th Edition, Vol. I& II, Butterworth – Heinman (an imprint of Elsevier), 2004
3. McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6th Edition, McGraw Hill, 2003.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT4203**	**FOOD PROCESS ENGINEERING– I**	3	1	0	4

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Processing Operations:** Post-harvest losses in field crops – Cleaning - Wet and Dry cleaning, Screen Cleaners, Air Screen Cleaners. Peeling - Flash steam, Knife, Abrasion, Caustic and Flame peeling. Grading and Sorting - Principles, types and equipments. Moisture content – free moisture, bound and unbound moisture. Equilibrium moisture content - determination methods, models, Importance and hysteresis effect. Water activity and its importance.	12
II	**Drying:** Theory and mechanism of drying - Drying characteristics of materials. Psychrometric chart – applications. Thin layer and deep bed drying. Methods of drying agricultural materials - batch and continuous drying. Drying equipment design and performance of various drying equipments.	12
III	**Types of Dryers:** Tunnel Dryer, Belt Dryer, Drum Dryer, Spray Dryer, Fluidized Bed Dryer, Spouted bed dryer, Pneumatic Dryer, Rotary Dryer, Vacuum Drying, Freeze Drying, Heat Pump drying, Di-electric drying and Micro wave drying.	12
IV	**Preservation by Heating:** Methods of applying heat to food - Blanching, Pasteurization, Sterilization. Thermal death time relationships (D, Z and F values). Process calculations: General method, Ball's formula method. Sterilization – methods and equipments. UHT sterilization.	12
V	**Preservation by Cooling:** Chilling - Equipments, Cold storage. Freezing - Thermodynamics of food freezing, Phase diagrams, Ice crystals formation, Properties of frozen foods. Freezing time calculations, Freezing equipments. Freeze concentration.	12
	TOTAL INTRUCTIONAL HOURS	60

COURSE OUTCOMES

- Adapt specific pre-processing operations and estimate the moisture content of food materials
- Infer the concepts of food drying
- Classify the dryers and illustrate the working of dryers
- Appraise the techniques of preservation by heating
- Elaborate the techniques of preservation by cooling

TEXT BOOKS

1. Fellows P.J., ―Food processing Technology: Principles and Practice‖, 3rd Edition, Wood Head Publishing Limited, New Delhi, 2009.
2. Sahay K.M. and Singh K. K., ―Unit Operations of Agricultural Processing‖, 2nd Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2012.

REFERENCE BOOKS

1. Earle R.L., ―Unit Operations in Food Processing‖, Web Edition, Pergamon Press, U.K., 2004.
2. Paul Singh R. and Dennis R. Heldman, ―Introduction to Food Process Engineering‖, 5th Edition, Academic Press, USA, 2014.
3. James G Brennan, ―Food Processing Handbook‖, 2nd Edition, Wiley VCH, Weinheim, 2011.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT4204**	**FOOD ANALYSIS**	3	0	0	3

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**INTRODUCTION**- Introduction, food regulations and standards; sampling methods, and sample preparation foranalysis; statistical evaluation of analytical data. General methods of food analysis- Moisture determination by different methods; ash analysis-different methods; titrable acidity in foods;determination of crude fiber and dietary fibre.	9
II	**LIPIDS, PROTEINS AND CARBOHYDRATE ANALYSIS -** Analysis of oils and fats for physical and chemical parameters and quality standards, protein analysis by different techniques; analysis of carbohydrates by different techniques	9
III	**SPECTROSCOPIC TECHNIQUES -** Basic principles; application of UV-Visible spectrophotometer in the analysis of food additives; IR Spectroscopy in online determination of components of food- FT-IR tintometer in colorintensitydetermination; application of Atomic Absorption Spectrophotometer and ICP-AES in analysis of mineral elements and fluorimeter in vitamin analysis.	9
IV	**CHROMATOGRAPHIC TECHNIQUES -** Basic principles; application of paper chromatography and TLC in food analysis; detection ofadulterants in foods; Column chromatography for purification analysis- Ion exchange and affinitychromatography; HPLC and GC in food analysis; Significance of MS detectors in HPLC and GC;FAME analysis in oils and fats.	9
V	**ELECTROPHORESIS, REFRACTOMETRY AND POLARIMETRY -** Basic principles; application of the electrophoresis in food analysis; Brixs value of fruit juices; totalsoluble solids in fruit products; Refractive indices of oils and fats; specific rotations of sugars;Estimation of simple sugars and disaccharides by polarimeter.	9
	TOTAL INTRUCTIONAL HOURS	45

COURSE OUTCOMES

- Understand the principles behind analytical techniques in food analysis.
- Know the methods of selecting appropriate techniques in the analysis of food products.
- Realize the role of food analysis in food standards and regulations for the manufacture and the sale of food products and food quality control in food industries.
- Familiarize with the current state of knowledge in food analysis.

TEXT BOOKS

1. Pomeranz, Yeshajahu. “Food Analysis: Theory and Practice”. 3rd Edition. AspenPublishers / Springer, 2000.
2. Nielsen, S. Suzanne. “Food Analysis”. 3rd Edition. Springer, 2003.

REFERENCES

1. Otles, Semih. “Methods of Analysis of Food Components and Additives”. CRC Press, 2005.
2. Nollet, Leo M.L. “Hand Book of Food Analysis” II Rev. Edition. Vol. I, II & III, Marcel &Dekker, 2004.
3. Nollet, Leo M.L. “ Food Analysis by HPLC”. II Rev. Edition, Marcel & Dekker, 2000
4. Otles, Semih. “Handbook of Food Analysis Instruments”. CRC Press, 2009.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16HE4101**	**TOTAL QUALITY MANAGEMENT**	3	0	0	3

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Introduction :**Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of productand service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction,Customer complaints, Customer retention.	9
II	**TQM Principles :**Leadership - Quality Statements, Strategic quality planning, Quality Councils – Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward,Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen – Supplier partnership - Partnering, Supplier selection, Supplier Rating.	9
III	**TQM Tools And Techniques I :**The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking – Reason to bench mark, Bench marking process - FMEA - Stages, Types.	9
IV	**TQM Tools And Techniques II :**Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.	9
V	**Quality Management System :**Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration--**Environmental Management System:**Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO14001—Benefits of EMS.	9
	TOTAL INTRUCTIONAL HOURS	45

COURSE OUTCOMES

- To apply the tools and techniques of quality management
- To manufacturing and services processes.

TEXT BOOK

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,MaryB.Sacre,HemantUrdhwareshe andRashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCES

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall(India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,2006.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT4001**	**FOOD ANALYSIS LAB**	0	0	4	2

EXPERIMENTS:

1. Determination of moisture in spices powder by distillation method and Hot air oven method.
2. Determination of total fat, protein in milk and milk products.
3. Rancidity test for fried foods to assess primary and secondary oxidative products.
4. Detection and estimation of additives in food materials
5. Determination of pectin present in the given sample
6. Determination of Iron content in foods.
7. Determination of Iodine content in iodized salt.
8. Determination of viscosity of food samples
9. Estimation of saccharin present in the given sample
10. Detection of anti oxidant, polyphenols and flavonoids in foods.
11. Determination of soluble and insoluble fibre in foods.
12. Detection of adulterants in food materials.
13. Familiarization on working of analytical instruments like HPLC, UV visible spectrophotometer, flame photometer

Total Practical Hours 45

COURSE OUTCOMES

- Better understanding in analysis of foods and food products for chemical components.
- Knowing standards for food products.
- Obtain knowledge of adulterants in foods.

REFERENCE BOOKS:

1. Nielsen, S. Suzanne, ed. *Food analysis*. New York: Springer, 2010.
2. Huber, Ludwig. *Validation and qualification in analytical laboratories*. CRC Press, 2007.
3. Pomeranz, Yeshajahu, ed. *Food analysis: theory and practice.* Springer Science & Business Media, 2013.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH	**16FT4002**	**HEAT AND MASS TRANSFER LAB**	0	0	4	2

Programme	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**

Experiments:

1. Flow measurement a) Orifice meter b) Venturimeter c) Coils
2. Flow through square duct, annular and circular pipes
3. Pressure drop studies in packed bed
4. Flow through fluidized bed, valves and pipe fittings
5. Calibration of V-notch
6. Solving problems on single and multiple effect evaporator
7. Determination the efficiency of heat transfer in agitated vessel.
8. Determination of efficiency of liquid solid separation by filtration.
9. Determination of absorption efficiency in a packing tower
10. Heat transfer in natural convection/ forced convection
11. Determination of the activity coefficients by vapor liquid equilibrium
12. Determination of vaporization efficiency (Ev) and thermal efficiency (Et) of the given system using steam distillation setup. Also verify with Raleigh's equation
13. Studying the theoretical and actual recovery of solvent using leaching

Total Practical Hours 45

COURSE OUTCOMES

- Evaluate the process/performance parameters for mass transfer operations (distillation column, leaching)
- Determine diffusivity and Stefan Boltzman constant using fundamental principles
- Calculate the individual and overall heat transfer coefficient of heat exchangers
- Determine the discharge coefficient using variable area flow meters and variable head flow meters
- Assess the flow of fluids through closed conduits, open channels, valves and pipe fitting

REFERENCES:

1. McCabe W.L., Smith J.C. and Harriot P., ―Unit Operations of Chemical Engineering‖, 7th Edition, McGraw Hill, New York, 2005.
2. Perry Robert, ―Perry's Chemical Engineers Hand Book‖, 8th Edition, McGraw Hill, New York, 2007.

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B.Tech 16FT5201 **FOOD PROCESS ENGINEERING - II** **3 1 0 4**

Course Objectives

- To understand and remember the concept of food processing and also to know the mechanisms

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**SIZE REDUCTION:** Fibrous foods, Dry foods and Liquid foods – Energy Used in Grinding. New Surface Formed by Grinding. Grinding and Cutting equipments - Crushers, Hammer mills, Fixed head mills, Ball mills, Plate mills and Roller mills. Cutters - Slicers, Dicers, Shredder and Pulper. Size reduction in liquids.	12
II	**MECHANICAL SEPERATION:** Sedimentation in liquids - Gravitational sedimentation – Floatation - Sedimentation of particles in gas. Centrifugal separation – Velocity of particles – Radius of neutral zone – Equipments. Filtration – Constant rate and Constant pressure filtration - Equipments, Sieving effectiveness and Applications.	12
III	**CRYSTALLIZATION:** Crystallization Equilibrium – Nucleation – Meta stable region – Seed Crystals. Heat of Crystallization - Rate of crystal growth. Stage equilibrium crystallization. Equipments - Types – Applications.	12
IV	**MIXING:** Characteristics of mixtures. Measurement of mixing - sample size, sample composition. Particle mixing and Liquid Mixing - mixing index. Mixing of different quantities. Rate of Mixing and Energy Input in Mixing. Mixing equipments - Liquid Mixers, Powder and Particle Mixers, Dough and Paste Mixers.	12
V	**EXTRUSION**: Theory - Rheological properties and Operating Characteristics. Single and Twin screw extruders - Ancillary Equipments. Applications and Effects on Foods. **Material handling**: Types of handling and conveying system for food products - Belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor.	12
	Total Instructional Hours	**60**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand size reduction techniques for solids and liquids
CO2- Understand the mechanical separation in food processing
CO3- Understand the crystallization process
CO4- Understand the mixtures and mixing equipment
CO5- Understand extrusion process and material handling systems.

TEXT BOOKS:

1. Fellows P.J., ―Food processing Technology: Principles and Practice‖, 3rd Edition, Woodhead Publishing Ltd., New Delhi, 2009.
2. Earle R.L., ―Unit Operations in Food Processing‖, Web Edition, Pergamon Press, UK, 2004

REFERENCES BOOKS:

1. James G Brennan, ―Food Processing Handbook‖, 2nd Edition, Wiley VCH, Weinheim, 2011.
2. Paul Singh R and Dennis R. Heldman, ―Introduction to Food Process Engineering‖, 5th Edition, Academic Press, USA, 2014.
3. 3. Sahay K.M. and Singh K.K., ―Unit Operations of Agricultural Processing‖, 2nd Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2012.
4. Albert Ibarz and Gustavo V. Barbosa-Cánovas. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.2003.

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V SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5202	**FOOD QUALITY ASSURANCE AND CONTROL**	**3**	**0**	**0**	**3**

Course Objectives

- To understand and study about the quality assurance and quality control of food processing

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**FOOD QUALITY STRANDARDS:** Quality of Foods, Quality Standards - mandatory and optional standards, Food Safety Systems - ISO 9000, ISO 14000, ISO 22000, Mechanism of developing and fixing food standards, Good Manufacturing Practice, HACCP, Standards of Weights and Measures.	9
II	**QUALITY ASSURANCE AND CONTROL IN FOOD INDUSTRY:** Objectives, importance and functions of quality control, Concept of Quality Assurance and Quality Control, Quality Control procedures, Quality Assurance procedures, International organizations: ISO, CAC, WTO, USFDA, Codex, EIC. National organizations: BIS, CCFS, Agmark, MMPO and APEDA, Good Laboratory Practices.	9
III	**REGULATION FOR FOOD BUISNESS OPERATOR**: Food adulteration and food safety, Food laws - Food Safety and Standards Act (FSSAI), Prevention of Food Adulteration Act, Packaged Commodities Rules, Functions of Food Business Operator, QA Audit, IPR and Patents, Issues affecting consumers and industry - Genetically Modified Foods, Fortification, Pesticide Residues, Organic Foods, Food Additives.	9
IV	**SAMPLING AND STATISCAL QUALITY CONTROL:** Sampling- concept, methods and importance. Statistical Process and Quality Control - concept, importance and tools. Control charts: importance, types, design process, Control limits and errors, Process Capability	9
V	**SENSORY EVALUATION**: Introduction, sensory panel - screening and selection methods, training of sensory panel, Physiological factors affecting sensory panel, Hedonic rating of food. Sensory Evaluation tests - Difference - Paired Comparison, Triangle, Duo-trio Test, Quantitative - Grading, scaling and ranking.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Remember the food quality standards
CO2- Understand the implementation of quality assurance in food industry
CO3- Understand the regulations for FBO
CO4- Remember the sampling techniques
CO5- Remember the methods of sensory evaluation

TEXT BOOKS:

1. Inteaz Alli, ―Food Quality Assurance: Principles and Practices‖, 2nd Edition, Taylor and Francis, UK, 2014.
2. Andres Vasconcellos J, ―Quality Assurance for the Food Industry: A Practical Approach‖, CRC Press, New York, 2004

REFERENCES BOOKS:

1. David Kilcast, ―Sensory Analysis for Food and Beverage Quality Control: A Practial Guide‖, Woodhead Publishing Ltd, Cambridge, 2010
2. Singh, S. P., ―Food Safety, Quality Assurance, and Global Trade: Concerns and Strategies‖, International Book Distributing Company, Lucknow, 2009.
3. Manuals of Food Quality Control: Quality Assurance in Food Control Chemical Laboratory‖, FAO, Itlay, 1993.
4.Ronald E. Wrolstad. “Handbook of Food Analytical Chemistry” Vol I, John Wiley & sons, 2005

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5203	**BAKING AND CONFECTIONERY TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives

- To understand and remember the technology of baking and confectionery

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION TO BAKING:** Classification of bakery products. Bakery ingredients and their functions-Essential ingredients: Flour, yeast and sour dough, water, salt- Other ingredients: Sugar, color, flavor, fat, milk, milk powder and bread improvers. Leaveners and yeast foods. Shortenings, emulsifiers and antioxidants.	9
II	**EQUIPMENTS:** Introduction to utensils and equipments used in bakery industry with their purpose.Bulk handling of ingredients- Dough mixing and mixers, Dividing, rounding, sheeting, and laminating-Fermentation enclosures and brew equipment - Ovens and Slicers; Extrusion. Rheology of dough-Farinograph, Amylograph, Alveograph and Extensiograph.	9
III	**BREAD MAKING PROCESS:** The Chemistry of dough Development. Bread making methods- Straight dough/bulk fermentation - Sponge and dough- Activated dough development- Chorley wood bread process- Dough retarding and freezing-emergency No time process. Advantages and disadvantages of various methods of bread-making. Characteristics of good bread: Internal characters; external characters. Bread defects/faults and remedies. Spoilage of bread-Causes, detection and prevention.	9
IV	**BAKERY PRODUCT:** Production of cakes and cookies/biscuits. Types of biscuit dough‘s –Developed dough, short dough‘s, semi-sweet, enzyme modified dough‘s and batters. Cake making: Ingredients and their function Structure builders. Tenderizers, moisteners and flavor enhancers. Production process for Wafers- type of flour, raising agents and maturing. Other miscellaneous products- puff pastry, chemically leavened. Problems of baking.	9
V	**CONFECTIONERY PRODUCTS:** Definition, importance of sugar confectionery. General technical aspects of industrial sugar confectionery manufacture - compositional effects. Manufacture methods of high boiled sweets: - Ingredients -.prevention of recrystalization and stickiness Types of confectionery products-Caramel, Toffee and Fudge and other confections-:- ingredients - Formulation – Processing method- Quality control- Aerated confectionery-Methods of aeration- Manufacturing process- Chemistry of Hydrocolloids, Hydrocolloid pre treatment Processes -product quality parameters, faults and corrective measures. Spoilage of confectionery products	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the basic concepts of baking

CO2- Understand the mechanisms behind equipment used for baking and confectionary

CO3- Remember the processing of bread

CO4 - Understand the role of ingredients in bakery products

CO5- Understand the role of ingredients in confectionery products

TEXT BOOKS:

1. Matz, Samuel A., "Bakery Technology and Engineering", III Edition, Chapman & Hall, London.
2. Cauvain, Stanley P, and Young, Linda S., "Technology of Bread Making", II Edition Aspen publication. Maryland, 1999

REFERENCES BOOKS:

1. Edwards W.P. "Science of bakery products", RSC, UK,2007
2. Samuel A. Matz., "Equipment for Bakers", Pan Tech International Publication. 1988.
3. Sugar Confectionery manufacture-(Ed) E.B.Jackson, II edition, Blackie Academic and professional, Glasgow,1995.
4. Bernard. W. Minifie., PhD “Chocolate, Cocoa, and confectionery” (Science and Technology), 3rd edition,CBS publishers and Distributors, New Delhi

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5204	**MILLING TECHNOLOGY FOR FOOD MATERIALS**	**3**	**0**	**0**	**3**

Course Objectives

- To understand and remember the milling technology of food materials with by-products

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**STRUCTURE, STORAGE AND PEST MANAGEMENT OF GRAINS:** Grains - Definition. Importance. Physical properties of grains. Structure, Composition and Nutritional value – paddy, wheat, maize, oat, sorghum. Grain storage systems - farm level storage, bagged storage, bulk storage, hermetic storage, outdoor storage. Losses during storage, Grain protection methods – physical and chemical methods. Integrated stored grain pest management.	9
II	**MILLING OF PADDY:** Rice milling flow sheet. Cleaning. Parboiling-traditional and improved methods, Physio–chemical changes during parboiling, Effect of parboiling on rice quality. Husking- Methods of husking, Huskers/Shellers – impact type, centrifugal dehusker, under runner disc huller, rubber roll sheller. Separation – indented tray and compartment type separator. Whitening – friction type and abrasive type whiteners. Color sorter. New quality control instruments. Byproducts from rice milling.	9
III	**MILLING OF WHEAT:** Types of wheat. Wheat milling – Simple and detailed flow sheet. Preparation of Wheat for Milling – wheat blending, tempering or conditioning, Roller milling – break rolls and reduction rolls, operation and corrugation specification, Sifting – Plan sifters, Purifying - purifier. Milling performance evaluation. Functional properties of flour. Flour treatment – Enrichment, Enhancement of flour appearance, Improvement of functional properties. By products from wheat milling.	9
IV	**MILLING OF CORN AND MILLS:** Types of corn. Dry milling – Tempering, dehulling, degermination and milling. Wet milling – Steeping, Germ, fiber, starch and gluten separation, starch refinement. By products from corn milling. Legumes – Structure, Types, Nutritional and Anti-nutritional factors. Pulse Milling – Conditioning, Pitting, Oil/water treatment, drying, dehuskers – Tangential Abrasive Dehulling Device (TADD), Central Institute of Agricultural Engineering (CIAE) design, Schule design, CFTRI mini dhal mill, Husk separation and grading, Splitting – Equipments. Milling - Dry and wet milling, Dehulling efficiency.	9
V	**MILLING OF OIL SEEDS:** Types of Oil seeds. Oil seed processing - Mechanical extraction – Hydraulic press, Screw press, Filter press. Mechanical extraction of coconut oil and palm oil. Cold pressing and Hot Pressing. Solvent extraction – Flow sheet. Factors influencing extraction. Refining of oil – Degumming, Dewaxing, Neutralization, Bleaching, Filtration and Deodorization. Hydrogenation. Winterization. Oil seed flour concentrates and isolate.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the structure and storage of grains
CO2- Remember the processing of paddy
CO3- Remember the processing of wheat
CO4- Understand the importance of milling of pulses
CO5- Understand the milling process of oil seeds

TEXT BOOKS:

1.Chakraverty A., ―Post-Harvest Technology of Cereals, Pulses and Oil Seeds‖, 3rd Edition, Oxford IBH Publishing Co. Pvt. Ltd., New Delhi, 2008.

2. Sahay K.M. and Singh K.K., ―Unit Operations of Agricultural Processing‖, 2nd Edition, Vikas Publishing House, New Delhi, 2008.

REFERENCES BOOKS:

1. Chakraverty A., Mujumdar A.S., VijayaRaghavan G.S. and Ramaswamy H.S., ―Handbook of Postharvest Technology - Cereals, Fruits, Vegetables, Tea, and Spices‖, Marcel Dekker, Inc., New York, 2003.

2. Kulp K. and Pont J.G., ―Handbook of Cereal Science and Technology‖, 2nd Edition, Marcel Dekker, Inc., New York, 2000.

3.Richard D. O'Brien, ―Fats and Oils: Formulating and Processing for Applications‖, 3rd Edition, CRC Press, London, 2008.

4..Morris, Peter C. and James H Bryce “Cereal Biotechnology”. CRC / Woodhead, 2000

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5205	FRUITS AND VEGETABLE PROCESSING TECHNOLOGY	3	0	0	3

Course Objectives

- To understand and remember the technology of fruits and vegetable processing

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**BASIC AGRICULTURAL ASPECTS OF VEGETABLES AND FRUITS** Ability to identify all commercially important fruits and vegetables with their names in important Indian languages, important regions, season, Morphology, structure and composition of fruit and vegetable. Production and processing scenario of fruits and vegetable: India and World. Scope of Fruit and Vegetable Preservation Industry in India. Present status, constraints and prospectus	9
II	**STORAGE OF FRESH FRUITS AND VEGETABLES** Physical, Textural characteristics, structure and composition. Maturity standards; Importance, methods of Maturity determinations maturity indices for selected fruits and vegetables. Harvesting of important fruits and vegetables. Fruit ripening- chemical changes, regulations, methods. Storage practices: Control atmospheric, Bead atmosphere, hypotactic storage, cool store, Zero emerge cool chamber, stores striation. Commodity pre-treatment's - chemicals, wax coating, prepackaging, phytonutrients in fruits and vegetables grading, cleaning, Physiological post harvest diseases chilling injury and disease. Handling and packaging of fruits and vegetables	9
III	**FREEZING & DEHYDRATION OF FRUITS AND VEGETABLES:** General pre processing, different freezing methods and equipments, problems associated with specific fruits and vegetables; Dehydration – General pre processing, different methods of drying including sun, tray, spray drying and low temperature, osmotic dehydration and other modern methods; Indian Food Regulation and Quality assurance.	9
IV	**CANNING, PUREES AND JUICES:** Canning- General pre processing, specific or salient points in fruits and vegetables like – Blanching, exhausting, processing conditions; Indian Food Regulation and Quality assurance Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic. Indian Food Regulation and Quality assurance Vegetable Purees/ pastes - General and specific processing, different packing including aseptic. Indian Food Regulation and Quality assurance	9
V	**FRUIT AND VEGETABLE PRODUCTS:** Ready to eat fruit and vegetable products, Jams/Marmalades, Squashes/cordials, Ketchup/sauces, Chutneys, Fruit Bar, Soup powders, Candied Fruits, Natural colors, Fruit and Vegetable Fibres-General and specific processing, different packing including aseptic, Dried Onion, Powder. Garlic: Dried Garlic, Powder, Oil. Potato: Wafer; starch, Papad, Carrot: Preserve, candy, Pickle, Jam. Cauliflower and cabbage: Dried cauliflower and cabbage, Sauerkraut, Pickle Leafy vegetables; Dried Leafy Vegetables. (Spinach, Fenugreek, Coriander leaves, Curry leaves).Bitter gourd: Pickle, Dried bitter gourd. Indian Food Regulation and Quality assurance.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the agricultural aspects of fruits and vegetables
CO2- Understand the nature of fresh fruits and vegetables
CO3- Remember the concepts of freezing and dehydration
CO4- Understand the processing of canning
CO5- Understand the processing of fruits and vegetable products

TEXT BOOKS:

1. Fellows, P J. "Food Processing Technology: Principles and Practice". 2nd Edition, CRC/ Woodhead, 1997
2. Salunke,D. K and S. S Kadam "Hand Book of Fruit Science and Technology: Production, Composition, Storage and Processing". Marcel Dekker, 1995.

REFERENCES BOOKS:

1. "Food Processing & Preservation", Prentice Hall of India, 2002.
2. Wim Jongen, ‒Fruit and Vegetable Processing- Improving Quality‖, Wood Head Publishing Ltd, England, 2002
3.Thompson A.K., ‒Fruits and Vegetable - Harvesting, Handling and Storage‖, Blackwell Publishing, USA, 2003.
4.Lal G., Siddappa G. and Tondon G.L., ‒Preservation of Fruits and Vegetables‖, Indian Council of Agricultural Research, New Delhi, 1986.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5001	**BAKING AND CONFECTIONARY TECHNOLOGY LABORATORY**	**0**	**0**	**4**	**2**

Course Objectives

- To understand the practical knowledge about the concepts of baking and confectionery

S.No.	DESCRIPTION
1.	Estimation of wet and dry gluten content of wheat flour
2.	Estimation of water absorption power of wheat flour
3.	Determination of sedimentation value of wheat flour
4.	Determination of dough rising capacity of wet and dry yeast
5.	Estimation of quality parameters of bakery ingredients
6.	Experiment on leavening power of baking powder, sodium-bicarbonate and ammonium- bicarbonate
7.	Preparation and analysis of bread
8.	Preparation and analysis of toffee / candy
9.	Preparation and analysis of chocolates
10.	Preparation and analysis of biscuits / cookies

Total Practical Hours 45

Course Outcomes

Upon completion of the course, students can be able to

- Understand the processing of baking and confectionery products

REFERENCE BOOKS:

1. Duncan Manley,―Biscuit, Cracker and Cookie Recipes for the Food Industry‖, Woodhead Publishing, England, 2001.
2. Yogambal Ashokkumar, ―Text book of Bakery and Confectionery‖, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2012.
3. Samuel A. Matz, ―Bakery Technology and Engineering‖, 3rd Edition, Chapman and Hall, London, 2005.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5002	**FOOD PROCESS ENGINEERING LABORATORY**	**0**	**0**	**4**	**2**

Course Objectives

- To understand the practical knowledge about the engineering concepts of food materials

S.No.	DESCRIPTION
1.	Determination of size, roundness, sphericity and 1000 grain weight of food grains
2.	Determination of bulk density, true density and porosity
3.	Determination of angle of repose for grain sample
4.	Determination of co efficient of friction for grain sample
5.	Experiment on drying characteristics of food material using tray dryer
6.	Determination of fineness modulus for ground material using ball mill
7.	Determination of separation efficiency of inclined belt separator
8.	Determination of conveying efficiency and power requirement of screw conveyor
9.	Experiment on analysis of particle size distribution using hammer mill
10.	Experiment on paddy dehusker to determine the shelling efficiency
11.	Experiment on terminal velocity apparatus
12.	Experiment on drying characteristics of food material using fluidized bed dryer
	Total Practical Hours **45**

Course Outcomes

Upon completion of the course, students can be able to

- Understand the Engineering mechanisms of equipment and properties of foods

REFERENCE BOOKS:

1. Sharma Shri K., Mulvaney Steven J. and Rizvi Syed S. H., ―Food Process Engineering: Theory and Laboratory Experiments‖, 1st Edition, Wiley Inter-science, New Jersey, 1999.
2. Rao M., Syed. S.H. Rizvi and Ashim K. Datta, ―Engineering Properties of Foods‖, 4th Edition, CRC Press, Florida, 2005

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6201	**DAIRY ENGINEERING**	**3**	**0**	**0**	**3**

Course Objectives

- To understand the processing of milk and milk products along with the equipment used for it

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PROPERTIES OF MILK:** Indian Dairy industry, Milk - Definition, types of market milk, Composition of milk, Factors affecting composition of milk, System of pricing of milk, Nutritive value of milk, Physico-chemical properties of milk: Color, Flavour, Specific Gravity, Boiling point, Freezing point, Refractive Index, Acidity and pH, Viscosity, Surface Tension	9
II	**RAW MILK COLLECTION, TRANSPORTATION AND RECEPTION:** Raw milk collection system, Cooling and Transportation of milk, Platform tests of milk: Smell, Appearance, Temperature, Sediment, Acidity, Lactometer Reading, Fat, Solids-Not-Fat, Dye Reduction Test: MBRT test, Resazurin tests, Mastitis test, Filtration/Clarification of raw milk, Bactofugation of milk, Cooling and storage of raw milk, Bulk transportation technologies – carbondioxide impregnation.	9
III	**Design of Equipment:** Selection of Accessories - Pipes, Aseptic valves, Filters, Pumps, Blenders, Storage Tank. Design of dairy equipment – Heat exchangers, Homogenizer, Spray dryer, Bulk coolers, Evaporators, Butter churner, Separators. Calculation of Refrigeration Load. Process Automation.	9
IV	**Fluid Milk Processing:** Milk Standardization, Cream separation, Homogenization, Milk Pasteurization: HTST and Batch Pasteurization, Milk Sterilization, Bottling/Packaging of milk, Liquid milk filling, Aseptic filling of milk. **Milk Products:** Manufacture of cheese, ice-cream, yoghurt, condensed milk, milk powder.	9
V	**Cleaning and Sanitization of Dairy Equipment:** Basic principles, Cleaning and Sanitizing – agents and methods. Can washer - Rotary type and Straight through type. Selection and maintenance of can washers, CIP - Types of CIP system, Design of CIP system, CIP of dairy equipment.	9
	Total Instructional Hours	**45**

Upon completion of the course, students can be able to

Course Outcomes

CO1- Remember the constituents of milk

CO2- Understand the pre-handling of milk

CO3- Understand the processing of milk

CO4- Understand the equipment used for processing of milk

CO5- Understand the cleaning process in dairy plant

TEXT BOOKS:

1. Sukumar De, ―Outlines of Dairy Technology‖, Royal Oxford University Press, Delhi, 2010.

2. Tufail Ahmed, ―Dairy Plant Engineering and Management‖, Kitab Mahal, New Delhi, 2012.

REFERENCES BOOKS:

1.Jane Selia dos Reis Coimbra, Jose A. Teixeira, ―Engineering Aspects of Milk and Dairy Products‖, CRC Press, New York, 2010.

2. Robinson R.K., ―Modern Dairy Technology: Advances in Milk Products‖, Volume 2, Springer London Ltd., 2012.

3. Hui,Y.H,, ―Dairy Science and Technology Handbook: Applications Science, Technology and Engineering‖, Volume 3, Wiley, New Delhi, 2014.

4. Selia, Jane dos Reis Coimbra and Jose A. Teixeir "Engineering Aspects of Milk and Dairy Products".

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6202	**FOOD PACKAGING**	**3**	**0**	**0**	**3**

Course Objectives

- To Understand the concepts of packaging for various food products

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Basics in Food Packaging:** Definitions and basic functions of a food package. Food package design and development. Packaged product quality and shelf life. Current status in food packaging in India. Package standards and regulation. Labelling, Bar coding.	9
II	**Metal cans:** Raw materials for can making – steel, aluminium. Can making processes - three piece welded cans, DWI, DRD cans – end making processes – coating. Film laminates and inks, metal packages – corrosion and sulphur staining. Application of metal containers in food industries. **Glass containers:** Definition and composition. Glass container manufacture – melting, forming, surface treatments. Closure selection. Glass bottle design and specification. Application of glass containers in food industries	9
III	**Plastic Packaging:** Types of plastics used in packaging – PE, PP, PET, PVC, EVOH, PVA. Secondary conversion techniques – film, extrusion and thermal lamination. Printing of plastic films and rigid plastic containers. Food contact and barrier properties. Sealability and closure. Application of plastics for food packaging.	9
IV	**Paper and Paperboard Packaging:** Properties of paper and paperboard. Paper and paperboard manufacture - SBB, SUB, FBB, WLC. Package types – paper, pouches, sachets, cartons, boxes, tubes, tubs, containers, drums, tapes, cushion, cap liners and diaphragm. Application of paper and paperboards for food packaging.	9
V	**Trends in Food Packaging**: Active packaging, modified atmosphere packaging - vacuum and Inert gas Packaging, Biodegradable and edible packaging, Aseptic packaging, Shrink wrapping, Nano packaging, Antimicrobial packaging, self-heating and cooling cans.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand basic concepts in food packaging
CO2- Understand and choose appropriate metal and glass containers for food packaging
CO3- Understand the classification of plastics and elaborate their properties
CO4- Understand the use of paper and paperboards for various food applications
CO5- Remember the recent trends in food packaging

TEXT BOOKS:

1. Richard Coles and Mark J. Kirwan, –Food and Beverage Packaging Technology‖, 2nd Edition, Blackwell Publishing Asia Pty Ltd, CRC press, USA, 2011.

2. Robertson Gordon L., –Food Packaging: Principles and Practice‖, 3rd Edition, Marcel Dekker Inc, USA, 2012.

REFERENCES BOOKS:

1. Han Jung H., –Innovations in Food Packaging‖, 2nd Edition, Academic Press, USA 2013.

2. Dong Sun Lee, Kit L. Yam and Luciano Piergiovanni, –Food Packaging Science and Technology‖, CRC press, USA, 2008.

3. Otto G. Piringer and A.L. Baner, –Plastic Packaging Materials for Food‖, 1st Edition, Wiley- VCH, Germany, 2008.

4. Ahvenainen, Raija, ed. Novel food packaging techniques. Elsevier, 2003.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6203	POULTRY, MEAT AND FISH PROCESS TECHNOLOGY	3	0	0	3

Course Objectives

- To study the poultry, egg, meat and fish processing parameters and conditions

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**POULTRY PROCESSING:** Types and characteristics of poultry products. Unit operation in poultry processing. Pre-slaughter factors affecting poultry meat quality. Types of poultry cuts. Factors affecting the shelf-life of poultry meat. Sensory quality of poultry meat- color, texture and flavor. Preservation techniques: chemical treatments, heating, drying and irradiation	9
II	**EGG PROCESSING:** Structure, composition, nutritive value of egg. Functional properties of eggs, Factors affecting egg quality and measures of egg quality. Preservation of egg by different methods. Egg powder processing-spray drying, Foam mat drying	9
III	**MEAT PROCESSING:** Types of Meat and its sources, composition, structure of meat. Ante mortem handling, slaughtering of animals, inspection and grading of meat. Introduction to Halal. Post-mortem changes of meat. Meat -Tenderization, Aging. Meat quality evaluation. Wholesale and retail cuts. Preservation of meat-curing, smoking, drying, freezing. Processed meat products- Hamburgers, sausages and meat balls	12
IV	**FISH PROCESSING**: Types of fish, composition and nutritive value of fish. Harvesting of fish. Spoilage factors of fish. Post-mortem changes in fish. Preservation- Freezing and Individual quick freezing, Canning and smoking operations, Salting and drying of fish, pickling.	6
V	**HYGIENE AND SANITATION:** Handling and maintenance of tools and core equipment. Meat plant layout. Meat processing hygiene. Cleaning and sanitation in meat plants. Food safety measures –GMP and GHP.	6
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the process parameters poultry processing
CO2- Understand the structure and processing of egg
CO3- Understand the processing of meat and meat products
CO4- Understand the different processing and preservation operations of fish
CO5- Remember safety measures and hygienic conditions

TEXT BOOKS:

1.Panada P.C., ―Text book on Egg and Poultry Technology‖, 1st Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 1996

2.Gunter Heinz and Peter Hautzinger, ―Meat Processing Technology‖, 1st Edition, Rap Publication, Monteplier, 2007

REFERENCES BOOKS:

1.Ionnis S. Boziaris, ―Seafood Handbook: Technology, Quality and Safety‖, Wiley Blackwell, UK, 2014.

2. Mead G.C., ―Poultry Meat Processing and Quality‖, 1st Edition, CRC Press, London, 2004.

3. Alan R. Sams, ―Poultry Meat Processing‖, 1st Edition, CRC Press, London, 2001

4. Mountney, VivianE. Poultry products technology. Routledge, 2017.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6204	REFRIGERATION AND COLD CHAIN MANAGEMENT	3	1	0	4

Course Objectives

- To study the storage systems such as refrigeration and cold storage

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Introduction to refrigeration, unit of refrigeration capacity. Review of Second law of thermodynamics and interpretation. Production of low temperatures - principles and process. Refrigerants - classification and thermodynamic properties. Ozone depletion potential. Reversed Carnot cycle. Limitations of reversed Carnot systems	12
II	**REFRIGERATION SYSTEMS:** Refrigeration cycle – simple vapour compression, vapour absorption cycle, p-h and T-s diagrams, COP. Energy ratios and Power consumption of a refrigerating machine. Standard rating cycle and effect of operating conditions. Air refrigeration system – reversed Brayton cycle.	12
III	**COMPONENTS OF A REFRIGERATION SYSTEM:** Evaporator- dry and flooded type, liquid cooling evaporator. Condenser- water cooled, air cooled and evaporative condenser. Compressor - Reciprocating type compressors. Expansion valve - thermostatic expansion valve.	12
IV	**LOW TEMPERATURE STORAGE SYSTEMS:** Pre-cooling systems, Cold storage- construction, insulation and operation. Design of cold storage unit. Calculation of refrigeration load in cold store. Prefabricated systems, walk-in-coolers. Frozen storage, Cryogenics – Linde and Claude system for liquefaction of air.	12
V	**COLD CHAIN:** Introduction, Components of cold chain. Refrigerated distribution and transport systems, Cold chain in retail, Traceability- Application of RFID in cold chain. Role of refrigeration in food production - candy manufacture, beverage processing, bakery products, meat products, poultry products, fishery products, fruit /vegetables and dairy products.	12
	Total Instructional Hours	**60**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the basics of refrigeration with thermodynamic principles and Carnot cycle
CO2- Understand the concept of refrigeration cycles
CO3- Remember the various components of refrigeration system and its types
CO4- Understand the concept of low temperature storage systems for foods
CO5- Understand and apply cold chain and refrigeration for food products

TEXT BOOKS:

1.Rajput R.K., ―Refrigeration And Air-conditioning‖, 3rd Edition, S.K. Kataria and Sons (Publishers), Delhi, 2012.

2. Dellino C.V.J., ―Cold and Chilled Storage Technology‖, 2nd Edition, Springer, US, 2011.

REFERENCES BOOKS:

1. Arora C.P., ―Refrigeration and Air Conditioning‖, 2nd Edition, Tata McGraw-HillPublishing Company Ltd., Delhi, 2008.

2. Khurmi R.S. and Gupta J.K., ―Textbook of Refrigeration and Air Conditioning‖, 5th Edition, S. Chand Publishers, New Delhi, 2006.

3. Narayanan K.V., ―A Textbook of Chemical Engineering Thermodynamics‖, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2013

4.Evans, Judith A., ed. *Frozen food science and technology*. John Wiley & Sons, 2009.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6001	**FOOD PACKAGING AND FRUITS & VEGETABLE PROCESSING LABORATORY**	**0**	**0**	**4**	**2**

Course Objectives

- To understand the impact of packaging material on various products and also to know the processing of fruits and vegetables

S.No.	DESCRIPTION
1.	Experiment on juice extractor and pulper
2.	Experiment on osmotic dehydration of fruits and vegetables
3.	Preparation and analysis of jam/jelly, sauce
4.	Preparation and analysis of squash
5.	Estimation of bursting strength of packaging materials
6.	Experiment on canning of fruits and vegetables
7.	Determination of tear / puncture resistance of packaging materials
8.	Determination of tensile strength of different packaging materials
9.	Estimation of water absorption capacity of paper based packaging materials
10.	Estimation of water vapour permeability of different packaging materials
11.	Determination of overall migration of different plastic packaging materials
12	Determination of shelf life of modified atmospheric packed food

Total Practical Hours 45

Course Outcomes **Upon completion of the course, students can be able to**

CO1 - Understand the knowledge on extraction, pulping, dehydration and prepare fruit/vegetable based products

CO2 - Understand the mechanical properties of packaging materials

CO3 - Understand the water barrier properties of packaging materials

REFERENCE BOOKS:

1. Ranganna S., ―Handbook of Analysis and Quality Control for Fruit and Vegetable‖, Tata McGraw-Hill, 2001.
2. Gordon L. Robertson, ―Food Packaging and Shelf Life: A Practical Guide‖, CRC Press, USA, 2009.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6002	**DAIRY ENGINEERING LABORATORY**	**0**	**0**	**4**	**2**

Course Objectives

- To understand the practical knowledge about the processing of dairy products

S.No.	DESCRIPTION
1.	Studies on milk sampling, judging and grading of milk.
2.	Determination of acidity, specific gravity and clot-on-boil test of milk.
3.	Determination of fat, SNF and total solids content in milk.
4.	Determination of MBRT and alcohol index test of milk.
5.	Determination of pasteurization efficiency of milk.
6.	Estimation of homogenization efficiency
7.	Estimation of surface tension of milk.
8.	Determination of total milk protein content in milk.
9.	Determination of churning efficiency of butter churner.
10.	Determination of efficiency of spray dryer

Total Practical Hours 45

Course Outcomes

Upon completion of the course, students can be able to

- Understand the analysis of Dairy products
- Understand the processing of dairy products

REFERENCE BOOKS:

1.Jane Selia dos Reis Coimbra, Jose A. Teixeira, ―Engineering Aspects of Milk and Dairy Products‖, CRC Press, New York, 2010.

2. Robinson R.K., ―Modern Dairy Technology: Advances in Milk Products‖, Volume 2, Springer London Ltd., 2012.

3. Hui,Y.H,, ―Dairy Science and Technology Handbook: Applications Science, Technology and Engineering‖, Volume 3, Wiley, New Delhi, 2014.

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VII SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16HE7101	**PROFESSIONAL ETHICS**	3	0	0	3

Course Objectives

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**HUMAN VALUES:** Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.	9
II	**ENGINEERING ETHICS:** Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.	9
III	**ENGINEERING AS SOCIAL EXPERIMENTATION :** Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	9
IV	**SAFETY, RESPONSIBILITIES AND RIGHTS :** Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.	9
V	**GLOBAL ISSUES:** Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the human values
CO2- Understand the Engineering Ethics
CO3- Understand and relate engineering and social experimentation
CO4- Remember the responsibilities
CO5- Understand the ethical global issues

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES BOOKS:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004
2.Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7201	**FOOD ADDITIVES**	3	0	0	3

Course Objectives

- To expose the students to the use of different chemical additives in foods during food processing and preservation

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION :** Definition, role of food additives, classification of food additives based on their role, dual role of certain additives, INS numbering system of food additives, safety requirements of food additives, Acceptable daily intake of food additives, JECFA and Food Chemical Codex standards for food additives, status of food additives with respect to Indian laws, GMP and permissible upper levels of food additives under Indian food laws.	9
II	**ACIDITY REGULATORS AND PRESERVATIVES:** Acidity Regulators – definition, chemical structure, role and importance, pH modulation and taste, acidity profile, permitted acidity regulators, levels of usage and food applications. Preservatives of chemical and microbial origin; mode of action on spoilage organisms and pathogens, factors affecting the performance of preservatives, active forms of preservatives, necessity in a food and levels of usage; permitted preservatives and food applications. Case studies / illustrations58	9
III	**EMULSIFIERS, STABILIZERS AND THICKENERS:** Emulsion, surface tension, oil in water and water in oil emulsion, Hydrophilic and Lipophilic balance (HLB), role of emulsifiers, different classes of emulsifiers and their chemical structure, their HLB values and role in emulsion stabilization; role of different stabilizers and other substances in emulsion stability; emulsion formation process and equipment; measurement of emulsion stability; permitted emulsifiers and stabilizers and food applications. Thickeners – definition, chemical structure, role in food processing and product end characteristics, list of permitted thickeners and food applications	9
IV	**ANTIOXIDANTS AND ANTI-CAKING AGENTS:** Antioxidants - Chemistry of oxidative deterioration of food and its constituents and its effect on the quality; defining antioxidant; water soluble and oil soluble antioxidants and their chemical structure, permitted antioxidants; mechanism of action, permitted levels and food application. Anti-foaming and propellants, Anti-caking agents – definition, role in preventing spoilage, mode of action, permitted list of anti-caking agents and food application.	9
V	**COLOR AND ARTIFICIAL SWEETENERS:** Color – Natural and synthetic food colors, their chemical structure, shades imparted, stability, list of colors, usage levels and food application. Artificial Sweeteners – list, structure, taste profile, permitted list, usage levels and food applications.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the need of food additives and preservatives
CO2- Understand the importance of acidity regulators and preservatives
CO3- Understand the role of emulsifiers, stabilizers and thickeners
CO4- Understand the antioxidants and anticaking agents
CO5- Understand about colours and sweetners

TEXT BOOKS:

1.Mahindru, S. N. “Food Additives- Characteristics Detection and Estimation”, TATA McGraw Hill, 2000
2. Wilson, R. “Ingredient Handbook Sweeteners”, Blackwell, 2007

REFERENCES BOOKS:

1. Emerton, V. “Food Colors”, Blackwell, 2008
2.Peter A Williams and Glyn O Philips, “ Gums and stabilizers for the Food Industry”, RSC, 2006.
3. Branen, A. L. “Food Additives” 2nd Edition, CRC press, 2002
4. Rahman, M. Shafiur, ed. Handbook of food preservation. CRC press, 2007.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7202	PLANTATION CROPS & SPICES PRODUCT TECHNOLOGY	3	0	0	3

Course Objectives

- To learn about the plantation crops and spices product technology

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PROCESSING OF PLANTATION CROPS:** Importance of plantation crops – cashew –harvesting – uses of cashew – cashew nut processing. Coconut – harvesting – Processing. Cocoa bean - Occurrence – Chemistry of the cocoa bean – Processing of cocoa bean – cocoa powder – cocoa liquor.	9
II	**PROCESSING OF TEA:** Types of tea – green, oolong and CTC – Chemistry and technology of CTC tea – Manufacturing process Grading of tea.	9
III	**PROCESSING OF COFFEE:** Coffee – Occurrence – chemical constituents fermentation of coffee beans – Process flow sheet for the manufacture of coffee powder. Export and Import Duties of plantation crops.	9
IV	**PROCESSING OF SPICES:** Importance of Spices- Processing of Spices- Pepper, cardamom, ginger and turmeric, cumin, coriander, cinnamon, fenugreek, garlic, clove and vanilla –method of manufacture of oleoresins and essential oils.	9
V	**PROCESSING OF TUBER CROPS:** Chemical composition and processing of tuber crops - tapioca, sugar beet, potato and yam - starch and sago production-Grades. Other by-products-Applications and Processing.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Remember the steps involved in processing of plantation crops
CO2- Understand the processing of tea and coffee
CO3- Understand the appropriate techniques for processing of spices
CO4- Understand the use of food processing operations in the processing of tuber crops
CO5- Understand the biosynthesis of flavors

TEXT BOOKS:

1. Pandey P.H., ―Post-Harvest Engineering of Horticultural Crops through Objectives‖, Saroj Prakasam, Allahabad, 2003.
2. Kumar K., Md Abdul Kadar JBM., Rangaswamyi P. and Irulappan I., "Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants‖, Oxford and IBH Publishing, 2006.

REFERENCES BOOKS:

1. Minifie Bernard W., ―Chocolate, Cocoa and Confectionery Technology‖, 3rd Edition, Springer Netherlands, 2012.
2.Shanmugavelu K.G., Kumar N. and Peter K.V., ―Production Technology of Spices and Plantation Crops‖, Jodhpur Agrobios (India) Agro House, 2005.
3.National Institute of Industrial Research (NIIR) Board, ―Handbook on Spices‖, Asia Pacific Business Press Inc., New Delhi, 2004.
4. Shanmugavelu, Katuputur Gnanamurthi, N. Kumar, and K. V. Peter. Production technology of spices and plantation crops. Agrobios, 2002.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7001	FOOD PROCESS EQUIPMENT DESIGN LABORATORY	0	0	4	2

Course Objectives

- To understand the side view, front view and back view of various equipment used in food industry

S.No.	DESCRIPTION
1.	Studies of symbols and materials used for design and drawing
2.	Design and drawing of pipes and fittings
3.	Design and drawing of storage tanks
4.	Design and drawing of agitated vessel
5.	Design and drawing of double pipe heat exchangers
6.	Design and drawing of shell and tube heat exchangers
7.	Design and drawing of plate heat exchanger
8.	Design and drawing of single effect evaporator
9.	Design and drawing of cyclone separators
10.	Design and drawing of rotary drier
11.	Design and drawing of spray drier
12.	Design and drawing of spray drier

Total Practical Hours 45

Course Outcomes

Upon completion of the course, students can be able to

CO1 - Draw the front view, back view and side view of the equipment used in food industry

REFERENCE BOOKS:

1. Joshi M.V. and Mahajan V.V., ―Process Equipment Design‖, 4th Edition, MacMillan India, New Delhi, 2009

2.Dawande S.D., ―Process Equipment Design Volume 1 and 2‖, 5th Edition, Denett and Company, India, 2015.

3.Perry R.H. and Green D.W., ―Chemical Engineers Handbook‖, 8th Edition, McGraw-Hill, New York, 2007.

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PROFESSIONAL ELECTIVES

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	**16FT5301**	**TECHNOLOGY OF FATS AND OILS**	**3**	**0**	**0**	**3**

Course Objectives

- **To study the technology, processing, analysis of fats and oils**

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PROPERTIES OF OILS AND FATS:** Oils and fats – sources, composition. Nutritional importance of fats and oils. Physical properties of fats and oils - color, odour, consistency, melting point, flash point, smoke point. Chemical properties of fats and oils - iodine value, saponification value, free fatty acids, peroxide value.	9
II	**VEGETABLE OIL AND ANIMAL FAT PRODUCTION:** Industrial production of oils- seed handling and storage. Preparation of seed for extraction of oil. Processing- peanut oil, rice bran oil, sunflower oil and soy bean oil. Production of cod liver oil. Method of extraction- cold pressing and hot pressing, Equipments- Filter press, hydraulic press. Production of margarine. Production of Lard.	9
III	**SOLVENT EXTRACTION AND REFINING OF OILS:** Solvent extraction – prepress and direct extraction, removal and recovery of solvent from miscella and extracted residue. Physical refining, Chemical Refining, Degumming - types, dewaxing/winterization, bleaching – deodorizing, hydrogenation.	9
IV	**EDIBLE OIL, FAT PRODUCTS AND MODIFICATION OF OILS:** Modification of oils - Refined oil – fractionation- Blending – Interesterification – Types – Chemical and Enzymatic, Applications. Margarines, spreads, mayonnaise. Shortenings in bakery products and confectionery lipids. Fat substitutes and its types.	9
V	**PACKAGING AND STORAGE OF OIL:** Changes during storage of oil. Role of fat or oil in frying .Selection of frying oil. Applications of frying oil .Rancidity - atmospheric oxidation and enzyme action. Quality standards of oil - Packaging of oils and fats.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1 -Understand the physical and chemical properties of fats and oils
CO2- Remember the mechanical methods for oil extraction
CO3- Understand the solvent extraction and refining of oils
CO4-Understand and develop edible oil, fat products and modified oil
CO5- Understand and choose an appropriate package and storage for oils

TEXT BOOKS:

1.Fereidoon Shahidi, ―Bailey‘s Industrial Oil and Fat Products‖, 6th Edition, Wiley - Interscience, New Jersey, 2005.
2.Richard D. O'Brien, ―Fats and Oils: Formulating and Processing for Applications‖, 3rd Edition, CRC Press, London, 2010.

REFERENCES BOOKS:

1.Casimir C. Akoh and David B. Min, ―Food Lipids: Chemistry, Nutrition and Biotechnology‖, CRC Press, USA, 2008.
2.Wolf Hamm and Richard J. Hamilton, ―Edible Oil Processing‖, Wiley - Blackwell, UK, 2013.
3. Bockisch, Michael, ed. Fats and oils handbook (Nahrungsfette und Öle). Elsevier, 2015.
4. Hamilton, Richard John, ed. Recent advances in chemistry and technology of fats and oils. Springer Science & Business Media, 2012.

Chairman, Board of Studies **Principal/Dean**

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5302	**FOOD STORAGE AND INFESTATION CONTROL**	**3**	**0**	**0**	**3**

Course Objectives

- **To understand the raw material and preserve it by storing in a proper environment**

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**FUNDAMENTALS OF STORAGE INFESTATION:** Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses - total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products. .	9
II	**ECOLOGY OF INSECTS AND STORAGE LOSSES:** Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.	9
III	**ECOLOGY OF INSECTS AND STORAGE LOSSES:** Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.	9
IV	**PEST CONTROL MEASURES:** Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control-prophylactic and curative. Pesticides – characteristics, uses and precautions in handling. Integrated approaches to stored grain pest management. .	9
V	**QUALITY CONTROL IN GRAINS:** Detection of insect infestation in stored food grains, losses in stored food grains – weveiled and unweveiled grains, determination of moisture content in stored food grains, Quality control aspects in FCI godowns, central warehouse. Demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Remember and identify possible sources of pest infestation in storage

CO2- Understand and interpret ecology of region specific insects and its impact on storage

CO3- Understand and recommend appropriate storage structures and preventive measures for pests

CO4- Understand and elect integrated pest management approach and curative measures in grain storage

CO5- Understand the suitable quality control techniques in grain storage

TEXT BOOKS:

1.Mohan and Awaknavar J.S., ―Pest Management in Store Grains‖, Satish Serial Publishing House, New Delhi, 2009.

2.Nair K.R., ―Integrated Production and Pest Management‖, DK Publishers and Distributors, Delhi, 2007.

REFERENCES BOOKS:

1.Hagstrum D.W., and Subramanyam B., ―Fundamentals of Stored Product Entomology‖ American Association of Cereal Chemists Inc., 2006.

2.Subramanyam B., ―Integrated Management of Insects in Stored Products‖, CRC Press, 1995.

3.Slansky Jr. F., and Rodriguez J.G., ―Nutritional Ecology of insects, mites, spiders and related invertebrates‖, John Wiley, 1987.

4. Taub, Irwin A., and R. Paul Singh, eds. Food storage stability. CRC Press, 1997.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5303	**CEREAL TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives

- To develop the knowledge of students in the area of Cereal processing and technology.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PRODUCTION, STRUCTURE AND COMPOSITION**: Status, major growing areas and production of cereals and millets in India and the world, structure, Physical properties; Density, Bulk density, Angle of repose, Hardness, asperity, porosity, stack of milling and moisture on physical properties. Chemical composition, Distribution of nutrients and Aroma of cereals and millets; anti-nutritional factors.	9
II	**WHEAT AND RICE:** Wheat: Morphology, Physicochemical properties, Wheat Quality, Wheat Milling, quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products – Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Milling of rice: Conventional Milling, Modern milling, Advantages and disadvantages of milling machineries, By products of rice milling, Parboiling of rice: Aging of rice: Enrichment: - Need of Enrichment, Methods of enrichment, Enrichment levels, fortification of amino acids. -Processed Foods from rice: Breakfast cereals, flakes, puffing, canning and instant rice.	9
III	**OTHER CEREALS:** Corn - Morphology, Physico-chemical properties, Corn milling - Wet and dry milling, Milling fractions and modify starches Corn Products – Corn flakes, Corn starch, canned corn products, puffed product; HFCS; Oats- Milling, Oat Products – Steel cut, rolled oats, quick cooking; Rye bread; Traditional and Fermented cereal products	9
IV	**MILLETS:** Sorghum, Pearl Millet, Finger millet, Foxtail millet, Kodo Millet - storage, insect control; processing - Pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet	9
V	**BAKED AND EXTRUDED PRODUCTS:** Baked foods - chemical dough development, mechanical dough development, sheeting extrusion other rapid methods; Bread staling – theory, manifestation, retardation measures; Indian Confectionery. Extrusion processing – methods and products.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand and identify the specific processing technologies used for cereals

CO2- Understand the application of scientific principles in the processing technologies specific to the materials.

CO3 –Understand the processing of millet

CO4 – Understand the importance of baked and extruded product

CO5 – Understand the processing of rice and wheat

TEXT BOOKS:

1.Matz, Samuel A. " The Chemistry and Technology of Cereals as Food and Feed" II Edition, CBS, 1996.

2.Delcour, Jan A. and R. Carl Hoseney. "Principles of Cereal Science and Technology". III Edition. American Association of Cereal Chemists, 2010.

REFERENCES BOOKS:

1.Kulp, Karel "Handbook of Cereal Science and Technology". IIEdition,CRC Press, 2000.

2.Morris, Peter C. and James H Bryce "Cereal Biotechnology". CRC / Woodhead, 2000

3. Owens, Gavin, ed. Cereals processing technology. CRC Press, 2001.

4. Hamaker, Bruce R., ed. Technology of functional cereal products. Elsevier, 2007.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT5304	**POST HARVEST TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives

- To develop the knowledge of students in the area of post-harvest processing of various foods and related technology. This course will enable students to appreciate the application of scientific principles in the processing of these materials.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**CEREALS AND PULSES:** Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control, Processing: Wheat - milling, (Atta and maida), quality aspects of flour, wheat proteins and their function; wheat based baked products – Bread, Biscuit, Cakes, extruded products, malting and malt products; Rice- Milling, Parboiling, Quick cooking rice. Pulses - Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products– puffed, flakes, flour, soya milk, soy protein Isolate.	9
II	**VEGETABLES AND FRUITS:** Climacteric and non-climacteric fruits, ripening process, phytonutrients in fruits and vegetables; Handling, transportation, controlled atmosphere ripening process, grading, cleaning, pretreatments, modified atmosphere packaging, chilling. General pre-processing, different freezing methods and equipment, problems associated with specific fruits and vegetables; Dehydration– General preprocessing, different methods of drying, osmotic dehydration and other modern methods. Canning - General pre-processing, specific or salient points in fruits and vegetables like – Blanching, exhausting, processing conditions. Fruit Juice / pulp/ Nectar/Drinks, concentrates Vegetable Purees/pastes.	9
III	**OIL SEEDS, NUTS AND SUGARS:** Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, hydrogenation; oil blends. Honey- Composition and Quality aspects; Sugars- Manufacture of table sugar, High Fructose corn syrup and Glucose syrup; Jaggery – sources, manufacture.	9
IV	**MILK AND MILK PRODUCTS:** Processing of Milk – Pasteurization, homogenization, sterilization, HTST and UHT processes; Processing and preservation of milk products - cream, sour cream, butter, ghee, skimmed milk concentrate and skimmed milk powder, whey concentrate and whey powder, yoghurt, cheese and other products.	9
V	**MEAT, FISH & POULTRY:** Pre and post slaughter handling, meat inspection and grading. Structure and composition of meat, carcass chilling, ageing; storage of fresh meat - Modified atmosphere packaging, packaging of retail cuts; Processing and preservation - artificial tenderizing, chilling, freezing, curing, smoking, ready-to-eat meats and meat products; Marine and fresh water fish, shell fish - composition and nutrition; spoilage factors, ship board operations, storage and transport. Processing and Preservation - chilling, freezing, canning, smoking, curing, salting and drying, fish meal and fish oils. Processing plant operations - slaughter, bleeding, scalding, de-feathering, eviscerating, chilling, packaging; composition and nutrition, poultry meat products Eggs- structure, composition, quality factors, storage, pasteurization, freezing and drying, egg substitutes.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the concepts and processing of cereals and pulses
CO2- Remember the insight and reduce fruit and vegetable losses during processing after harvesting
CO3- Understand the specific processing technologies used especially for oil seeds, nuts and sugars
CO4- Understand the post-harvest processing of milk and milk products
CO5- Remember the meat, fish and poultry processing technologies

TEXT BOOKS:

1.Hamm, Wolf and Hamilton, R, J. "Edible Oil Processing", Blackwell / Ane Books, 2004.
2.Morris, Peter C and Bryce, J.H. "Cereal Biotechnology", CRC / Wood Head, 2000.

REFERENCES BOOKS:

1.Rajah, Kanes K. "Fats in Food Technology", Blackwell / Ane Books, 2004.
2. Mead G.C., ―Poultry Meat Processing and Quality‖, 1st Edition, CRC Press, London, 2004.
3. Sukumar De, ―Outlines of Dairy Technology‖, Royal Oxford University Press, Delhi, 2010.
4. Alzamora, S.M., Tapia, M.S. and Lopez – Malo, A. "Minimally Processed Fruits and Vegetables: Fundamental Aspects and Applications", Springer, 2005.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6301	**FERMENTATION TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives

- To understand the fermentation concepts with the applications

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**FOOD FERMENTATION:** Origin and history of food fermentation, Micro-organisms for fermentation, Starter Cultures and fermented Products, Manufacture of fermented products, Quality and flavour of fermented products.	9
II	**TYPES OF FERMENTATION:** Types of fermentation submerged/solid state. Sterilization-air sterilization, media sterilization. Batch/continuous fermentation, scale up in fermentation. Maintenance of aseptic conditions.	9
III	**AERATION AND AGITATION IN FERMENTATION:** Aeration and agitation in fermentation: Oxygen requirement, measurement of adsorption coefficients, bubble aeration, mechanical agitation, correlation between mass-transfer coefficient and operating variables.	9
IV	**PRODUCTION OF FERMENTED PRODUCTS:** Semi solid cultured dairy products- principles and applications- packaging quality assurance and sanitation. Meat fermentation- principles and application. Fermented cereal food and beverages.	9
V	**PRODUCTION OF FERMENTED PRODUCTS:** Production of vitamins, amino acids, organic acids, enzymes and antibiotics, alcohols. Industrial production of beer, wine, enzymes-amylase, pectinase, proteases, vitamins, antibiotics, baker's yeast, single cell protein. Fermented foods: Sauerkraut, yoghurt, cheese, miso, tempeh, tofu, idli, dosa.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the principles of microbiology in the production of fermented foods

CO2-Understand the classification of fermentation process and maintain aseptic conditions in a fermentation process

CO3-Understand the process parameters in aeration and agitation of a fermentation operation

CO4- Understand the use of concepts of fermentation in dairy, meat, cereal and beverage products

CO5- Understand processes involved in production of various fermented products

TEXT BOOKS:

1. Y.H.Hui, Lisbeth Meunier-Goddik, JytteJosephsen, Wai-Kit Nip and Peggy S. Stanfield., "Handbook of Food and Beverage Fermentation Technology", CRC Press, UK, 2004

2. Robert W. Hutkins., "Microbiology and Technology of Fermented Foods", CRC Press, UK, 2004

REFERENCES BOOKS:

1. Gutierre, Gustavo F., ―Food Science and Food Biotechnology‖, CRC Press, New York, 2003.

2.Crueger W. and Crueger A., ―Biotechnology: A Textbook of Industrial Microbiology‖, Science Tech. Madison, USA, 1984.

3. Najafpour, D. Ghasem, ―Biochemical Engineering and Biotechnology‖, Elsevier, USA, 2007.

4.Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of fermentation technology. Elsevier, 2013.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6302	**BIOPROCESS ENGINEERING**	**3**	**0**	**0**	**3**

Course Objectives

- To learn the bioprocess engineering concepts in the food processing applications

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**ENZYME:** Introduction, Single and Multi-substrate reactions - mechanisms and kinetics; turnover number; Enzyme Inhibition and Kinetics- competitive, non-competitive and uncompetitive; Enzyme Immobilization – Physical and chemical methods..	9
II	**MICROBIAL STRAIN IMPROVEMENT:** Media – composition, design, formulation and optimization. Microbial Strains: Isolation, cultivation and preservation techniques; strain selection and improvement - Recombinant DNA Techniques and Cloning Strategies..	9
III	**STOICHIOMETRY OF CELL GROWTH AND PRODUCT FORMATION:** Elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients, energetic analysis of microbial growth and product formation.	9
IV	**FERMENTATION AND STERLIZATION:** Batch, fed batch and continuous fermentation. Main parameters to be monitored and controlled in fermentation processes. Microbial growth kinetics model - Simple unstructured and Monod model. Sterilization methods, Thermal death kinetics of microorganisms, batch and continuous heat sterilization, filter sterilization.	9
V	**BIOREACTOR:** Basic configuration of bioreactor and ancillaries. Types of reactor- Air Lift Reactor, Bubble Column Reactor, Immobilized enzyme reactors-packed bed, fluidized bed and membrane reactors.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the kinetics of enzymatic reactions, enzyme inhibition and enzyme immobilization
CO2- Understand the microbial strain preservation and improvement techniques
CO3- Remember the stoichiometric calculation of microbial growth and product formation
CO4- Understand the appropriate fermentation process and sterilization methods
CO5- Understand the working of bioreactors

TEXT BOOKS:

1.Trevor Palmer and Philip L.R. Bonner, ―Enzymes: Biochemistry, Biotechnology, Clinical Chemistr, 2nd Edition, Woodhead Publishing, Cambridge, 2007.

2.Stanbury P.F., Whitaker A. and Hall S.J., ―Principles of Fermentation Technology‖, 2nd Edition, Pergamon, USA, 1995

REFERENCES BOOKS:

1.Shuler M.L. and Kargi F., ―Bioprocess Engineering: Basic Concepts‖, 2nd Edition, PHI, New Delhi, 2002.
2. Najafpour, D. Ghasem, ―Biochemical Engineering and Biotechnology‖, Elsevier, USA, 2007.
3. Doran, Pauline M. Bioprocess engineering principles. Elsevier, 1995.
4. Gabelman, Alan. Bioprocess production of flavor, fragrance, and color ingredients. Wiley, 1994.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6303	**CANE SUGAR TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives

- To understand the technology of cane sugar

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION AND PREPROCESSING OPERATION:** Brief account of sugar industry- composition of sugar cane, manufacturing process of sugarcane juice, types of cane sugar, terminology. Harvesting indices, Cane cutting – Manual and Mechanical, Transportation, Cane conveyor, Washing, Shredding.	9
II	**JUICE EXTRACTION AND JUICE CONCENTRATION:** Crushing –Types of crushers, crushing efficiency. Extraction of juice – methods. Accumulators – types. Maceration. Theory of cane diffusivity. Types of diffusers. Weighing of juice - Maxwell Boulogne Scale and Magnetic Flow Meters. Concentration - Importance-types of heaters- construction and working of tubular heater, Direct Contact Heater (DCH), Plate Heater (PHE), advantages and disadvantages. Evaporator- types-performance measures.	9
III	**CLARIFICATION:** Clarification – importance, methods, clarifying agent, bleaching agent. Role of pH, non-sugars, colloids and gums in cane juice clarification. Lime - specification, storage. Preparation of milk of lime, rotary lime slacker, classifier, MOL tanks, lime pumps, use of hydrated lime powder. Sulphur - specification and storage, production of sulphur dioxide gas, construction and working of sulphur burner, film type sulphur burner.	9
IV	**CRYSTALLIZATION AND REFINING:** Sugar boiling, Nucleation and crystal growth, super saturation and meta stable stage, seeding – shock seeding, true seeding. Crystallizers. Refining - Brown sugar, importance of refining, Affination, clarification, carbonation, sulphitation, phosphitation, decolorization, centrifugation - dewatering of sugar. Drying.Bagging and storage. Factors affecting sugar refining process.	9
V	**MANUFACTURING OF JAGGERY/GUR AND OTHER BYPRODUCTS**: Extraction of Juice, Clarification of Gur, Concentration of Juice, Drying and grading of Gur, Storage of Gur. Byproducts - Drying and uses of Bagasse - Back strap Molasses - Characteristics of Molasses. Direct Utilization of Molasses - Distilling Industries - Applications in animal feed – Biogas – Biofertilizers production- Inverted syrup.	9
	Total Instructional Hours	**45**

Course outcomes

Upon completion of the course, students can be able to

CO1- Remember the sugar cane constituents and apply preprocessing operations
CO2- Understand the suitable cane juice extraction and concentration methods
CO3- Understand the appropriate clarification methods for sugarcane juice
CO4- Remember crystallization and refining techniques
CO5- Understand the knowledge for manufacturing of cane sugar by-products

TEXT BOOKS:

1.Paturau J.M., ―By-Products of the Cane Sugar Industry‖, 2nd Edition, Elsevier Publishing Company, New York, 1989.
2.Baikow V.E., ―Manufacturing and Refining of Raw Cane Sugar‖, 2nd Edition, Volume - I and II, Elsevier Publishing Company, New York, 1967

REFERENCES BOOKS:

1.Heriot T, H. P., ―The Manufacture of Sugar From The Cane and Beet‖, Read Books, New York, 2007.
2.Ram BehariLal and Mathur, ―Hand Book of Cane Sugar Technology‖, Oxford and IBH Publishing Company, New Delhi, 1995.
3.Chung Chi Chou, ―Handbook of Sugar Refining: A Manual for the Design and Operation of Sugar Refining Facilities‖, John Wiley and Sons, 2000.
4. Jenkins, George Horner. Introduction to cane sugar technology. Elsevier, 2013.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6304	**ENZYME TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives

- This course enable the student to know the different types of enzymes and its food application`

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION I**ntroduction-Definition-Historical highlights-classification of enzymes nomenclature- structural features of enzyme-Methods of extraction and purification of enzymes.	9
II	**MECHANISM OF ENZYME ACTION** Specificity-types of specificity-role of 3D structure -active site-substrate and enzyme concentration relationships-different effects –pH and temperature.	9
III	**ENZYME KINETICS** MM equation, Line weaver Plot, - kinetics. Immobilization-need for immobilization advantages –disadvantages-immobilization techniques- -effects of pH, temperature, substrate concentration, stability, kinetic properties-role of immobilized enzymes in food processing-commercial food application	9
IV	**ENZYMES OF FOOD IMPORTANCE** Endogeneous enzymes in food quality-color- lipoxynase, chlorophyllase, polyphenol oxidase ,texture- Pectic enzymes, Amylases, cellulases, proteases, flavour and aroma-nutritional quality.	9
V	**APPLICATIONOF ENZYMES IN FOOD INDUSTRIES** Mechanism and application of enzymes in food processing-enzymatic browning.Application of enzyme in meat industry, fruit and vegetable industry, dairy industry- bakery industry	9
	Total Instructional Hours	**45**

Course outcomes

Upon completion of the course, students can be able to

CO1- Understand the enzyme structure and nomenclature
CO2- Remember the importance of enzyme in foods
CO3- Understand the application of enzyme in food industries
CO4- Remember the enzyme kinetics
CO5- Remember the action of enzymes

TEXT BOOKS:

1. Price, N. L. and StevenL., "*Fundamentals of Enzymology*", Oxford Scientific 2000.
2. Godfrey T. West S (Eds), "*Industrial Enzymology*" 2nd Edition Mac Millan Press, London 1996.

REFERENCE:

1. Colowick,S.P.and Kalpan,N.O.(Eds), "*Methods of enzymology*" Academic press 1977.
2. ph.D and Hentry,"*Enzyme technology*" 2000.
3. Marangoni, A.G, "*Enzyme Kinetics*". A modern approach A John Wiley & Sons 2003.
4.Trevor Palmer. Understanding Enzymes. Fourth Edition. Prentice Hall,LondonRobert L. Ory, Allen J. St. Angelo, "*Enzymes in food and beverage processing*" American chemical society 1977.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7301	BIOLOGY AND CHEMISTRY OF FOOD FLAVOURS	3	0	0	3

Course Objectives

- To understand the flavour compounds involved in development of flavor
- 2To understand the analytical techniques involved in flavor analysis

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION :**Problems in flavour research – classification of food flavours; chemical compounds responsible for flavour.	9
II	**FLAVOUR COMPOUNDS :** Chemical compound classes and their flavour responses; flavour development during biogenesis, flavour development during food processing; use of biotechnology to develop flavours.	9
III	**THE CHEMICAL SENSES :** Anatomy of the chemical senses; neural development of the chemical senses; receptor mechanisms, neural coding; the control of eating.	9
IV	**FLAVOUR ANALYSIS :** Subjective versus Objective methods of analysis; psychophysics and sensory evaluationand its types, ENOSE, ETONGUE; Instrumental analysis; sample handling and artifacts; data handling	9
V	**TEACHING FLAVOUR CONCEPTS :** Problem based learning; tongue and nose; Onion-Beverage-Maillard reaction-Thio-stench	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the problems in flavor research
CO2- Understand the compounds responsible for flavours
CO3- Understand the chemical senses
CO4- Understand the flavor analysis procedures
CO5- Understand the flavor concepts and applications

TEXT BOOKS:

1. Fisher, Carolyn and Thomas R. Scott. “Food Flavours: Biology and Chemistry”. The Royal Society of Chemistry, 1997.
2. Heath, H.B. and G. Reineccius. “ Flavor Chemistry and Technology”. CBS Publishers, 1996.

REFERENCES BOOKS:

1. Hofmann, Thomas. “Challenges in Taste Chemistry and Biology”. American Chemical Society Publications, 2004.
2. . Charalambous, G. “Food Flavors: Generation, Analysis and Process Influence”. Elsevier,1995.
3.Reineccius, Gary. “Flavor Chemistry and Technology”. II Edition, Taylor & Francis, 2006.
4. Shahidi, Fereidoon and Chi-Tang Ho. “Flavor Chemistry of Ethnic Foods”. Kluwer Academic / Plenum, 1999

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7302	**FOOD LAWS AND SAFETY**	**3**	**0**	**0**	**3**

Course Objectives

- To study various food laws, importance and functions of food safety management systems, to impart knowledge on food laws and safety in food processing

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**HISTORICAL PERSPECTIVES INCLUDING NECESSITY OF FOOD LAWS :** Establishment of US Pure Food Law inearly 1900s and of Food & Drug Administration to enforce safety of food products; Urbanisation of population and necessity of processed and preserved foods and the necessity of ensuring quality of food to prevent adulteration. Prevention of Food Adulteration Act 1954 & Rules 1955 established in India to enforce safety and purity of food products; Various aspects of defining adulteration, taking samples of food for analysis by public analyst, prosecution for adulteration and punishment; Standards of various food products; FPO; Infant Milk Substitute Act; Laws relating to vegetable oils; Use of permitted additives like colours, preservatives, emulsifiers, stabilisers, antioxidants etc. Food Safety & Standards Act 2006 and the provisions therein; Integrated Food Law - Multi departmental – multilevel to single window control system, consumer protection Act.	9
II	**FOOD SAFETY IN PROCESSING :** Building and equipment design; microbiological quality of water, air;Safety in food procurement, storage, handling and manufacture; Food safety in retail food businesses; international food service operators, institutional food service operators; application of the principals of modern hygiene; Food handlers, habits, clothes, illness;	9
III	**KEY SAFETY PRINCIPLES:** Training & Education for safe methods of handling food; cleaning and sanitization of processing plants; principles of cleaning and sterilization ; sterilization & disinfection different methods used-detergents, heat, chemicals; selecting and installing equipment; Cleaning of equipment and premises. Safety limits of sanitizers; pest control management and disposal of waste.	9
IV	**FOOD SAFETY MANAGEMENT SYSTEM :**Food safety and quality management systems- Physical,chemical and Microbial hazards and their control in food industry; Good laboratory practice (GLP); Quality systems standards including ISO; - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP);	9
V	**MANAGEMENT :** Good Manufacturing Practice and HACCP; Surveillance networks, Consumer and food service operator education; GM Foods, safety and labeling;International Food Standards ISO 9000 and related standards; Impact of food safety on global trade.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the safety during processing
CO2- Understand the key safety principles
CO3- Understand the manufacturing practices
CO4- Understand the need of food laws
CO5- Understand the management systems

TEXT BOOKS:

1.Rees, Naomi and David Watson ―International Standards for Food Safety , Aspen Publication, 2000.
2. Schmidt, Ronald H. and Rodrick, G.E. ―Food Safety Handbook , Wiley Interscience, UK, 2005.

REFERENCES BOOKS:

1.Mehta, Rajesh and J. George ―Food Safety Regulations, Concerns and Trade :The Developing Country Perspective , Macmillan, 2005.
2. The Prevention of Food Adulteration Act, 1954 , Commercial Law Publishers India) Pvt. Ltd.,
3. Wallace, Carol A., William H. Sperber, and Sara E. Mortimore. Food safety for the 21st century: Managing HACCP and food safety throughout the global supply chain. John Wiley & Sons, 2018.
4. Bari, Md Latiful, and Dike O. Ukuku, eds. Foodborne pathogens and food safety. CRC Press, 2015.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7303	**FUNCTIONAL FOODS AND NUTRACEUTICALS**	**3**	**0**	**0**	**3**

Course Objectives

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION AND SIGNIFICANCE :** Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoo chemicals and microbes in food, plants, animals and microbes	9
II	**ANALYSIS OF PHYTOCHEMICALS :** Qualitative and quantitative methods: phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, Chitin; Carotenoids - Factors affecting bioavailability, chemical and histochemical characterization of cell wall polysaccharides in almond seed in relation to lipid bioavailability.	9
III	**ASSESSMENT OF ANTIOXIDANT ACTIVITY :** In vitro and In vivo methods for the assessment of antioxidant activity, Comparison of different In Vitro methods to evaluate the antioxidant, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources	9
IV	**ROLE IN HEALTH AND DISEASE :** Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and symbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.	9
V	**SAFETY ISSUES :** Health Claims, regulations and safety issues- International and national.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the significance of functional foods and nutraceuticals
CO2- Understand the analysis oh phytochemicals
CO3- Understand the procedures for assessing antioxidant activity
CO4- Understand the role of nutraceuticals in health and disease
CO5- Understand the safety issues

TEXT BOOKS:

1. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", II Edition, CRC, 2001
2. Wildman, Robert "Handbook of Nutraceuticals and Functional Foods". CRC, 2006.

REFERENCES BOOKS:

1. Shi, John, FereidoonShahidi and Chi-Tang Ho "Asian Functional Foods". CRC/Taylor &Francis, 2007.
2. Watson, Robald Ross "Functional Foods and Nutraceuticals in Cancer Prevention". Blackwell Publishing, 2007
3. Gibson, G.R. and C.M.Willams. "Functional Foods: Concept to Product". Woodhead, 2000.
4. Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003.

Chairman, Board of Studies **Principal/Dean**

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7304	**FOOD TOXICOLOGY AND ALLERGY**	**3**	**0**	**0**	**3**

Course Objectives

- To study the concepts of food toxicology, various toxins and allergy, also the instruments used to identify the toxins

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION TO FOOD TOXICOLOGY:** Definition and need for understanding food toxicology; Hazards -Microbiological, nutritional and environmental. Basics of immune response - humoral and cell mediated response. Allergen and mechanism of allergic response.	9
II	**NATURAL TOXINS, FOOD ALLERGY AND SENSITIVITY:** Toxins – Natural toxin and poison, difference between toxin, poison and natural toxin, toxin foods, unsafe food, bio-toxin, toxin characteristics, classification of natural toxin. Chemistry of food allergens, food disorders associated with metabolism, biotransformation and Elimination of Toxicants, lactose intolerance, celiac disease and asthma.	9
III	**TOXICANTS FORMED DURING FOOD PROCESSING:** Intentional direct additives, preservatives, nitrate, nitrite, and N- nitroso compound flavour enhancers, food colors, indirect additives, residues and contaminants, heavy metals, other organic residues and packaging materials. Toxicity of heated and processed foods, food carcinogens and mutagens - Polycyclic aromatic hydrocarbons, N - nitrosamines, Acrylamide and their mode of action.	9
IV	**ASSESSMENT OF TOXICANTS IN FOOD SAMPLING:** Quantitative and qualitative analysis of toxicants in foods; Biological determination of toxicants. Assessment of food safety – Risk assessment and risk benefit indices of human exposure, acute toxicity, mutagenicity and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioural effect, immunotoxicity.	9
V	**INSTRUMENTATION TECHNIQUES TO DETECT TOXINS:** Chromatography, Principles, procedure and applications of Thin layer chromatography, Gas chromatography column chromatography, Ion exchange chromatography and High performance liquid chromatography**,** PCR Techniques, ELISA. Spectrophotometry, Principles, instrumentation and applications of atomic absorption spectrophotometry (AAS) and atomic emission spectrophotometry (AES), Centrifugation; Principles, instrumentation and applications of preparative and ultracentrifuge.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the concepts of food toxicology
CO2- Understand the reactions of natural toxins
CO3- Remember the toxicants during food processing
CO4- Understand the procedures of sampling
CO5- Understand the instrumentation techniques to detect toxins

TEXT BOOKS:

1.Helferich, William and Carl K.Winter “Food Toxicology” CRC Press, 2001.

2. Alluwalia, Vikas “Food Hygiene and Toxicology” Paragon International Publishers, 2007

REFERENCES BOOKS:

1.Labbe, Ronald G. and Santos Garcia “Guide to Food Borne Pathogens” John Wiley & Sons, 2001.

2.Cliver, Dean O. and Hans P.Riemann “Food Borne Diseases” 2nd Edition., Academic Press / Elsevier, 2002.

3.Riemann, Hans P. and Dean O. Cliver “Food Borne Infections and Intoxications” 3rd Edition., Academic Press/Elsevier, 2006.

4. Shibamoto, Taka yuki and Leonard F.Bjeldanzes “Introduction to Food Toxicology” 2nd Edition.Academic Press, 2009.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7305	**INSTRUMENTATION AND PROCESS CONTROL**	**3**	**0**	**0**	**3**

Course Objectives

- To learn about the process control methods and systems

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**LAPLACE TRANSFORM AND FIRST ORDER SYSTEM:** Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application. Open-loop systems, first order systems and their transient response for standard input functions, Linearization and its application in process control.	9
II	**SECOND ORDER SYSTEM:** Second order systems - Interacting system and non-interacting system, manometer, damped oscillator, dynamic response of second order system, Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems.	9
III	**CONTROLLERS AND DYNAMIC RESPONSE:** Controllers - Proportional, Proportional Integral, Proportional Derivative and Proportional Integral Derivative (PID). Dynamic behavior of feedback controlled processes. Effect of proportional, Integral, Derivative and composite control actions on the response of controlled processes. **Automation:** Control components of SCADA, working of SCADA, comparison of SCADA with DCS, comparison of PLC with RTU.	9
IV	**STABILITY ANALYSIS AND FREQUENCY RESPONSE:** Stability for linear systems, Routh stability criterion and its limitations. Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, Bode stability criterion, phase and gain margin, Ziegler- Nichols optimum controller settings and its limitations.	9
V	**PROCESS INSTRUMENTS:** Principles of measurements - Static and dynamic response of instruments, Temperature measurements – Expansion Thermometer, filled system thermometers, thermocouple, thermistors, optical pyrometers, radiation pyrometers. Pressure measurements - Manometers, bourdon gauge and bellow gauge, pressure transducers, pressure measurement by vacuum. Level measurement – sight glass level indicator, float and tape liquid level gauge.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the use of Laplace transformation for first order control systems

CO2- Understand the Laplace transformation for second order control systems and determine its dynamic response

CO3- Understand the concepts of feedback controller, its dynamic response and automation

CO4- Understand the stability criteria for various controllers

CO5- Understand the temperature and pressure measuring instruments

TEXT BOOKS:

1.Vyas R.P., ―Process Control and Instrumentation‖, 6th Edition, Central Techno Publications, Nagpur, 2011.

2.Eckman D.P., ―Industrial Instrumentation‖, Wiley Eastern Ltd, New Delhi, 2004.

REFERENCES BOOKS:

1.Stephanopoulos S.G., ―Chemical Process Control: An introduction to Theory and Practice‖, Prentice Hall of India, New Delhi, 1997.

2.Coughanowr Donald R., ―Process Systems Analysis and Control‖, 3rd Edition, McGraw Hill, New York, 2009.

3.Singh S.K., ―Industrial Instrumentation and Control‖, 2nd Edition, Tata McGraw-Hill, New Delhi, 2006.

4. Luyben, William L. Process modeling, simulation and control for chemical engineers. McGraw-Hill Higher Education, 1989.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7306	TECHNOLOGY OF SNACK AND EXTRUDED FOODS	3	0	0	3

Course Objectives

- To understand the processing of snack and extruded products

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Current status of snack food industry in India. Types of snack food – Raw Vegetable Snack, Formed dough products from potato and maize derivatives, Half Products, Directly expanded extruded snack, Puffed Snacks and other. Types and Functions of ingredients – structure forming materials, dispersed phase/filling materials, plasticizers/lubricants, soluble solids, nucleating substances, coloring and flavouring substances.	9
II	**POTATO AND RICE BASED SNACKS**: Potato Chip - Pre cleaning and peeling, slicing, drying/frying, salting and seasoning, quality control. Fabricated potato snacks – potato flakes, potato granules, potato starch, ground and crushed dehydrated potato. Rice based Snacks – Products using whole grains – Gun puffed rice. Products using flours	9
III	**CORN AND EXTRUSION BASED SNACKS**: Tortilla chip – Corn soaking and smoking, Grinding, Masa flour, Sheeting and Cutting, Baking and Frying. Popcorn – Popping methods, oil popping and dry popping. Commercial and industrial popcorn process. Flavorings and Applicators. Extruder components – Single and Twin screw, Single and Multiple die extruders. Second generation and Third generation snacks, Co extruded snacks, Masa based snacks, Flat bread, Crisp bread.	9
IV	**PASTA PRODUCTS**: Raw materials. Preparation of raw materials for extrusion. Spaghetti, noodles, macaroni and similar products. Dry and frozen pasta products. Pretzel – Types – Formulation and Processing - mixing, extrusion, proofing, cooking, surface salting, baking and drying. Problems in pretzel manufacture.	9
V	**HEALTH ASPECTS** Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses. Organic foods types of organic foods, identifying organic foods, organic food & preservatives	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand and choose the appropriate ingredient based on their functionality
CO2- Understand the production of potato and rice based snacks
CO3- Remember the suitable techniques for corn based snacks production
CO4- Understand the production of extruded snack foods
CO5- Understand the categorization and formulation of pasta products

TEXT BOOKS:

1.Edmund W. Lusas and Lloyd W. Rooney, ―Snack Food Processing‖, 1st Edition, CRC Press, Florida, 2001.
2.Robin Guy, ―Extrusion cooking: Technologies and Applications‖, 1st Edition, CRC Press, Florida, 2001.

REFERENCES BOOKS:

1.Panda H., ―The Complete Technology Book on Snack Foods‖, National Institute of Industrial Research, New Delhi, 2003.
2.Sergio O. Serna-Saldivar, ―Industrial Manufacture of Snack Food‖, Woodhead Publishing, New Delhi, 2008.
3.Mian N. Riaz., ―Extruders in Food Application‖, CRC Press, Florida, 2000.
4. Guy, Robin, ed. Extrusion cooking: technologies and applications. Woodhead publishing, 2001.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7307	**BEVERAGE TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives

- To gain knowledge on machinery and process involved in beverage technology and fermentation process involved in making beverage process

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**BASIC INGREDIENTS IN BEVERAGES :** Beverage-definition-why we drink beverages-ingredients- water, carbon dioxide, bulk and intense sweeteners, water miscible and water dispersible flavouring agents, colours – natural and artificial, Micro and nanoemulsions of flavors and colors in beverages, preservatives, emulsifiers and stabilizers.	9
II	**BEER AND WINE MANUFACTURE:** Ingredients- Malt- hops- adjuncts- water, yeast. Beer manufacturing process, distillation, malting, preparation of sweet wort, brewing, fermentation, pasteurization and packaging. Beer defects and Spoilage.Wine-fermentation-types –red and white. Wine defects and spoilage	9
III	**CARBONATEDBEVERAGES :** Procedures- carbonation equipments-ingredients-preparation of syrups-Filling system-packaging containers and closures	9
IV	**NON CARBONATED BEVERAGE:** Coffee bean preparation-processing-brewing-decaffeination- instant coffee-Teatypes- black, green and oolong- fruit juices, nectars, quash, RTS beverages, isotonic Beverages. Flash pasteurization, Canning and Aseptic Packaging of beverages	9
V	**QUALITY CONTROL :** Effective application of quality controls, brix, acidity to brix ratio, single strength of juice- sanitation and hygiene in beverage industry-Quality of water used in beverages - threshold limits of various ingredients according to PFA, EFSA and FDA – Absolute requirements of Soluble solids and titrable acidity in beverages.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the role of ingredients used in beverage processing
CO2- Understand the processing of beer and wine processing
CO3- Understand the procedure of carbonated beverages
CO4- Understand the procedure of non-carbonated beverages
CO5- Understand the steps for quality control

TEXT BOOKS:

1.Ashurst, P.R, "Chemistry and technology of Soft drink and fruit juices", 2ndedition, Blackwell Publishing Ltd. 2005

2. Steen, D.P and Ashurst, P.R, "Carbonated soft drinks – Formulation and manufacture", Blackwell Publishing Ltd. 2000.

REFERENCES BOOKS:

1.Amalendu Chakraverty et al, "Handbook of Post-Harvest Technology", Ed:.,Marcel Dekker Inc. (Special Indian edition) 2000.

2.Robert.W.Hutkins, "Microbiology and Technology of Fermented foods", IFT Press, Blackwell Publishing Ltd. 2006.

3."Brewing yeast and fermentation Chris Boulton and David Quain", Blackwell Science Ltd

4."Prevention of Food Adulteration Acts and Rules Manual"

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7308	**FOOD PROCESS PLANT LAYOUT AND SAFETY**	**3**	**0**	**0**	**3**

Course Objectives

- To understand and design with the safety measures for processing industry

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**SELECTION OF PLANT LAYOUT:** Introduction and classification of food plants, Site selection of plant. Plant location factors plant lay out advantages types of layout-characteristics of an efficient layout. Techniques of plant layout. General requirements and considerations for construction, materials and floors. Drains and drain layout. Ventilation, fly control, mould prevention, illumination in food plants.	9
II	**INDUSTRIAL SAFETY:** Process industries, potential hazards, toxic chemicals and physical safety analysis, high pressure, high temperature operation, radioactive materials, safe handling and operation of machineries.	9
III	**SAFETY PERFORMANCE**: Safety Appraisal, effective steps to implement safety procedures, periodic inspection and safety procedures; proper selection and replacement of handling equipment, personal protective equipment	9
IV	**ACCIDENTS:** Industrial accidents – accident costs – identification of accident spots, remedial measures, identification and analysis of causes of injury to men and machines – accident prevention – accident proneness – vocational guidance, fault free analysis. Fire prevention and fire protection.	9
V	**HEALTH HAZARDS AND LEGAL ASPECTS:** Health hazards – occupational – industrial health hazards – health standards, and rules – safe working environments – parliamentary legislations – factories act – labour welfare act – ESI Act – Workmen Compensation Act.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand and design the plant layout
CO2- Understand the different industrial hazards
CO3- Remember the industrial safety performance and safety procedures
CO4- Remember the acquired knowledge for prevention of industrial accidents
CO5- Understand the health hazards and legal aspects in industries

TEXT BOOKS:

1.Handley William, ―Industrial Safety Hand Book‖, 2nd Edition, McGraw Hill, New York, 1969.
2.Fawatt H.H. and Wood W.S., ―Safety and Accident Prevention in Chemical Operation‖, 2nd Edition, Inter-science, New York, 1984.

REFERENCES BOOKS:

1.Heinrich H.W., Dan Peterson P.E. and Nester Rood, ―Industrial Accident Prevention‖, 2nd Edition, McGraw-Hill Book Co., 1980.
2.Blake R.P., ―Industrial Safety‖, 3rd Edition, Prentice Hall Inc., New Jersey, 1993.
3.Amit Gupta, _Industrial Safety and Environment‖, 2nd Edition, Laxmi Publications Pvt. Ltd., New Delhi, 2006.
4. Reniers, Genserik LL. Multi-plant safety and security management in the chemical and process industries. Weinheim: Wiley-VCH, 2010.

Chairman, Board of Studies **Principal/Dean**

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT8301	**DRYING TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives

- To understand the specific drying methods and drier mechanisms

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**FUNDAMENTALS OF DRYING:** Drying and dehydration – Basics and principles. Mechanism of drying – Drying curves, Drying rate periods – constant and falling rate periods. Drying and Food Quality – Post-drying problems and In-drying problems. Effect of drying on Water activity, EMC, Sorption isotherms. Moisture diffusivities in food. Quality changes in food - Browning, color loss, shrinkage, solubility, texture and rehydration.	9
II	**TYPES OF DRYERS:** Classification of dryers – Based on mode of operation, mode of heat transfer – conduction, convection and radiation. Based on feed properties. Selection of dryers - energy costs, safety, and environmental factors. Conventional versus innovative drying techniques. Tray dryer – principle operational aspects and design.	9
III	**LOW COST DRYING METHODS:** Solar drying. Types of solar dryers – Direct, Indirect and mixed mode. Green house solar dryers. Osmotic dehydration – Principal. Osmotic agents, Factors affecting osmotic dehydration. Effect of water activity. Osmo convective drying. Applications, Advantages and Limitations.	9
IV	**DRYING OF SOLIDS:** Rotary dryer – Principle, Types, Applications. Freeze drying – Phase diagram of water, Principle – Freezing, Primary and Secondary drying stage. Fluidized bed drying - Principles of fluidization, Types of fluidized bed dryers. Pneumatic drying – Principle, Working mechanism, Applications.	9
V	**DRYING OF LIQUIDS AND SLURRIES:** Drum drying – principle. Types of drum driers – Single and double drum driers. Types of Feeding system. Foam mat drying – Principles, foaming agents, Foaming Properties, Continuous foam mat dryer. Spray drying – Principle. Components of spray dryer -Atomizer types. Single stage and double stage spray dryer. Design aspects. Advantages and limitations.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the mechanism and quality changes during drying
CO2- Understand the suitable dryers for food products based on requirement
CO3- Understand and identify appropriate low cost drying methods
CO4- Understand and choose suitable dryers for solid food materials
CO5- Understand and recommend appropriate dryers for liquid food materials

TEXT BOOKS:

1.Mujumdar A.S., ―Handbook of Industrial drying‖, 3rd Edition, CRC press, Taylor and Francis group.UK.2007.

2.Xiao Dong Chen and Mujumdar A.S, ―Drying Technologies in Food Processing‖, 1st Edition, Wiley-Blackwell, 2008.

REFERENCES BOOKS:

1.Jangam S.V., Chung Lim Law and Mujumdar A.S., ―Drying of Foods, Vegetables and Fruits‖, Volume 1, Electronic Version, 2010.

2.Hii, C.L., Jangam S.V., SzePhengOng and Mujumdar, A.S., ―Solar Drying: Fundamentals, Applications and Innovations‖, Electronic Version, 2012.

3.Toledo R.T., ―Fundamentals of Food Process Engineering‖, Springer, 2007.

4. Tsotsas, Evangelos, and Arun S. Mujumdar, eds. Modern drying technology. Wiley-VCH, 2007.

Chairman, Board of Studies **Principal/Dean**

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT8302	EMERGING TECHNOLOGIES IN FOOD PROCESSING	3	0	0	3

Course Objectives

- To study the various emerging techniques in food processing

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**HIGH PRESSURE PROCESSING OF FOODS:** High Pressure Processing – Principle - Description, Packaging requirements, Uses and Effects on food quality. High Pressure Regulations. Other applications of high pressure - High pressure freezing, High Pressure thawing, High Pressure non-frozen storage. Pulsed Electric **Field Processing**: Principle - Mechanism of action. PEF treatment systems - processing parameters. Applications. Safety aspects, Problems and challenges in PEF.	9
II	**HIGH INTENSITY PULSED LIGHT TECHNOLOGY:** Principles of Pulsed Light Technology, Effect of Pulsed Light Technology on food products, enzymes and food properties. Systems for Pulsed Light Technology. **Irradiation of Foods:** Fundamentals of food irradiation - Definition, Doses of Irradiation. Biological effects of irradiation – effect on micro-organisms, parasites and insects, viruses, ripening and sprouting inhibition	9
III	**ULTRASOUND:** Fundamentals of ultrasound, ultrasonic processing equipment, Inactivation of micro-organisms and enzymes. Application- mixing and homogenization, foam formation and destruction, precipitation of airborne powders, filtration and drying, extraction. **Ozonation**: Solubility, stability and reactivity of ozone. Antimicrobial properties of ozone. Ozone Treatment System. Food applications.	9
IV	**OHMIC HEATING:** Ohmic Heating - fundamentals, electrical conductivity. Generic Configurations - Batch Configuration, Transverse Ohmic heating and Collinear Ohmic heating. Product suitability for thermal treatments. **Di-electrical Heating:** Dielectric properties of foods. Dielectric heating, difference between MW and RF. Microwave heating – working principle. Microwave processing of foods – baking, thawing, drying, pasteurization and sterilization. Radio-frequency heating – material properties, adopting RF technology, heating and drying application.	9
V	**NOVEL HYBRID DRYING TECHNOLOGIES:** Need for hybrid drying systems. Hybrid systems - Heat pump drying, fluidized bed drying, combined microwave and vacuum drying, infra-red drying, superheated steam drying, pressure regulating drying, rotating jet spouted bed drying. **Automation:** Automation process control for food industry – introduction. Recent trends in tools of automation – Computer vision systems, On-line sensors, Expert systems, Robot Technology, Computer Integrated manufacturing	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the concepts and effects of high pressure processing
CO2- Understand the experiment with pulsed electric field and pulsed light technology for foods
CO3 – Understand and adapt ultrasound and ozone techniques for foods
CO4- Understand and apply ohmic heating principle in food processing
CO5- Understand the novel drying techniques and adapt automation in food processing

TEXT BOOKS:

1.Da-Wen Sun, ―Emerging Technologies for Food Processing‖, 2nd Edition, Elsevier Academic Press, London, 2014.

2.Howard Q. Zhang, Gustavo V. Barbosa-Canovas, Balasubramaniam V.M., Dunne C. P., Farkas D.F. and Yuan J.T.C., ―Non-thermal Processing Technologies for Food‖, 1st Edition, John Wiley and Sons Ltd., UK, 2011.

REFERENCES BOOKS:

1.Han, Jung H., ―Packaging for Non-thermal Processing of Food‖, Wiley-Blackwell, Oxford, 2007.

2.Mujumdar A.S., ―Handbook of Industrial drying‖, 4th Edition, CRC Press, UK, 2014.

3.Lelieveld H.L.M., ―Food Preservation by pulsed electric fields: From research to application‖, Wood Head Publishing Ltd., England, 2007.

4. Sun, Da-Wen. Emerging technologies for food processing. Elsevier, 2014.

Chairman, Board of Studies **Principal/Dean**

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT8303	**MODELLING, SIMULATION AND SOFT TOOLS**	3	0	0	3

Course Objectives

- To understand the simulation and modeling tools

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION TO MODELING:** Physical, Mathematical and Chemical Systems. Modeling - Principles of model Formulation, Representation of Model, Fundamental Laws, Types of Modeling Equations, Black Box Principles, Boundary Condition, Validation of model. Benefits of modeling in food process.	9
II	**MODELS IN FERMENTATION:** Introduction, Biological models - Genetic models, growth models, killing-off models and productions models. Technological models - heat transfer models, oxygen transfer models and mixing models. Economic models and mixed models. **Models in MAP:** Principle and methods, macro, micro and meso level models.	9
III	**MODELING OF COOLING AND FREEZING PROCESSES:** Introduction, modeling product heat load during cooling - single tank model and tank network model. Modeling product heat load during freezing. Numerical solution of heat conduction equation with phase change. Finite different models and element model. Modeling of combined heat and mass transfer - porous, non-porous foods, foods with impermeable skin and frozen foods.	9
IV	**MODELING OF THERMAL PROCESS:** Types, basic equations - Microbiological and quality kinetics, thermal transport equations. Conduction equations, complex models for non-uniformity and convective flows, sterilization of liquids foods and foods containing particulates. Models for microwave and ohmic heating.	9
V	**SOFT TOOLS FOR MODELING OF FOOD PROCESSES**: Soft tools for Sensory analysis, Mathematical analysis, data treatment tools, design tools, Simcad Pro simulation software, COMSOL, gPROMS	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Remember the concepts of modeling in food processing
CO2- Understand the suitable mathematical models in fermentation and MAP
CO3- Understand the modeling concepts in cooling and freezing processes of foods
CO4- Understand the models used in thermal processing of foods
CO5- Understand the use of appropriate software for modeling processes

TEXT BOOKS:

1.Luyben W.L., ―Process Modeling, Simulation and Control for Chemical Engineers‖, 2nd Edition, McGraw Hill Book Co., New York, 1990.
2.Tijskens L.M.M., Hertog T.M. and Nicolai B.M., ―Food Process Modeling‖, CRC Press, 2001

REFERENCES BOOKS:

1.Babu B.V., ―Process Plant Simulation‖, Oxford University Press, New Delhi, 2004.
2.Farid M.M., ―Mathematical Modeling of Food Processing‖, CRC Press, 2010.
3.Jun S. and Irudayaraj J.M., ―Food Processing Operations modeling: Design and analysis‖, CRC Press, 2009.
4. Csáki, Csaba. Simulation and systems analysis in agriculture. Elsevier, 1985.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT8304	ANALYTICAL INSTRUMENTS IN FOOD INDUSTRIES	3	0	0	3

Course Objectives

- To learn about the various analytical instruments used for food analysis

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**SPECTROMETRY:** Classification of Instrumental methods– Electromagnetic radiation – electromagnetic spectrum, Interaction of electromagnetic radiation with matter. Visible spectrometry and Colorimetry – Theory, Instrumentation (Line diagram alone) and applications. Ultra violet spectroscopy – Theory, instrumentation - Single and Double beam, applications. Infra-red spectroscopy – Theory, Fundamental Vibrations, Instrumentation, Applications.	9
II	**ATOMIC ABSORPTION AND NMR SPECTROSCOPY**: AAS - Principle, Instrumentation and applications. NMR spectroscopy – Principle, Instrumentation, Chemical shift and applications. **Thermal methods:**Thermogravimetry, Differential thermal analysis, Differential Scanning Calorimetry – Principle, Instrumentation and Applications.	9
III	**X-RAY AND FLAME PHOTOMETER:** X-ray diffraction - Principle, instrumentation, detectors and applications. Flame photometer - Theory, Instrumentation and applications.Polarimetry **-** specific rotation, optical activity, Principle and instrumentation. Saccharimetery- Analysis of Sugar.	9
IV	**CONDUCTANCE AND POTENTIAL MEASUREMENTS**: Definitions, Conductance Measurements, applications, Types, advantages and disadvantages of Conductometric titrations. Potential measurements, pH determination, Potentiometric Titrations. Basic principles of electrophoresis, theory and application of paper and gel.	9
V	**CHROMATOGRAPHIC TECHNIQUES:** Introduction**,** Paper chromatography, Thin Layer Chromatography, Column Chromatography - Gas chromatography,HPLC – reverse phase and normal phase - Principle, Instrumentation and Applications.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the application of UV-Visible and IR spectroscopy in food analysis

CO2- Understand and make use of AAS, NMR and thermal methods to analyze different food materials

CO3- Understand and apply X- ray diffraction, flame photometers and Polarimetry in food analysis

CO4- Remember and recognize the usage of conductance and potential measurements for analysis of components

CO5- Understand and infer the chromatographic principles to separate and analyze materials

TEXT BOOKS:

1.Chatwal, Gurdeep R., and Anand, Sham K., ―Instrumentation Methods of Chemical Analysis‖, 2nd Edition, Himalaya Publications, Bombay, 2003.

2.Willard H.H, Merritt L.L, Dean J.A, and Settle F.A., ―Instrumental Methods of Analysis‖, 7th Edition, CBS Publishers and Distributors, New Delhi, 1988.

REFERENCES BOOKS:

1.Skoog Douglas A., West Donald M., Holler F James, and Crouch Stanley R., ―Analytical Chemistry: An Introduction‖, 7th Edition, South-Western, Australia, 2000.

2.Rouessac F., ―Chemical Analysis: Modern International Method and Techniques‖, 3rd Edition, Wiley, New Delhi, 1999.

3.Banwell G.C., ―Fundamentals of Molecular Spectroscopy‖, 2nd Edition, Tata McGraw-Hill, New Delhi, 1992.

4. Kress-Rogers, Erika, and Christopher JB Brimelow, eds. Instrumentation and sensors for the food industry. Vol. 65. Woodhead Publishing, 2001.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT8305	**SEPARATION TECHNIQUES IN FOOD PROCESSING**	3	0	0	3

Course Objectives

- To study the separation techniques in food processing

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Mechanism of Separation and Filtration Processes:** Review of conventional processes. Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances. Process concept, theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter, Surface based solid – liquid separations involving a second liquid, Sirofloc filter.	9
II	**Membrane Separation:** Types and choice of membranes, membrane module- Plate and frame, tubular, spiral wound and hollow fibre. Membrane processes - dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis. Membrane fouling – cleaning techniques.	9
III	**Adsorption and Chromatography:** Mechanism, Types and choice of adsorbents, adsorption techniques – pressure swing and temperature swing cycles. Affinity and Immuno-chromatography. Large scale chromatography – theory and general system.	9
IV	**Ionic Separation and Permeation:** Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, ion exchange chromatography and electrodialysis. Separations involving pervaporation and permeation techniques for solids, liquids and gases.	9
V	**Other Separation Processes:** Zone melting, Adductive crystallization, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the concepts of separation and filtration techniques
CO2- Understand and select the suitable membrane process and cleaning techniques
CO3- Understand the classification of adsorption techniques
CO4- Understand the concepts of ionic separation and permeation
CO5- Understand and elaborate other separation processes and effluent treatment

TEXT BOOKS:

1.Seader J.D., Ernest J. Henley and Keith Roper D., ‐Separation Process Principles‖, 3rd Edition, John Wiley and Sons Inc., New York, 2011.

2.Roussel Ronald W., ‐Handbook of Separation Process Technology‖, John Wiley, New York, 2008

REFERENCES BOOKS:

1.Scott K. and Hughe R., ‐ Industrial Membrane Separation Technology‖, Blackie Academic and Professional Publications, Glasgow, 1996.

2.Schoen H.M., ‐New Chemical Engineering Separation Techniques‖, Inter-science Publishers, New York, 1972.

3.Humphrey Jimmy L., George E. Keller II., ‐Separation Process Technology‖, McGraw-Hill Publishing Company Ltd., USA, 1997.

4. Grandison, Alistair S. Separation processes in the food and biotechnology industries. CRC Press, 1996.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT8306	WASTE MANAGEMENT AND BY-PRODUCT UTILIZATION IN FOOD INDUSTRIES	3	0	0	3

Course Objectives

- To understand the concepts of waste management and its utilization in food industries

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**IMPORTANCE AND CHARACTERISTICS OF INDUSTRIAL WASTE:** Classification of waste, characterization of waste, magnitude of waste generation in different food processing industries, importance of waste management, Economical aspects of waste treatment and disposal, Strategies for minimizing waste, Application of 3R's and life cycle assessment (LCA).	9
II	**WASTE TREATMENT METHODS:** Membrane separation, advanced oxidation/reduction, electrolytic methods, up-flow anaerobic sludge blanket (UASB), aerobic and anaerobic methods, activated sludge treatment, sludge thickening, sludge conditioning, sludge dewatering, composting and incineration, land filling, vermicomposting.	9
III	**BY PRODUCTS FROM OIL SEED AND TUBER PROCESSING INDUSTRIES:** Oil processing industries – Introduction, De-oiled cake, animal feed, fertilizer, bio sorbents, waxes, soap stock, cocoa butter replacer. Tuber processing industries- Introduction, enzyme production, biogas, bakers yeast, bio-ethanol, animal feed, corn syrup, organic acids, nutraceuticals.	9
IV	**BY PRODUCTS FROM ANIMAL PRODUCT BASED INDUSTRIES:** Dairy industry - Introduction- opportunities – whey, bio surfactants, bacteriocin. Meat, fish, poultry processing industries- bio active peptide, protein extract, gelatin, heparin, pepsin, bio molecule from bone and blood, keratin form animal hair, bone meal, meat meal,chondroitin sulfate, squalene, fish oil, micro nutrients- vitamins and minerals, pigments.	9
V	**BY PRODUCTS FROM MILLING, FRUITS AND VEGETABLES PROCESSING INDUSTRIES:** Milling industries- introduction, bran utilization- dietary fibre, substrate for mushroom cultivation and enzyme production, briquettes, edible oils. Fruits and vegetable processing industries- current scenario in waste generation- anti oxidants, natural colorants and flavors, pectin and other poly saccharides, organic acids, adsorbent, phyto chemicals.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the classification of food waste and recommend the strategies for waste minimization

CO2- Understand and identify the method for treatment of liquid and solid waste

CO3- Understand and utilize residues from oil seed and tuber processing industries

CO4- Understand the by-product production from animal product based industries

CO5- Understand and develop by-products from grain, fruits and vegetables processing

TEXT BOOKS:

1.Chandrasekaran M., ―Valorization of Food Processing By-Products‖, CRC Press, 2013.

2.Vasso Oreopoulou and Winfried Russ, ―Utilization of By-Products and Treatment of Waste in the Food Industry‖, Springer Science Business Media, USA, 2007.

REFERENCES BOOKS:

1.Keith Waldron, ―Handbook of waste management and co-product recovery in food processing‖, Wood head Publishing Ltd., England, 2007.

2.Green J.H. and Kramer A., ―Food Processing Waste Management‖, AVI Publishing Company, Malaysia,1981.

3.Nelson L. Nemerow and Franklin J. Agardy, ―Strategies of Industrial and Hazardous Waste Management‖, John Wiley and Sons, 1998.

4. Oreopoulou, Vasso, and Winfried Russ, eds. Utilization of by-products and treatment of waste in the food industry. New York, NY, USA:: Springer, 2007.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT8307	**ECONOMICS AND MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objectives

- To enable the students to understand the various concepts of economics, process development, design consideration and cost estimation in chemical industry.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTEREST AND PLANT COST:** Time value of money - equivalence, Depreciation, Depletion, estimation of capital cost, Capital requirement for complete plant, cost indices, capital recovery.	9
II	**PROJECT PROFITABILTY AND FINANCIAL RATIOS:** Estimation of project profitability, Investment alternatives, income statement and financial ratios, balance sheet preparation- problems.	9
III	**ECONOMIC BALANCE IN EQUIPMENTS:** Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipment	9
IV	**PRINCIPLES OF MANAGEMENT:** Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations, Management information systems (MIS).	9
V	**PRODUCTION PLANNING CONTROL:** Work measurement techniques, motion study, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in production and quality control.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the capital cost and the value of money for the complete plant
CO2- Understand the profitability of the project and balance sheet preparation
CO3- Understand the economic operation of the equipment
CO4- Understand the planning and management
CO5- Understand the production planning, control chart preparation and quality control

TEXT BOOKS:

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, 2004.
2. Schweyer. H.E, "Process Engineering Economics", Mc Graw Hill, 1969.

REFERENCES BOOKS:

1. F.C. Jelen and J.H. Black, "Cost and Optimization Engineering", McGraw Hill, 3rd Edn., 1992
2. Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.
3. Zimmer and Scarborough, ―Essentials of Entrepreneurship and Small Business Management‖, 5th Edition, PHI Learning Pvt. Ltd., 2009.
4. Supply Chain Management, Chopra and peter, Pearson, 5th edition, 2013

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT8308	**EMERGING NON-THERMAL PROCESSING OF FOOD**	**3**	**0**	**0**	**3**

Course Objectives

- To understand the various emerging non-thermal food processing methods

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION:** Type and sources of radiation, dosimetry, mode of action of ionizing radiation – direct and indirect effect, radiation effect on food constituents, dose requirement for different products and regulations.	9
II	**EMERGING STORAGE AND PACKAGING METHODS :** Controlled atmosphere storage- modified atmosphere storage- Diffusion channel - controlled atmosphere packaging, modified atmosphere packaging, vacuum packaging - need of modifying atmospheric gas composition – types of scrubbers	9
III	**MINIMAL PROCESSING :** Minimal processing – hurdle technology – various parameters which inhibits the growth of microorganism. Ozone – its role in food industry – generation – application. Intermediate moisture foods – formulation – preparation	9
IV	**MEMBRANE TECHNOLOGY:** Membrane technology – terminologies-types of membrane- types of membranemodules- osmosis- reverse osmosis- ultra filtration-changes during concentration.	9
V	**RECENT ADVANCEMENT IN FOOD PRESERVATION :** Pulsed electrified sterilization - application. High pressure technology – application, Oscillating magnetic field sterilization, Ultra sound, Ohmic heating – application in food industry.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Understand the concepts of non-thermal processing
CO2- Understand the non-thermal packaging techniques
CO3- Understand the minimal processing steps
CO4- Understand the technology of membranes
CO5- Understand the recent advancement in food preservation

TEXT BOOKS:

1. Lal and Siddappa., "*Fruit and Vegetable preservation*", ICMR 1986.
2. Manoranjan Kalia and Sangita, "*Food preservation and processing*". Kalyani Publishers. Ludhiana 1996.

REFERENCES BOOKS:

1.Fellows, P.J, "*Food Processing Technology*" 2001. 154 FP-2013 SRM(E&T)
2.Leninger, H.A. and Beverlod, W.A. "*Food Process Engineering*", D.Reicle Pub. Corp.
3. Srivastha R.P. and Sanjeev kumar, "Fruit and vegetable Preservation" 1998.
4. Ohlsson, Thomas, and Nils Bengtsson, eds. Minimal processing technologies in the food industries. Elsevier, 2002.

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OPEN ELECTIVES

Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT6401	**PRINCIPLES OF FOOD SCIENCE**	**3**	**0**	**0**	**3**

Course Objectives

- This course enable the student to know the different types of enzymes and its food application`

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PROCESSING OF FOODS AND ITS IMPORTANCE** Source of food - food of plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods	9
II	**METHODS OF FOOD HANDLING AND STORAGE** Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.	9
III	**LARGE SCALE FOOD PROCESSING** Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc.; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.	9
IV	**FOOD WASTE IN VARIOUS PROCESESS** Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.	9
V	**FOOD HYGIENE** Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminatedwater and food; Personnel hygiene; Training & Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.	9
	Total Instructional Hours	**45**

Course outcomes

Upon completion of the course, students can be able to

CO1- Understand the concepts of food hygiene
CO2- Remember the processing of wastes from industry
CO3- Understand the importance of food
CO4- Understand the difficulties in food handling
CO5- Understand the various processing of foods

TEXT BOOKS:

1. Sivasankar, B. “Food Processing & Preservation”, Prentice Hall of India, 2002.
2. Khetarpaul, Neelam, “Food Processing and Preservation”, Daya Publications, 2005.

REFERENCE:

1. Karnal, Marcus and D.B. Lund “Physical Principles of Food Preservation”. Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M “Food Preservation and Safety Principles and Practice”. Surbhi Publications, 2001.
3. Heldman, Dennis R., and Richard W. Hartel. Principles of food processing. Springer Science & Business Media, 1997.
4. Karel, Marcus, Owen R. Fennema, and Daryl B. Lund. Principles of food science. Part II. Physical principles of food preservation. Marcel Dekker, Inc., 1975.

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Programme	Course Code	Name of the Course	L	T	P	C
B.Tech	16FT7401	**FOOD PRODUCT DEVELOPMENT**	**3**	**0**	**0**	**3**

Course Objectives

- To understand the concepts for developing new food products

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION :** The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving - brain storming- different techniques	9
II	**PROJECT SELECTION AND EVALUATION :** Collection of ideas and purpose of project - Selection criteria - screening ideas for new products (evaluation techniques)	9
III	**NEW PRODUCT PLANNING :**Design of proto type - testing - quality standards - marketing research - introducing new products	9
IV	**NEW PRODUCT DEVELOPMENT :** Research and new product development - Patents - Patent search - Patent laws – International code for patents - Intellectual property rights (IPR).	9
V	**MODEL PREPARATION & EVALUATION :** Creative design - Model Preparation - Testing - Cost evaluation - Patent application	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Remember the concepts for technological innovation
CO2- Understand the selection and evaluation process
CO3- Understand the planning steps
CO4- Understand the steps for developing a new product
CO5- Understand the model for development

TEXT BOOKS:

1.Twiss, Brian. “Managing Technological Innovation”, Pitman Publishing Ltd., 1992.
2.Watton, Harry B. “New Product Planning”, Prentice Hall Inc., 1992.

REFERENCES BOOKS:

1.Nystrom, Harry “Creativity and Innovation”, John Wiley & Sons, 1979.
2. Khandwalla, N. – “Fourth Eye (Excellence through Creativity) - Wheeler Publishing”, 1992.
3. I.P.R. Bulletins, TIFAC, New Delhi, 1997
4. Clark, Kim B., and Steven C. Wheelwright. "Managing new product and process development: text and cases." (1993).

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