HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University, Chennai)

(Approved by AICTE, New Delhi, Accredited by NAAC with 'A' Grade)

Coimbatore - 641 032.

B.TECH. FOOD TECHNOLOGY

HINDUSTHAN EDUCATIONAL AND CHARITABLE TRUST

HICET

CHOICE BASED CREDIT SYSTEM

Curriculum & Syllabus

2021-2022

VISION AND MISSION OF THE INSTITUTION

VISION

To become a premier institution by producing professionals with strong technical knowledge, innovative research skills and high ethical values.

MISSION

IM1: To provide academic excellence in technical education through novel teaching methods.

IM2: To empower students with creative skills and leadership qualities.

IM3: To produce dedicated professionals with social responsibility.

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FT - HiCET

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Dean (Academics)
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VISION AND MISSION OF THE DEPARTMENT

VISION

To be an excellent Department in training students to become professional Food Technologist who is technically capable of working in food operations sector and discovering licensed food products which could benefit the Eco-friendly society.

MISSION

M1. To impart students with a vibrant technical and analytical skills.

M2. To provide students with leadership quality and also the knowledge to handle all the problems relating Food Industry.

M3. To develop the research and development activities of students to explore the quality food products.

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PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional

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engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1. Ensure food safety and quality by using the technical skills and other emerging techniques.

PSO 2. Design and develop the safest food products and equipments needed for the eco-friendly society.

PSO 3. Integrate various concepts of food processing operations and come out with the best solution for the complex issues in food sector.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1. Utilize the principles of food science and Engineering to face various professional career challenges.

PEO 2. Analyze and create new food products and process for real world application with technical feasibility.

PEO 3. Exhibit professional and managerial capabilities with ethical conduct for continuous learning.

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CURRICULUM

DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS

CBCS PATTERN

UNDERGRADUATE PROGRAMMES

B.TECH. FOOD TECHNOLOGY (UG)

REGULATION-2016 & 2019

REGULATION-2019

For the students admitted during the academic year 2021-2022 and onwards

SEMESTER I

S.No.	Course Code	Course Title	Type	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21HE1101	Technical English	HS	2	1	0	3	40	60	100
2	21MA1102	Calculus and Linear Algebra	BS	3	1	0	4	40	60	100
3	21ME1101	Basics of Civil and Mechanical Engineering	ES	3	0	0	3	40	60	100
THEORY & LAB COMPONENT										
4	21PH1151	Applied Physics	BS	2	0	2	3	50	50	100
5	21CY1151	Chemistry for Engineers	BS	2	0	2	3	50	50	100
6	21CS1151	Python Programming and Practices	ES	2	0	2	3	50	50	100
PRACTICAL										
7	21HE1071	Language Competency Enhancement Course-I	HS	0	0	2	1	100	0	100
MANDATORY COURSES										
8	21HE1072	**Career Guidance Level – I** Personality, Aptitude and Career Development	EEC	2	0	0	0	100	0	100
			Total:	**16**	**2**	**8**	**20**	**470**	**330**	**800**
As Per AICTE Norms 3 Weeks Induction Programme is Added in The First Semester as an Audit Course										

SEMESTER II

S.No.	Course Code	Course Title	Type	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21HE2101	Business English for Engineers	HS	2	1	0	3	40	60	100
2	21MA2101	Differential Equations and Complex Variables	BS	3	1	0	4	40	60	100
3	21FT2105	Principles of Microbiology	ES	3	0	0	3	40	60	100
THEORY & LAB COMPONENT										
4	21IT2151	Programming in C	ES	2	0	2	3	50	50	100
5	21PH2151	Material Science	BS	2	0	2	3	50	50	100
6	21CY2151	Environmental Studies	BS	2	0	2	3	50	50	100
PRACTICALS										
7	21ME2001	Engineering Practices Lab	ES	0	0	4	2	60	40	100
8	21HE2071	Language Competency Enhancement	HS	0	0	2	1	100	0	100

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		Course-II								
MANDATORY COURSES										
9	21HE2072	**Career Guidance Level – II** Personality, Aptitude and Career Development	EEC	2	0	0	0	100	0	100
10	21HE2073	Entrepreneurship & Innovation	EEC	1	0	0	0	100	0	100
			Total:	**17**	**2**	**12**	**22**	**620**	**380**	**1000**

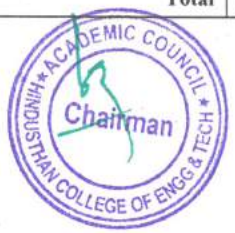
For the students admitted during the academic year 2020-2021 and onwards

SEMESTER III

S.No	Course Code	Course Title	Type	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	19MA3102	Fourier Analysis and Transforms	BS	3	1	0	4	25	75	100
2	19FT3201	Fluid Mechanics	PC	3	1	0	4	25	75	100
3	19FT3101	Principles of Thermodynamics	PC	3	0	0	3	25	75	100
4	19FT3202	Food Microbiology	PC	3	0	0	3	25	75	100
THEORY AND LAB COMPONENT										
5	19FT3251	Bio Chemistry	PC	2	0	2	3	50	50	100
PRACTICALS										
6	19FT3001	Food Microbiology Lab	PC	0	0	3	1.5	50	50	100
7	19FT3002	Food Production Analysis Lab	PC	0	0	3	1.5	50	50	100
MANDATORY COURSES										
8	19MC3191	Indian Constitution	MC	2	0	0	0	100	0	100
9	19HE3072	**Career Guidance Level – III** Personality, Aptitude and Career Development	EEC	2	0	0	0	100	0	100
10	19HE3073	Leadership Management Skills	EEC	1	0	0	0	100	0	100
			Total	**19**	**2**	**8**	**20**	**550**	**450**	**1000**

SEMESTER IV

S.No	Course Code	Course Title	Type	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	19FT4201R	Fundamentals of Heat and Mass Transfer	PC	3	1	0	4	25	75	100
2	19FT4203R	Engineering properties of food materials	PC	3	0	0	3	25	75	100
3	19FT4204	Refrigeration and Cold Chain Management	PC	3	1	0	4	25	75	100
THEORY AND LAB COMPONENT										
4	19FT4251	Food Chemistry	PC	2	0	2	3	50	50	100
5	19MA4152	Statistics and Numerical Methods	BS	3	0	2	4	50	50	100
PRACTICALS										
6	19FT4001	Unit Operations Laboratory	PC	0	0	3	1.5	50	50	100
7	19FT4002	Food Process Equipment Design Laboratory	PC	0	0	3	1.5	50	50	100
MANDATORY COURSES										
8	19MC4191	Essence of Indian tradition knowledge/Value Education	MC	2	0	0	0	100	0	100
9	19HE4072	**Career Guidance Level – IV** Personality, Aptitude and Career Development	EEC	2	0	0	0	100	0	100
10	19HE4073	Ideation Skills	EEC	1	0	0	0	100	0	100
			Total	**19**	**2**	**10**	**21**	**575**	**425**	**1000**



REGULATION-2019

For the students admitted during the academic year 2019-2020 and onwards

SEMESTER V

S.No.	Course Code	Course Title	Type	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	19FT5201	Baking and Confectionery Technology	PC	3	0	0	3	25	75	100
2	19FT5202	Food Additives	PC	3	0	0	3	25	75	100
3	19FT5203	Poultry, Meat and Fish Process Technology	PC	3	0	0	3	25	75	100
4	19FT5204	Principles of Food Processing	PC	3	0	0	3	25	75	100
5	19FT5205	Unit Operations in Food Processing	PC	3	0	0	3	25	75	100
6	19FT53XX	**Professional Elective -I**	PE	3	0	0	3	25	75	100
PRACTICALS										
7	19FT5001	Baking and Confectionery Technology Laboratory	PC	0	0	4	2	50	50	100
8	19FT5002	Unit Operations in Food Processing Laboratory	PC	0	0	4	2	50	50	100
MANDATORY COURSES										
9	19HE5071	Soft Skills - I	EEC	1	0	0	1	100	0	100
10	19HE5072	Design Thinking	EEC	1	0	0	1	100	0	100
			Total	**20**	**0**	**8**	**24**	**450**	**550**	**1000**

SEMESTER VI

S.No.	Course Code	Course Title	Type	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	19FT6201	Dairy Engineering	PC	3	0	0	3	25	75	100
2	19FT6202	Plantation crops and Spices Products Technology	PC	3	0	0	3	25	75	100
3	19FT6203	Fruits and Vegetable Processing Technology	PC	3	0	0	3	25	75	100
4	19FT6181	Professional Ethics in Engineering	HS	3	0	0	3	25	75	100
5	19FT63XX	**Professional Elective - II**	PE	3	0	0	3	25	75	100
6	19XX64XX	**Open Elective– I**	OE	3	0	0	3	25	75	100
PRACTICAL										
7	19FT6001	Dairy Engineering Laboratory	PC	0	0	3	1.5	50	50	100
8	19FT6002	Fruits and Vegetable Processing Technology Laboratory	PC	0	0	3	1.5	50	50	100
MANDATORY COURSES										
9	19FT6701	Industrial Training	EEC	0	0	0	1	0	100	100
10	19HE6071	Soft Skills - II	EEC	1	0	0	1	100	0	100
11	19HE6072	Intellectual Property Rights (IPR)	EEC	1	0	0	1	100	0	100
			Total	**20**	**0**	**6**	**24**	**450**	**650**	**1100**

LIST OF PROFESSIONAL ELECTIVES

S.No.	Course Code	Course Title	Type	L	T	P	C	CIA	ESE	TOTAL
PROFESSIONAL ELECTIVE I										
1	19FT5301	Technology of Fats and Oils	PE	3	0	0	3	25	75	100
2	19FT5302	Food Storage and Infestation Control	PE	3	0	0	3	25	75	100
3	19FT5303	Refrigeration and Cold Chain Management	PE	3	0	0	3	25	75	100
4	19FT5304	Post-Harvest Technology	PE	3	0	0	3	25	75	100
5	19FT5305	Cane sugar Technology	PE	3	0	0	3	25	75	100
6	19FT5306	Milling Technology for Food Materials	PE	3	0	0	3	25	75	100
PROFESSIONAL ELECTIVE II										
1	19FT6301	Beverage Technology	PE	3	0	0	3	25	75	100
2	19FT6302	Technology of Snack and Extruded Foods	PE	3	0	0	3	25	75	100
3	19FT6303	Food Biotechnology	PE	3	0	0	3	25	75	100
4	19FT6304	Bioprocess Engineering	PE	3	0	0	3	25	75	100
5	19FT6305	Enzyme Technology	PE	3	0	0	3	25	75	100
6	19FT6306	Crop Process Engineering	PE	3	0	0	3	25	75	100

LIST OF OPEN ELECTIVE - FOOD TECHNOLOGY

S.No.	Course Code	Course Title	Type	L	T	P	C	CIA	ESE	TOTAL
1	19FT6401	Traditional Foods	OE	3	0	0	3	25	75	100

REGULATION 2016

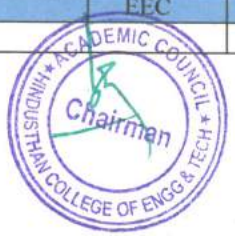
For the students admitted during the academic year 2018-2019 and onwards

SEMESTER VII

S.No.	COURSE CODE	COURSE TITLE	Course Category	L	T	P	C	CIA	ESE	Total
1	16HE7101	Professional Ethics	HS	3	0	0	3	25	75	100
2	16FT7201	Food Additives	PC	3	0	0	3	25	75	100
3	16FT7202	Plantation Crops & Spices Product Technology	PC	3	0	0	3	25	75	100
4	16FT73XX	Professional Elective – III	PE	3	0	0	3	25	75	100
5	16FT73XX	Professional Elective – IV	PE	3	0	0	3	25	75	100
6	16XX7401	Open Elective – II	OE	3	0	0	3	25	75	100
7	16FT7001	Food Process Equipment Design Laboratory	PC	0	0	4	2	50	50	100
8	16FT7801	Mini Project	PC	0	0	4	2	50	50	100
TOTAL				**18**	**0**	**8**	**22**	**250**	**550**	**800**

SEMESTER VIII

S.No	COURSE CODE	COURSE TITLE	Course Category	L	T	P	C	CIA	ESE	Total
1	16FT83XX	Professional Elective – V	PE	3	0	0	3	25	75	100
2	16FT83XX	Professional Elective – VI	PE	3	0	0	3	25	75	100
3	16FT8901	Project	EEC	0	0	20	10	100	100	200
TOTAL				**6**	**0**	**20**	**16**	**150**	**250**	**400**



LIST OF PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVE III										
1	16FT7301	Biology and Chemistry of Food Flavours	PE	3	0	0	3	25	75	100
2	16FT7302	Food Laws and Safety	PE	3	0	0	3	25	75	100
3	16FT7303	Functional Foods and Nutraceuticals	PE	3	0	0	3	25	75	100
4	16FT7304	Food Toxicology and Allergy	PE	3	0	0	3	25	75	100
PROFESSIONAL ELECTIVE IV										
1	16FT7305	Instrumentation and Process Control	PE	3	0	0	3	25	75	100
2	16FT7306	Technology of Snack and Extruded Foods	PE	3	0	0	3	25	75	100
3	16FT7307	Beverage Technology	PE	3	0	0	3	25	75	100
4	16FT7308	Food Process Plant Layout and Safety	PE	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE V										
S.No.	**Course Code**	**Course Title**	**Type**	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**TOTAL**
1	16FT8301	Drying Technology	PE	3	0	0	3	25	75	100
2	16FT8302	Emerging Technologies in Food Processing	PE	3	0	0	3	25	75	100
3	16FT8303	Modeling, Simulation and Soft Tools for Food Technologists	PE	3	0	0	3	25	75	100
4	16FT8304	Analytical Instruments in Food Industries	PE	3	0	0	3	25	75	100
PROFESSIONAL ELECTIVE VI										
1	16FT8305	Separation Techniques in Food Processing	PE	3	0	0	3	25	75	100
2	16FT8306	Waste Management and By-Product Utilization in Food Industries	PE	3	0	0	3	25	75	100
3	16FT8307	Economics and Management	PE	3	0	0	3	25	75	100
4	16FT8308	Emerging non-thermal processing of foods	PE	3	0	0	3	25	75	100

LIST OF OPEN ELECTIVES - FOOD TECHNOLOGY

SEMESTER VII										
S.No.	**Course Code**	**Course Title**	**Type**	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**TOTAL**
1	16FT7401	Food Product Development	OE	3	0	0	3	25	75	100

(L – Lecture, T –Tutorial, P – Practical, C – Credit, CIA – Continuous Internal Assessments, ESE – End Semester Examinations)

 # Continuous Internal Assessment (CIA) only.

****NCM (Non Credit Mandatory Course)**

$ Audit Course

@@ MOOC Course (Credit Transfer Course if any approved by Dean Office) -Minimum of 45 Hours from recognized MOOC portal like SWAYAM. Assessment with Score/Credit and Certificate is mandatory.

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Colour :

1. HS subjects
2. BS Subject
3. ES Subject
4. PC Subject
5. PE Subject
6. OE Subject
7. VA/EEC Subjects

Credit Distribution R2016

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	27	25	25	25	23	24	22	16	**187**

Credit Distribution R2019

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	20	22	20	21	24	24	20	14	**165**

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FT - HiCET

Dean – Academics

Dean (Academics)
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Principal

PRINCIPAL
Hindusthan College of Engineering & Technology
COIMBATORE - 641 032

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Chairman
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SYLLABUS

I SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21HE1101	TECHNICAL ENGLISH (COMMON TO ALL BRANCHES)	2	1	0	3

Course Objective

- ✓ To facilitate students to communicate effectively with coherence.
- ✓ To train the learners in descriptive communication.
- ✓ To introduce professional communication.
- ✓ To enhance knowledge and to provide the information on corporate environment.
- ✓ To equip the trainers with the necessary skills on critical thinking.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Listening and Speaking** – Opening a conversation, maintaining coherence, turn taking, closing a conversation (excuse, general wishes, positive comments and thanks) **Reading** – Reading articles from newspaper, Reading comprehension **Writing** Chart analysis, process description, Writing instructions **Grammar and Vocabulary-** Tenses, Regular and irregular verb, technical vocabulary.	9
II	**Listening and Speaking-** listening to product description, equipment & work place (purpose, appearance, function) **Reading-** Reading technical articles **Writing-** Letter phrases, writing personal letters, **Grammar and Vocabulary-**articles, Cause & effect, Prepositions.	9
III	**Listening and Speaking-** - listening to announcements **Reading-** Reading about technical inventions, research and development **Writing-** Letter inviting a candidate for interview, Job application and resume preparation **Grammar and Vocabulary-** Homophones and Homonyms.	9
IV	**Listening and Speaking-** - Practice telephone skills and telephone etiquette (listening and responding, asking questions). **Reading-** Reading short texts and memos **Writing-** invitation letters, accepting an invitation and declining an invitation **Grammar and Vocabulary-** Modal verbs, Collocation, Conditionals, Subject verb agreement and Pronoun-Antecedent agreement.	9
V	**Listening and Speaking-** listening to technical group discussions and participating in GDs **Reading-** reading biographical writing - **Writing-** Proposal writing, Writing definitions, **Grammar and Vocabulary-** Abbreviation and Acronym, Prefixes & suffixes, phrasal verbs.	9
	Total Instructional Hours	**45**

Course Outcome

CO1- Trained to maintain coherence and communicate effectively.
CO2- Practiced to create and interpret descriptive communication.
CO3- Introduced to gain information of the professional world.
CO4- acquired various types of communication and etiquette.
CO5- Taught to improve interpersonal and intrapersonal skills.

TEXT BOOKS:

T1- Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2016.
T2- Raymond Murphy, "Essential English Grammar", Cambridge University Press, 2019.

REFERENCE BOOKS :

R1- Meenakshi Raman and Sangeetha Sharma. "Technical Communication- Principles and Practice", Oxford University Press, 2009.
R2- Raymond Murphy, "English Grammar in Use"- 4th edition Cambridge University Press, 2004.
R3- Kamalesh Sadanan "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.TECH.	21MA1102	CALCULUS AND LINEAR ALGEBRA	3	1	0	4

Course Objective

1. Understand the concept of differentiation.
2. Evaluate the functions of several variables which are needed in many branches of engineering.
3. Understand the concept of double integrals.
4. Understand the concept of triple integrals.
5. Develop the skill to use matrix algebra techniques that is needed by engineers for practical Applications

Unit	Description	Instructional Hours
I	**DIFFERENTIAL CALCULUS** Rolle's Theorem – Lagrange's Mean Value Theorem- Maxima and Minima – Taylor's and Maclaurin's Theorem	12
II	**MULTIVARIATE CALCULUS (DIFFERENTIATION)** Total derivatives - Jacobians – Maxima, M inima and Saddle points - Lagrange's method of undetermined multipliers – Gradient, divergence, curl and derivatives	12
III	**DOUBLE INTEGRATION** Double integrals in Cartesian coordinates– Area enclosed by the plane curves (excluding surface area)– Green's Theorem (Simple Application) - Stoke's Theorem – Simple Application involving cubes and rectangular parellopiped.	12
IV	**TRIPLE INTEGRATION** Triple integrals in Cartesian co-ordinates – Volume of solids (Sphere, Ellipsoid, Tetrahedron) using Cartesian co-ordinates. Gauss Divergence Theorem – Simple Application involving cubes and rectangular parellopiped.	12
V	**MATRICES** Eigen values and Eigen vectors – Properties of Eigen values and Eigen vectors (without proof) - Cayley - Hamilton Theorem (excluding proof) - Reduction of a quadratic form to canonical form by orthogonal transformation.	12
	Total Instructional Hours	60

Course Outcome

CO1: Apply the concept of differentiation in any curve.
CO2: Identify the maximum and minimum values of surfaces.
CO3: Apply double integrals to compute area of plane curves.
CO4: Evaluation of triple integrals to compute volume of solids.
CO5: 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.

TEXT BOOKS:

T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018.

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

REFERENCE BOOKS :

R1- Thomas & Finney " Calculus and Analytic Geometry" , Sixth Edition,,Narosa Publishing House, New Delhi.

R2 – Weir,M.D and Joel Hass, ' Thomas Calculus" 12th Edition,Pearson India 2016.R3 - Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	21ME1101	BASIC CIVIL AND MECHANICAL ENGINEERING	3	0	0	3

Course Objectives

- To learn about the working principles of IC engines and detailed explanation of components of power plant units.
- To study Refrigeration and Air Conditioning system.
- To impart basic knowledge on Civil and Mechanical Engineering.
- To study materials used for the construction of civil structures.
- To gain knowledge on the fundamentals of construction of structure.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**A – MECHANICAL ENGINEERING**	
	IC ENGINES Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines.	9
II	**POWER PLANT ENGINEERING**: Introduction, Classification of Power Plants – Working principle of steam, Gas, Diesel, Hydro-electric and Nuclear Power plants – Merits and Demerits –Prime movers and Power Transmission systems- Pumps– working principle of Reciprocating pumps (single acting and double acting) – Centrifugal Pump.	9
III	**REFRIGERATION AND AIR CONDITIONING SYSTEM** Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system – Layout of typical domestic refrigerator – Window and Split type room Air conditioner.	9
IV	**B – CIVIL ENGINEERING**	
	SURVEYING AND CIVIL ENGINEERING MATERIALS **Surveying**: Objects – types – classification – principles – measurements of distances	9
	Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel sections-Woods-Plastics.	
V	**BUILDING COMPONENTS AND STRUCTURES**	
	Foundations: Types, Bearing capacity – Requirement of good foundations.	9
	Superstructure: Brick masonry – stone masonry – beams – columns – lintels – roofing – flooring – plastering – Types of Bridges and Dams.	
	TOTAL INSTRUCTIONAL HOURS	45

COURSE OUTCOMES

CO1: Apply the concept of differentiation in any curve.
CO2: Identify the maximum and minimum values of surfaces.
CO3: Apply double integrals to compute area of plane curves.
CO4: Evaluation of triple integrals to compute volume of solids.
CO5: 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.

TEXT BOOKS:

1. Venugopal K. and Prabhu Raja V., —Basic Mechanical Engineeringl, Anuradha Publishers, Kumbakonam, 2000.
2. Shanmugam G and Palanichamy M S, —Basic Civil and Mechanical Engineeringl, Tata McGraw Hill Publishing Co., New Delhi, 1996.

REFERENCES:

1. Ramamrutham S., — Basic Civil Engineeringl, Dhanpat Rai Publishing Co. (P) Ltd.1999.
2. Seetharaman S.,' — Basic Civil Engineeringl, Anuradha Agencies, 2005.
3. Shantha Kumar S R J., — Basic Mechanical Engineeringl, Hi-tech Publications, Mayiladuthurai.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21PH1151	APPLIED PHYSICS (COMMON TO ALL BRANCHES)	2	0	2	3

Course Objective

1. Enhance the fundamental knowledge in properties of matter
2. Analysis the oscillatory motions of particles
3. Extend the knowledge about wave optics
4. Gain knowledge about laser and their applications
5. Conversant with principles of optical fiber, types and applications of optical fiber

Unit	Description	Instructional Hours
I	**PROPERTIES OF MATTER** Elasticity – Hooke's law – Stress-strain diagram - Poisson's ratio – Bending moment – Depression of a cantilever – Derivation of Young's modulus of the material of the beam by Uniform bending theory and experiment.	6
	Determination of Young's modulus by uniform bending method	3
II	**OSCILLATONS** Translation motion –Vibration motion – Simple Harmonic motion – Differential Equation of SHM and its solution – Damped harmonic oscillation - Torsion stress and deformations – Torsion pendulum: theory and experiment.	6
	Determination of Rigidity modulus – Torsion pendulum	3
III	**WAVE OPTICS** Conditions for sustained Interference – air wedge and it's applications - Diffraction of light –Fraunhofer diffraction at single slit –Diffraction grating – Rayleigh's criterion of resolution power - resolving power of grating.	6
	Determination of wavelength of mercury spectrum – spectrometer grating	3
	Determination of thickness of a thin wire – Air wedge method	3
IV	**LASER AND APPLICATIONS** Spontaneous emission and stimulated emission – Population inversion – Pumping methods – Derivation of Einstein's coefficients (A&B) – Type of lasers – Nd:YAG laser and CO_2 laser- Laser Applications – Holography – Construction and reconstruction of images.	6
	Determination of Wavelength and particl size using Laser	3
V	**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) – Fiber optical communication link – Fiber optic sensors – Temperature and displacement sensors.	6
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Illustrate the fundamental properties of matter
CO2: Discuss the Oscillatory motions of particles
CO3: Analyze the wavelength of different colors
CO4: Understand the advanced technology of LASER in the field of Engineering
CO5: Develop the technology of fiber optical communication in engineering field

TEXT BOOKS: T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.

T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2015.

REFERENCE BOOKS:

R1 - Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill, New Delhi – 2015

R2 - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi 2016

R3 - Dr. G. Senthilkumar "Engineering Physics – I" VRB publishers Pvt Ltd., 2016

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21CY1151	CHEMISTRY FOR ENGINEERS (COMMON TO ALL BRANCHES)	2	0	2	3

Course Objective

1. The boiler feed water requirements, related problems and water treatment techniques.
2. The principles of polymer chemistry and engineering applications of polymers and composites.
3. The principles of electrochemistry and with the mechanism of corrosion and its control.
4. The principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
5. The important concepts of spectroscopy and its applications.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**WATER TECHNOLOGY** Hard water and soft water- Disadvantages of hard water- Hardness: types of hardness, simple calculations, estimation of hardness of water – EDTA method – Boiler troubles - Conditioning methods of hard water – External conditioning - demineralization process - desalination: definition, reverse osmosis – Potable water treatment – breakpoint chlorination. **Estimation of total, permanent and temporary hardness of water by EDTA**	6 +3=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, Polymerization – types 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, Bakelite – moulding of plastics (extrusion and compression); Composites: definition, types of composites – polymer matrix composites (PMC) –FRP	6
III	**ELECTROCHEMISTRY AND CORROSION** Electrochemical cells – reversible and irreversible cells - EMF- Single electrode potential – Nernst equation (derivation only) – Conductometric titrations. Chemical corrosion – Pilling – Bedworth rule – electrochemical corrosion – different types –galvanic corrosion – differential aeration corrosion – corrosion control – sacrificial anode and impressed cathodic current methods - protective coatings – paints – constituents and functions. **Conductometric titration of strong acid vs strong base (HCl vs NaOH). Conductometric precipitation titration using $BaCl_2$ and Na_2SO_4. Estimation of Ferrous iron by Potentiometry.**	6+9 =15
IV	**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. Batteries and fuel cells: Types of batteries- alkaline battery- lead storage battery- lithium battery- fuel cell H_2 -O_2 fuel cell applications.	6
V	**ANALYTICAL TECHNIQUES** Beer-Lambert's law – UV-visible spectroscopy and IR spectroscopy – principle – instrumentation (block diagram only) – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – estimation of nickel by atomic absorption spectroscopy. **Determination of iron content of the water sample using spectrophotometer. (1,10 phenanthroline / thiocyanate method).**	6+3
	Total Instructional Hours	**45**

Course Outcome	CO1: Differentiate hard and soft water and to solve the related problems on water purification and its significance in industries and daily life CO2: Acquire the basic knowledge of polymers, composites and FRP and their significance. CO3: Develop knowledge on the basic principles of electrochemistry and understand the causes of corrosion, its consequences to minimize corrosion to improve industrial design. CO4: Develop knowledge about the renewable energy resources and batteries along with the need of new materials to improve energy storage capabilities. CO5: Identify the structure and characteristics of unknown/new compound with the help of spectroscopy.

TEXT BOOKS

T1 - P. N. Madudeswaran and B.Jeyagowri, "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, Chennai
T2 - P.C.Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub. Co., New Delhi (2018).

REFERENCES

R1 - B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2012).
R2 - S.S.Dara "A Text book of Engineering Chemistry" S.Chand & Co. Ltd., New Delhi (2017).

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21CS1151	PYTHON PROGRAMMING AND PRACTICES	2	0	2	3

Course Objectives

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

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**ALGORITHMIC PROBLEM SOLVING** Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation(pseudo code, flow chart, programming language), algorithmic problem solving, simple strategiesfor developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert acard in a list of sorted cards, guess an integer number in a range, 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, circulate the values of n variables, distance between two points.**	7+2
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: returnvalues, 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.**	5+4
IV	**LISTS, TUPLES, DICTIONARIES** Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, listparameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations andmethods; advanced list processing - list comprehension; **Illustrative programs: selection sort, insertion sort, merge sort, histogram.**	3+6
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, copying file contents.**	5+4
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1: Develop algorithmic solutions to simple computational problems.

CO2: Read, write, execute by hand simple Python programs.

CO3: Structure simple Python programs for solving problems and 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:

1. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised andupdated for Python 3.6.2, Shroff Publishers, First edition (2017).
2. S. Annadurai, S.Shankar, I.Jasmine, M.Revathi, Fundamentals of Python Programming, Mc-Graw Hill Education (India) Private Ltd, 2019.

REFERENCE BOOKS:

1. Charles Dierbach, —Introduction to Computer Science using Python: A ComputationalProblem-Solving Focus, Wiley India Edition, 2013.
2. Timothy A. Budd, —Exploring Pythonl, Mc-Graw Hill Education (India) Private Ltd., 2015.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming inPython: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21HE1071	LANGUAGE COMPETENCY ENHANCEMENT COURSE- I	0	0	2	1

Course Objective

- ✓ To enhance student language competency
- ✓ To train the students in LSRW skills
- ✓ To develop student communication skills
- ✓ To empower the trainee in business writing skills.
- ✓ To train the students to react to different professional situations

Unit	Description	Instructional Hours
I	**LISTENING** Listening to technical group discussions and participating in GDs. listening to TED talks. Listen to Interviews & mock interview. Listening short texts and memos.	3
II	**READING** Reading articles from newspaper, magazine. Reading comprehension. Reading about technical inventions, research and development. Reading short texts and memos.	3
III	**WRITING** E-mail writing: Create and send email writing (to enquire about some details, to convey important message to all, to place an order, to share your joy and sad moment). Reply for an email writing.	3
IV	**SPEAKING** To present a seminar in a specific topic (what is important while choosing or deciding something to do). To respond or answer for general questions (answer for your personal details, about your family, education, your hobbies, your aim etc.,).	3
V	**SPEAKING** Participate in discussion or interactions (agree or disagree express your statement with a valid reason, involve in discussion to express your perspective on a particular topics).	3
	Total Instructional Hours	**15**

Course Outcome

CO1- Trained to maintain coherence and communicate effectively.
CO2- Practiced to create and interpret descriptive communication.
CO3- Introduced to gain information of the professional world.
CO4- acquired various types of communication and etiquette.
CO5- Taught to improve interpersonal and intrapersonal skills.

TEXT BOOKS:

T1- Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2016.

T2- Raymond Murphy, "Essential English Grammar", Cambridge University Press, 2019.

REFERENCE BOOKS :

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

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Programme	Course code	Name of the Course	L	T	P	C
B.TECH.	21HE1072	CAREER GUIDANCE LEVEL I Personality, Aptitude and Career Development	2	0	0	0
Pre-requisite		None			Syllabus version 1	

Course Objectives:

- Introduce students to building blocks of Logical reasoning and Quantitative Aptitude [SLO 1]
- Train students on essential grammar for placements [SLO 2]
- Introduce students on scientific techniques to pick up skills [SLO 3]
- Provide an orientation for recruiter expectation in terms of non-verbal skills, and for how to build one's career with placements in mind [SLO 4]

Expected Course Outcome:
Enable students to approach learning Aptitude with ease, and understand recruiter expectation.

Student Learning Outcomes (SLO): 1, 2, 3 and 4

Module:1 Lessons on excellence **1 hour** **SLO:** 3
Skill introspection, Skill acquisition, consistent practice

Module:2 Logical Reasoning **7 hours** **SLO:** 1
Thinking Skill

- Problem Solving
- Critical Thinking
- Lateral Thinking

Taught through thought-provoking word and rebus puzzles, and word-link builder questions

Coding & decoding, Series, Analogy, Odd man out and Visual reasoning

- Coding and Decoding
- Series
- Analogy
- Odd Man Out
- Visual Reasoning

Sudoku puzzles
Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers

Attention to detail
Picture and word driven Qs to develop attention to detail as a skill

Module:3 Quantitative Aptitude **8 hours** **SLO:** 1
Speed Maths

- Addition and Subtraction of bigger numbers
- Square and square roots
- Cubes and cube roots
- Vedic maths techniques
- Multiplication Shortcuts
- Multiplication of 3 and higher digit numbers
- Simplifications
- Comparing fractions
- Shortcuts to find HCF and LCM
- Divisibility tests shortcuts

Algebra and functions

Module:4 Recruitment Essentials **1 hour** **SLO:** 4
Looking at an engineering career through the prism of an effective resume

- Importance of a resume - the footprint of a person's career achievements

- How a resume looks like?
- An effective resume vs. a poor resume: what skills you must build starting today and how?

Impression Management
Getting it right for the interview:
- Grooming, dressing
- Body Language and other non-verbal signs
- Displaying the right behaviour

Module:5 Verbal Ability **3 hours** **SLO:** 2

Essential grammar for placements:
- Nouns and Pronouns
- Verbs
- Subject-Verb Agreement
- Pronoun-Antecedent Agreement
- Punctuations

Verbal Reasoning

Total Lecture hours: 20 hours

Mode of Evaluation: Assignments, 3 Assessments with End Semester (Computer Based Test)

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II SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21HE2101	BUSINESS ENGLISH FOR ENGINEERS (COMMON TO ALL BRANCHES)	2	1	0	3

Course Objective

1. Introduce business communication.
2. Train to respond different professional situations.
3. Make the learners familiar with the managerial skills
4. Empower the trainee in business writing skills.
5. Educate to interpret and expertisedifferent business content.

Unit	Description	Instructional Hours
I	**Listening and Speaking** – listening and discussing about programme and conference arrangement Reading –reading auto biographies of successful personalities **Writing** Formal & informal email writing, Recommendations **Grammar and Vocabulary-** Business vocabulary, Adjectives & adverbs.	9
II	**Listening and Speaking-** listening to TED talks **Reading-**Making and interpretation of posters**Writing-** Business letters: letters giving good and bad news, Thank you letter, Congratulating someone on a success"**Grammar and Vocabulary-** Active & passive voice, Spotting errors (Tenses, Preposition, Articles).	9
III	**Listening and Speaking-**travel arrangements and experience **Reading-** travel reviews **Writing-** Business letters (Placing an order, making clarification & complaint letters). **Grammar and Vocabulary-** Direct and Indirect speech.	9
IV	**Listening and Speaking-** Role play- **Reading-** Sequencing of sentence **Writing-** Business report writing (marketing, investigating) **Grammar and Vocabulary-** Connectors, Gerund & infinitive.	9
V	**Listening and Speaking-** Listen to Interviews & mock interview **Reading-** Reading short stories, reading profile of a company - **Writing-** Descriptive writing (describing one's own experience) **Grammar and Vocabulary-** Editing a passage(punctuation, spelling& number rules).	9
	Total Instructional Hours	**45**

Course Outcome

CO1- To know different modes of business communication
CO2- To understand managerial techniques.CO3- To apply the rules of grammar and vocabulary in effective business communication.
CO4-To analyse and interpret business documents.
CO5-To draft business reports

TEXT BOOKS:

T1 - Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate",Cambridge University Press, 2016.

T2- Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2015.

REFERENCE BOOKS :

R1 -Michael Mc Carthy, "Grammar for Business", Cambridge University Press, 2009.

R2- Bill Mascull, "Business Vocabulary in use: Advanced 2nd Edition", Cambridge University Press, 2009.

R3-Frederick T. Wood, "Remedial English Grammar For Foreign Students", Macmillan publishers, 2001.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21MA2101	DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES	3	1	0	4

Course Objective

1. Describe some methods to solve different types of first order differential equations.
2. Solve ordinary differential equations of certain types using Wronskian technique
3. Use the effective mathematical tools for the solutions of partial differential equations.
4. Describe the construction of analytic functions and conformal mapping.
5. Illustrate Cauchy's integral theorem and calculus of residues

Unit	Description	Instructional Hours
I	**FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS** Solutions of Equations of the first order and of the first degree – Variable seperable method-Homogeneous equations – Exact differential equations (Excluding non Exact differential Equations) – Linear equations – Equations reducible to the linear form – Bernoulli's equation	12
II	**ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER** Second order linear differential equations with constant and variable co-efficients – Cauchy – Euler equations – Cauchy – Legendre equation – Method of variation of paramers. Solution of ODE related to electric circuits, bending of beams.	12
III	**PARTIAL DIFFERENTIAL EQUATIONS** Formation of partial differential equations by the 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.	12
IV	**COMPLEX DIFFERENTIATION** Functions of complex variables – Analytic functions – Cauchy's – Riemann's equations and sufficient conditions (excluding proof) – Construction of analytic functions – Milne – Thomson's method – Conformal mapping w = A+z , Az, 1/z and bilinear transformations.	12
V	**COMPLEX INTEGRATION** Cauchy's integral theorem – Cauchy's integral formula –Taylor's and Laurent's series (statement only) –Residues - Cauchy's Residue theorem.	12
	Total Instructional Hours	60

Course Outcome

CO1: Apply few methods to solve different types of first order differential equations.
CO2: Develop sound knowledge of techniques in solving ordinary differential equations
CO3 Solve Partial Differential Equations using various methods.
CO4: Infer the knowledge of construction of analytic functions and conformal mapping.
CO5: Evaluate real and complex integrals over suitable closed paths or contours.

TEXT BOOKS:

T1- Ravish R Singh, Mukul Bhatt, "Engineering Mathematics", McGraw Hill education (India) Private Ltd., Chennai,2017 T2- Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018.

REFERENCE BOOKS :

R1- Veerarajan T, "Engineering Mathematics", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016
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.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	21FT2105	PRINCIPLES OF MICROBIOLOGY	3	0	0	3

COURSE OBJECTIVES

- Understand the history of microbiology.
- Understand the structure and classification of microorganisms.
- Understand the techniques to detect the microbes.
- Understand the conditions for the growth of microrganisms.
- Understand the isolation and control techniques.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Introduction:** Development and Scope of Microbiology, History of Microbiology - Spontaneous generation theory, Biogenesis, Germ theory of diseases. Contributions by Anton Van Leeuwenhoek, Louis Pasteur, John Tyndall, Robert Koch, Joseph Lister, Edward Jenner, Alexander Fleming andWaksman.	9
II	**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
III	**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
IV	**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
V	**Isolation and Control of Microbes:** Pure culture technique – Serial dilution and plating methods; cultivation, maintenance and preservation of pure cultures. Control of microorganisms: Physical agents – heat, radiation and filtration; Chemical agents and their mode of action – Aldehydes, halogens, Quaternary ammonium compounds, phenol and phenolic compounds, heavy metals, alcohol, detergents and surfactants; Antibiotics and their mode of action – Pencillin, streptomycin, tetracycline and chloramphenicol.	9
	TOTAL INSTRUCTIONAL HOURS	45

COURSE OUTCOMES

CO1 - Acquire knowledge on historical developments in microbiology.
CO2 - Classify and identify the structure of microorganisms
CO3 – Interpret the different types of microscopes and staining techniques
CO4 - Formulate media for microbial growth
CO5 - Identify the technique used for isolation and control of microorganisms

TEXT BOOKS:

1.Pelczar M.J., Chan E.C.S. and Krieg N.R., —Microbiologyl, McGraw Hill, New York, 2004.
2.Powar C.B. and Daginawala H.F., —General Microbiologyl, Volume I and II, Himalaya Publishing House, New Delhi, 2005.

REFERENCE BOOKS:

1.Wiley J., Sherwood L., and Woolverton C., —Prescott's Microbiologyl, McGraw Hill, New York, 2013.
2.Harvey R.A., Cornelissen C.N. and Fisher B.D., —Microbiologyl, 3rd Edition, Lippincott Williams &Wlakins, Philidelphia, 2013.
3.Black J.G., —Microbiology – Principles and Explorationsl, Wiley Publications, USA, 2008.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	21IT2151	PROGRAMMING IN C	2	0	2	3

Course Objectives

- To develop C Programs using Basic programming constructs
- To develop C programs using Arrays and Strings
- To develop applications in C using Functions , Pointers and Structures
- To do Input / Output and File handling in C
- To develop C Programs using Basic programming constructs

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Basics of C Programming** Structure of C program - C programming: Data Types –Keywords – Variables - Operators: Precedence and Associativity - Expressions – Input / Output statements Decision making statements - Looping statements – Pre-processor directives - Compilation process ***Programs using decision - making and Looping Constructs.***	5+4(P)
II	**Arrays And Strings** Introduction to Arrays: Declaration, Initialization – One dimensional array – Two dimensional arrays – String operations and String functions ***Programs Using Arrays and string functions.***	5+4(P)
III	**Functions And Pointers** Introduction to functions: Function prototype, function definition, function call - Parameter passing: Pass by value, Pass by reference – Recursion – Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers — Pointer to pointers – pointer to strings ***Programs Using Functions and Pointers***	5+4(P)
IV	**Structures and Unions** Structure - Nested structures – Pointer to Structures – Array of structures – Self-referential structures – Dynamic memory allocation – Typedef-Unions – Union of Structures ***Programs Using Structures and Unions.***	7+2(P)
V	**File Processing** Files – Types of file processing: Sequential access, Random access – Sequential access file - Random access file – Command line arguments ***Programs Using File concepts***	7+2(P)
	TOTAL INSTRUCTIONAL HOURS	45

COURSE OUTCOMES

CO1 - Select appropriate data types and control structures for solving a given problem.
CO2 - Develop applications using arrays and strings
CO3 - Understand the importance of functions, pointers and dynamic memory allocation.
CO4 - Understand the Concepts of structures to develop applications in C using

TEXT BOOKS:

1. E. Balagurusamy – "Programming in ANSI C", Tata McGraw Hill, 7th Edition,201. ISBN 13: 9789339219666
2. Reema Thareja, — "Programming in C", Oxford University Press, Second Edition, 2016. ISBN 9780199456147

REFERENCES:

1. Ashok.N.Kamthane, Raj Kamal ," Computer Programming and IT", Pearson Education (India),2012, ISBN -9788131799604
2. Paul Deitel and Harvey Deitel, —"C How to Program", Eighth edition,2012, Pearson Publication ISBN–9780132990448
3. Kernighan, B.W and Ritchie,D.M, —The C Programming language, Second Edition, Pearson Education, 2012
ISBN 13: 9789332549449
4. Yashavant P. Kane tkar. " Let Us C", BPB Publications, 15th Edition , July 201, ISBN-13:978-8183331630

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21PH2151	MATERIAL SCIENCE (COMMON TO ALL BRANCHES)	2	0	2	3

Course Objective

1. Acquire fundamental knowledge of semiconducting materials which is related to the
2. engineering program
3. Extend the knowledge about the magnetic materials
4. Explore the behavior of super conducting materials
5. Gain knowledge about Crystal systems
6. Understand the importance of ultrasonic waves

Unit	Description	Instructional Hours
I	**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. Optical properties of semiconductor – Light through optical fiber(Qualitative). Determination of band gap of a semiconductor Determination of acceptance angle and numerical aperature in an optical fiber	6 3 3
II	**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. B – H curve by Magnetic hysteresis experiment	6 3
III	**PERCONDUCTING MATERIALS** Superconductivity : properties(Messiner effect, effect of magnetic field, effect of current and isotope effects) – Type I and Type II superconductors – High Tc superconductors – Applications of superconductors –Cryotron and magnetic levitation.	6
IV	**CRYSTAL PHYSICS** Crystal systems - Bravais lattice - Lattice planes - Miller indices - Interplanar spacing in cubic lattice - Atomic radius, Coordination number and Packing factor for SC, BCC and FCC crystal structures.	6
V	**ULTRASONICS** Production – Magnetostrictive generator – Piezoelectric generator – Determination of velocity using acoustic grating – Cavitations – Viscous force – co-efficient of viscosity. Industrial applications – Drilling and welding – Non destructive testing – Ultrasonic pulse echo system. Determination of velocity of sound and compressibility of liquid – Ultrasonic wave Determination of Coefficient of viscosity of a liquid –Poiseuille's method	6 3 3
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the purpose of acceptor or donor levels and the band gap of a semiconductor

CO2: Interpret the basic idea behind the process of magnetism and its applications in everyday

CO3: Discuss the behavior of super conducting materials

CO4: Illustrate the types and importance of crystal systems

CO5: Evaluate the production of ultrasonics and its applications in NDT

TEXT BOOKS:

T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.

T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2015.

REFERENCE BOOKS:

R1 - Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill, New Delhi – 2015

R2 - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi 2016

R3 - Dr. G. Senthilkumar "Engineering Physics – II" VRB publishers Pvt Ltd., 2016

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21CY2151	ENVIRONMENTAL STUDIES (COMMON TO ALL BRANCHES)	2	0	2	3

Course Objectives

1. The importance of environmental education, ecosystem and biodiversity.
2. The knowledge about environmental pollution – sources, effects and control measures of environmental pollution.
3. The natural resources, exploitation and its conservation
4. Scientific, technological, economic and political solutions to environmental problems.
5. An awareness of the national and international concern for environment and its protection.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY** Main objectives and scope of environmental studies-Importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – food chain, food web and ecological pyramids - energy flow in the ecosystem – ecological succession processes - Introduction, types, characteristic features, structure and function of the forest and ponds ecosystem – Introduction to biodiversity definition: types and value of biodiversity – hot-spots of biodiversity – threats to biodiversity– endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.	6
II	**NATURAL RESOURCES** Renewable and Non renewable resources - Forest resources: Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forests and tribal people - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture – Energy resources: Renewable and non renewable energy sources – Solar energy and wind energy - role of an individual in conservation of natural resources.	6+9=15
III	**ENVIRONMENTAL POLLUTION** Definition – causes, effects and control measures of: Air pollution- Water pollution – Water quality parameters- Soil pollution - Noise pollution- Nuclear hazards – role of an individual in prevention of pollution. **Determination of Dissolved Oxygen in sewage water by Winkler's method. Estimation of alkalinity of water sample by indicator method. Determination of chloride content of water sample by argentometric method.**	6
IV	**SOCIAL ISSUES AND THE ENVIRONMENT** From unsustainable to sustainable development – urban problems related to energy-environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- Municipal solid waste management. Global issues – Climatic change, acid rain, greenhouse effect and ozone layer depletion – Disaster Management – Tsunami and cyclones. **Determination of pH in beverages.**	6+3=9
V	**HUMAN POPULATION AND THE ENVIRONMENT** Population growth, variation among nations – population explosion – family welfare programme – environment and human health – effect of heavy metals – 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. **Estimation of heavy metal ion (copper) in effluents by EDTA.**	6+3=9
	Total Instructional Hours	**45**

Course Outcome

CO1: Realise the importance of ecosystem and biodiversity for maintaining ecological balance.
CO2: Understand the causes of environmental pollution and hazards due to manmade activities.
CO3: Develop an understanding of different natural resources including renewable resources.
CO4: Demonstrate an appreciation for need for sustainable development and understand the various social issues and solutions to solve the issues.
CO5: Gain knowledge about the importance of women and child education and know about the existing technology to protect environment

TEXT BOOKS:

T1- S.Annadurai and P.N. Magudeswaran, "Environmental studies", Cengage Learning India Pvt.Ltd, Delhi, 2020

T2 – Anubha Kaushik and C. P. Kaushik, "Perspectives in Environmental studies", Sixth edition, New Age International Publishers, New Delhi, 2019.

REFERENCES:

R1 – Erach Bharucha, "Textbook of environmental studies" University Press (I) Pvt.ltd, Hyderabad, 2015

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

R3 - Gilbert M. Masters and Wendell P. Ela "Introduction to Environmental Engineering and Science", 3rd edition, Pearson Education, 2013.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21ME2001	ENGINEERING PRACTICES LAB	0	0	4	2

Course Objectives

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

S.No.	DESCRIPTION
	GROUP A (CIVIL & MECHANICAL)
1.	Preparation of Single pipe line and Double pipe line connection by using valves, taps, couplings, unions, reducers and elbows.
2.	Arrangement of bricks using English bond for 1brick thick wall and 11/2 brick thick wall for right angle corner junction.
3.	Arrangement of bricks using English bond for 1brick thick wall and 11/2 brick thick wall for T junction.
4.	Preparation of arc welding of Butt joints, Lap joints and Tee joints. structures.
5.	Practice on sheet metal Models– Trays and funnels
6.	Hands-on-exercise in wood work, joints by sawing, planning and cutting.
7.	Practice on simple step turning, taper turning and drilling.
8.	Demonstration on Smithy operation.
9.	Demonstration on Foundry operation.
10.	Demonstration on Power tools.

S.No.	DESCRIPTION
	GROUP B (ELECTRICAL)
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 single phase circuits.
5.	Measurement of energy using single phase energy meter.
6.	Soldering practice using general purpose PCB.
7.	Measurement of Time, Frequency and Peak Value of an Alternating Quantity using CRO and Function Generator.
8.	Study of Energy Efficient Equipment's and Measuring Instruments.

Total Instructional Hours 45

Upon completion of the course, students can be able to

Course Outcomes

- Fabricate wooden components and pipe connections including plumbing works.
- Fabricate simple weld joints.
- Fabricate different electrical wiring circuits and understand the AC Circuits.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21HE2071	LANGUAGE COMPETENCY ENHANCEMENT COURSE- II	0	0	2	1

(COMMON TO ALL BRANCHES)

Course Objective

- ✓ **To introduce to business communication.**
- ✓ **To train the students to react to different professional situations.**
- ✓ **To make the learner familiar with the managerial skills**
- ✓ **To empower the trainee in business writing skills.**
- ✓ **To learn to interpret and expertise different content.**

Unit	Description	Instructional Hours
I	**Listening and Speaking** – listening and discussing about programme and conference arrangement **Reading** –reading auto biographies of successful personalities **Writing** Formal & informal email writing, Recommendations **Grammar and Vocabulary-** Business vocabulary, Adjectives & adverbs.	3
II	**Listening and Speaking-** listening to TED talks **Reading-** Making and interpretation of posters **Writing-** Business letters: letters giving good and bad news, Thank you letter, Congratulating someone on a success" **Grammar and Vocabulary-** Active & passive voice, Spotting errors (Tenses, Preposition, Articles).	3
III	**Listening and Speaking-**travel arrangements and experience **Reading-** travel reviews **Writing-** Business letters (Placing an order, making clarification & complaint letters). **Grammar and Vocabulary-** Direct and Indirect speech.	3
IV	**Listening and Speaking-** Role play - **Reading-** Sequencing of sentence **Writing-** Business report writing (marketing, investigating) **Grammar and Vocabulary-** Connectors, Gerund & infinitive.	3
V	**Listening and Speaking-** Listen to Interviews & mock interview **Reading-** Reading short stories, reading profile of a company - **Writing-** Descriptive writing (describing one's own experience) **Grammar and Vocabulary-** Editing a passage(punctuation, spelling & number rules).	3
	Total Instructional Hours	**15**

Course Outcome

CO1- Introduced to different modes and types of business communication.
CO2- Practiced to face and react to various professional situations efficiently.
CO3- learnt to practice managerial skills.
CO4- Familiarized with proper guidance to business writing.
CO5- Trained to analyze and respond to different types of communication.

TEXT BOOKS:

T1 - Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate",Cambridge University Press, 2016.

T2- Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2015.

REFERENCE BOOKS :

R1 - Michael Mc Carthy, "Grammar for Business", Cambridge University Press, 2009.

R2- Bill Mascull, "Business Vocabulary in use: Advanced 2nd Edition", Cambridge University Press, 2009.

R3- Frederick T. Wood, "Remedial English Grammar For Foreign Students", Macmillan publishers, 2001.

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Course code	Name of the Course	L	T	P	C
21HE2072	CAREER GUIDANCE LEVEL II Personality, Aptitude and Career Development	2	0	0	0
Pre-requisite	None	Syllabus version 1			

Course Objectives:

- Solve Logical Reasoning questions of easy to intermediate level [SLO 6]
- Solve Quantitative Aptitude questions of easy to intermediate level [SLO 7]
- Solve Verbal Ability questions of easy to intermediate level [SLO 8]

Expected Course Outcome:

Enable students to solve questions on Verbal, Logical and Quantitative Aptitude of placement level

Student Learning Outcomes (SLO): 6, 7, 8

Module:1 Logical Reasoning **5 hours** **SLO:** 6

Word group categorization questions

Puzzle type class involving students grouping words into right group orders of logical sense

Cryptarithmetic

Data arrangements and Blood relations

- Linear Arrangement
- Circular Arrangement
- Multi-dimensional Arrangement
- Blood Relations

Module:2 Quantitative Aptitude **8 hours** **SLO:** 7

Ratio and Proportion

- Ratio
- Proportion
- Variation
- Simple equations
- Problems on Ages
- Mixtures and alligations

Percentages, Simple and Compound Interest

- Percentages as Fractions and Decimals
- Percentage Increase / Decrease
- Simple Interest
- Compound Interest
- Relation Between Simple and Compound Interest

Number System

- Number system
- Power cycle
- Remainder cycle
- Factors, Multiples
- HCF and LCM

Module:3 Verbal Ability **7 hours** **SLO:** 8

Essential grammar for placements

- Prepositions
- Adjectives and Adverbs
- Tenses
- Forms and Speech and Voice
- Idioms and Phrasal Verbs
- Collocations, Gerund and Infinitives

Reading Comprehension for placements

- Types of questions
- Comprehension strategies
- Practice exercises

Articles, Prepositions and Interrogatives

- Definite and Indefinite Articles
- Omission of Articles
- Prepositions
- Compound Prepositions and Prepositional Phrases
- Interrogatives

Vocabulary for placements

- Exposure to solving questions of
- Synonyms
- Antonyms
- Analogy
- Confusing words
- Spelling correctness

Total Lecture hours: 20 hours

Mode of Evaluation: Assignments, 3 Assessments with End Semester (Computer Based Test)

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	21HE2073	ENTREPRENEURSHIP & INNOVATION	1	0	0	0

Course Objectives

1. To acquire the knowledge and skills needed to manage the development of innovation.
2. To recognize and evaluate potential opportunities to monetize these innovations.
3. To plan specific and detailed method to exploit these opportunities.
4. To acquire the resources necessary to implement these plans.
5: To make students understand organizational performance and its importance.

Module	Description
1.	Entrepreneurial Thinking
2.	Innovation Management
3.	Design Thinking
4.	Opportunity Spotting / Opportunity Evaluation
5.	Industry and Market Research
6.	Innovation Strategy and Business Models
7.	Financial Forecasting
8.	Business Plans/ Business Model Canvas
9.	Entrepreneurial Finance
10.	Pitching to Resources Providers / Pitch Deck
11.	Negotiating Deals
12.	New Venture Creation
13.	Lean Start-ups
14.	Entrepreneurial Ecosystem
15.	Velocity Venture

Course Outcome

CO1: Understand the nature of business opportunities, resources, and industries in critical and creative aspects.
CO2: Understand the processes by which innovation is fostered, managed, and commercialized.
CO3: Remember effectively and efficiently the potential of new business opportunities.
CO4: Assess the market potential for a new venture, including customer need, competitors, and industry attractiveness..
CO5: Develop a business model for a new venture, including revenue, Margins, operations, working capital, and investment.

Module	Description
1.	**Entrepreneurial Thinking**
2.	**Innovation Management**
3.	**Design Thinking**
4.	**Opportunity Spotting / Opportunity Evaluation**
5.	**Industry and Market Research**
6.	**Innovation Strategy and Business Models**
7.	**Financial Forecasting**
8.	**Business Plans/ Business Model Canvas**
9.	**Entrepreneurial Finance**
10.	**Pitching to Resources Providers / Pitch Deck**
11.	**Negotiating Deals**
12.	**New Venture Creation**
13.	**Lean Start-ups**
14.	**Entrepreneurial Ecosystem**
15.	**Velocity Venture**

TEXT BOOKS

T1: Arya Kumar "Entrepreneurship – Creating and leading an Entrepreneurial Organization", Pearson, Second Edition (2012).

T2: Emrah Yayici "Design Thinking Methodology", Artbiztech, First Edition(2016).

REFERENCE BOOKS

R1: Christopher Golis "Enterprise & Venture Capital", Allen & Unwin Publication, Fourth Edition (2007).

R2: Thomas Lock Wood & Edger Papke "Innovation by Design", Career Press.com, Second Edition (2017).

R3: Jonathan Wilson "Essentials of Business Research", Sage Publication, First Edition (2010).

WEB RESOURCES

W1: https://blof.forgeforward.in/tagged/startup-lessons

W2: https://blof.forgeforward.in/tagged/entrepreurship

W3: https://blof.forgeforward.in/tagged/minimum-viable-product

W4: https://blof.forgeforward.in/tagged/minimum-viable-product

W5: https://blof.forgeforward.in/tagged/innovation

W6:https://www.youtube.com/watch?v=8vEyL7uKXs&list=PLmP9QrmTNPqBEvKbMSXvwlwn7fdnXe6Lw

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SYLLABUS

III SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19MA3102	FOURIER ANALYSIS AND TRANSFORMS (COMMON TO EEE, ECE, EIE, AGRI, BM & FT)	3	1	0	4

Course Objective

1. Analyze Fourier series which is central to many applications in engineering.
2. Apply the effective tools for the solutions of one dimensional boundary value problems.
3. Apply the effective tools for the solutions of two dimensional heat equations.
4. Apply Fourier transform techniques in various situations.
5. Analyze Z transform techniques for discrete time systems

Unit	Description	Instructional 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 (Statement only) – Parseval's identity(Statement only).	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 Outcome

CO1: Understand the principles of Fourier series which helps them to solve physical problems of engineering.
CO2: Employ Fourier series in solving the boundary value problems.
CO3: Understand Fourier series in solving the two dimensional heat equations.
CO4: ApplyFourier transform techniques which extend its applications.
CO5: Illustrate the Z- transforms for analyzing discrete-time signals and systems.

TEXT BOOKS:

T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018

T2 - Bali. N.P and Manish Goyal& Watkins, "Advanced Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007

REFERENCE BOOKS :

R1 - Veerarajan. T.,"Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., Second reprint, New Delhi, 2012.

R2 - Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, Delhi,2018.

R3 -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.	19FT3201	FLUID MECHANICS	3	1	0	4

Course Objectives

Understand the classification of fluids.
Understand the statements regarding fluid flow.
Understand the fluid flow through pores.
Understand the performance of pumps.
Understand the flow measuring devices and valves.

UNIT	DESCRIPTION	INSTRUCTIONAL 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 INSTRUCTIONAL HOURS	**60**

COURSE OUTCOMES

CO1 - Classify fluids, apply hydrostatic equilibrium and dimensional analysis in fluid flow behaviour
CO2 - Derive and apply basic equations of fluid flow
CO3 - Analyze fluid flow through porous media and select suitable mixing equipment used in food industries
CO4 - Select and evaluate the performance of pumps
CO5 - 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 Engineeringl, 7th Edition, McGraw Hill, New York, 2017.
2. Gavhane K.A., —Unit Operations – I, 8th Edition, Nirali Prakashan 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.
Coulson & Richardson's Chemical Engineering. 5th edition, vol. 2. Elsevier, 2006.
3. Cengel, Yunus and Cimbala John M., —Fluid Mechanics Fundamentals and Applicationsl, 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.	19FT3101	PRINCIPLES OF THERMODYNAMICS	3	0	0	3

Course Objectives

Understand the basic concepts.
Understand the principles of thermodynamics law.
Understand the relationship of pure substance.
Understand the properties of steam.
Understand the mechanism of boiler.

UNIT	DESCRIPTION	INSTRUCTIONAL 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.	12
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.	12
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, Redllich Kwong equation, Virial equation of state. Principle of corresponding states – generalized compressibility charts.	12
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.	12
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.	12
	TOTAL INSTRUCTIONAL HOURS	**60**

COURSE OUTCOMES

CO1 - Outline the basic concepts and apply the first law of thermodynamics in selected processes
CO2 - Understand the principle of second law of thermodynamics and concepts of Carnot cycle
CO3 - Interpret the second law of thermodynamics and relate the properties of pure substance
CO4 - Estimate the properties of steam and measurement of quality of steam using calorimeters
CO5 - 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.	19FT3202	FOOD MICROBIOLOGY	3	0	0	3

Course Objectives

Understand the basic concepts.
Understand the principles of thermodynamics law.
Understand the relationship of pure substance.
Understand the properties of steam.
Understand the mechanism of boiler.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**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.	9
II	**Microbial Load Assessment:** Sampling methods, SPC, MPN, spiral platter, DEFT, microcolony HGMF, DMC, Dye reduction, swab/swab-rinse method, impedance, microcalorimetry, flow cytometry, ATP measurement, PCR, Fluorescent antibody, RIA, ELISA.	9
III	**Fermented Foods:** Fermentation– Introduction, batch, fed batch and continuous fermentation. Fermented foods – Sauerkraut, Cheese, Beer, Vinegar and Tempeh. Single cell protein – Introduction, nutritive value, advantages over plant and animal proteins. Production process – BEL, SYMBA, PEKILO, BIOPROTEIN, QUORN and PRUTEEN process. Probiotics.	9
IV	**Microbial Spoilage:** principles and types of spoilage, microbial spoilage of different types of foods–fruits and vegetables, meat, poultry, sea foods, cereals products, bakery products, dairy products, fermented foods and canned foods.	9
V	**Food Borne Diseases and Quality Control:** Gastroenteritis, Listeriosis, Salmonellosis, Shigellosis, Vibriosis, Campylobacteriosis. Food toxins – Aflatoxin and Botulin. Food sanitation – indicators of food safety, Coliform bacteria. Food processing plant sanitation. Microbiological standards and guidelines –Microbiological criteria for foods. Enforcement and control agencies.	9
	TOTAL INSTRUCTIONAL HOURS	**45**

COURSE OUTCOMES

CO1 - Recognize the sources and factors influencing the microbial growth
CO2 - Identify the techniques used to assess the microbial load and
CO3 - Apply the knowledge of microorganism in fermentation process
CO4 - Interpret microbial spoilage of different foods
CO5 - Distinguish food borne diseases and intoxication caused by microorganisms

TEXT BOOKS

1. Frazier W.C., Westhoff D.C. and Vanitha N.M., —Food Microbiologyl, 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2014.
2. Jay J.M., —Modern Food Microbiologyl, 6th Edition, Aspen Publications, Maryland, USA, 2000.

REFERENCE BOOKS

1. Adams M.R. and Moss M.O., —Food Microbiologyl, RSC Publishing, 2008.
2. Ray B. and Bhunia A., —Fundamental Food Microbiologyl, 5thEdition, CRC Press, 2013.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19FT3251	BIOCHEMISTRY	2	0	2	3

Course Objectives

To study the structure and properties of carbohydrates
To understand the structure and properties of lipids
To know the structural and functional role of proteins
To have an idea about classification of the enzymes and interpret the enzyme action and their immobilization
To learn the structure of nucleic acids and illustrate the basics of energy metabolism

UNIT	DESCRIPTION	INTRUCTIONAL HOURS
I	**Carbohydrates:** Classification; Simple Sugars: mono and disaccharides, Hygroscopicity and solubility, optical rotation, mutarotation; Sweetness: structure-activity relationship and sweetness index; Dextrose Equivalent, Degree of polymerisation; Sugar alcohols; Oligosaccharides: structure and occurrence. Polysaccharides: Starch-amylose and amylopectin- properties. Cellulose. Pectins, gums and seaweeds – structure & properties. Dietary fibres - Food sources, functional role and uses in foods. **Qualitative tests for monosaccharide, disaccharides, polysaccharides. Estimation of reducing sugar by dinitrosalicylic acid method. Estimation of starch by anthrone method**	9+6=15
II	**Lipids**: Structure, classification and composition of fats. Physical properties of fats and oils: crystal formation, polymorphism, melting point, plasticity, radiolysis. Shortening power of fats, emulsification, smoke point and polymerization. Chemical properties of fats – Hydrolysis, saponification, halogenation. Hydrolytic rancidity and oxidative rancidity. **Extraction and estimation of oil content**	9+2=11
III	**Proteins:** Amino acids - Definition, structure and classification. Protein - structure and conformation, Food sources and biological role. Properties of proteins in food systems: Dissociation, optical activity, solubility, hydration, swelling, foam formation and stabilization, gel formation, emulsifying effect. Denaturation. **Estimation of protein by biuret method, Lowry and Bradford.**	9+5=14
IV	**Enzymes as food processing aids:** Introduction, Nature, classification and nomenclature of enzymes. Specificity. Enzyme kinetics – Michelis - Menten equation, Factors affecting enzyme action, mechanism of enzyme action; active site. Immobilization methods. **Enzyme activity – phosphatase enzyme.**	9+2=11
V	**Nucleic Acids:** Composition and structure of DNA and RNA. **Metabolism**: Metabolism - Glycolysis; TCA cycle; substrate level phosphorylation. Protein metabolism – urea cycle. Cellular respiration - electron transport chain. Lipid metabolism – lipases and phospholipases. Fatty acid metabolism – beta oxidation and fatty acid synthesis. Inter relationship of metabolic pathways.	9
	TOTAL INTRUCTIONAL HOURS	**45+15=60**

COURSE OUTCOMES

Interpret the structure and properties of carbohydrates
Recall the structure and properties of lipids
Recognize the structural and functional role of proteins
Classify the enzymes and interpret the enzyme action and their immobilization
Infer the structure of nucleic acids and illustrate the basics of energy metabolism

TEXT BOOKS

1. Belitz H. D., Grosch W., andSchieberle P., —Food Chemistryl, 3rd Edition, Springer Verley.Berlin, 2008.
2. Jain J.L., Sunjay Jain and Nitin Jain, —Fundamentals of Biochemistryl, S. Chand & Co., NewDelhi, 2008.

REFERENCE BOOKS

1. Rastogi S.C., —Biochemistryl, 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2010.
2. Finley, John W., W. Jeffrey Hurst, and Chang Yong Lee. *Principles of food chemistry*. Springer, 2018.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19FT3001	FOOD MICROBIOLOGY LAB	0	0	3	1.5

COURSE OBJECTIVES

- Expose various microbial aspects of Food Processing
- Impart knowledge on identification of microbes using different technique and its enumeration methods
- Recognize the role of microbes in Food spoilage and preservation

UNIT	LIST OF EXPERIMENTS
I	Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques; Culture Media- Types and Use; Preparation of Nutrient broth and agar
II	Culture Techniques, Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
III	Microscopy – Working and care of Microscope; Microscopic Methods in the Study of Microorganisms; Staining Techniques- Simple, Differential- Gram's Staining
IV	Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in food products TVC
V	Microbiological Quality of Water (MPN)
VI	Microbiological quality of milk
VII	Enumeration of Lactic acid bacteria from fermented foods
VIII	Yeast & Mould count from fruits
IX	Enumeration of spores from pepper
X	Inhibitory effect of spices on microbial load in fish & flesh foods
XI	Enumeration & Isolation of *E. coli* from processed meat/chicken
XII	Thermal destruction of microbes: TDT & TDP
XIII	Enumeration & Isolation of Staphylococci from ready to eat street foods
XIV	Effect of cleaning and disinfection on microbial load

TOTAL WORKING HOURS: 45

COURSE OUTCOMES

CO1 - Complete understanding of isolation, characterization of various microbes associated with foods and food groups.
CO2 - Familiarize with microbiological techniques for the study of foods.
CO3 - Better understanding of methods to detect pathogens in foods.
CO4 - Inoculate, isolate and identify the microorganism from both liquid and solid samples
CO5 - Select the appropriate equipment for Microbiological works

REFERENCES

1. Yousef A.E. and Carlstrom C., —Food Microbiology: A Laboratory Manuall, Wiley Interscience Publications, 2003.
2. McLandsborough L., —Food Microbiology Laboratoryl, CRC Press, 2004.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19FT3002	FOOD PRODUCTION ANALYSIS LAB	0	0	3	1.5

COURSE OBJECTIVES

- Provide knowledge on food quality standards
- Understand role of food additives and their permissible limits
- Know food laws of India for consumer as well as industry

UNIT	LIST OF EXPERIMENTS
I	Studying the expansion characteristics of snack foods on frying.
II	Rancidity test for fried foods to assess primary and secondary oxidative products.
III	Determination of Vitamin C in fruit juices.
IV	Estimation of synthetic Food color in sweets, confectioneries and beverages.
V	Determination of Iron content in foods.
VI	Determination of Iodine content in iodized salt
VII	Detection of Annatto color in table butter.
VIII	Determination of Lead in spices powder.
IX	Detection of added MSG in foods.
X	Detection of sulphur-di-oxide in foods.
XI	Detection of anti-oxidant in foods.
XII	Detection of certain emulsifiers and stabilizers in foods

COURSE OUTCOMES

CO1 - Analyze the additives present in food
CO2 - Familiarize with the nutrients after processing
CO3 - Better understanding of processed foods with compliance to standards
CO4 - Demonstrate simple detection methods of food adulteration
CO5 - Implement the hygienic practices in food processing industry

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" 2nd Rev. Edition. Vol. I, II & III, Marcel & Dekker, 2004.
3. Nollet, Leo M.L. " Food Analysis by HPLC". 2nd 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.	19MC3191	INDIAN CONSTITUTION	2	0	0	0

COURSE OBJECTIVES

1. Sensitization of student towards self, family (relationship), society and nature.
2. Understanding (or developing clarity) of nature, society and larger systems, on the basis of human relationships and resolved individuals.
3. Strengthening of self reflection.
4. Development of commitment and courage to act.

UNIT	DESCRIPTIVE	INSTRUCTIONAL HOURS
UNIT I :	BASIC FEATURES AND FUNDAMENTALE PRINCIPLES	4

Meaning of the constitution law and constitutionalism – Historical perspective of the constitution of India – salient features and characteristics of the constitution of India.

UNIT II : FUNDAMENTAL RIGHTS 4

Scheme of the fundamental rights – fundamental duties and its legislative status – The directive principles of state policy – its importance and implementation - Federal structure and distribution of legislative and financial powers between the union and states.

UNIT III : PARLIAMENTARY FORM OF GOVERNMENT 4

The constitution powers and the status of the president in India. – Amendment of the constitutional powers and procedures – The historical perspective of the constitutional amendment of India – Emergency provisions : National emergency, President rule, Financial emergency.

UNIT IV: LOCAL GOVERNANCE 4

Local self government -constitutional scheme of India – Scheme of fundamental right to equality – scheme of fundamental right to certain freedom under article19 – scope of the right to life and personal liberty under article 21.

UNIT V: INDIAN SOCIETY 4

Constitutional Remedies for citizens – Political Parties and Pressure Groups: Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.

TOTAL INSTRUCTIONAL HOURS: 20

OUTCOMES:

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

1. Understand the history of Indian Constitution.
2. Understand the fundamental rights and amendment of Government.
3. Understand the functions of the Indian government.
4. Understand and abide the rules of the Indian constitution.
5. Understand the various constitutional schemes of Indian government.

TEXT BOOKS:

T1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.
T2. R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.
T3. Maciver and Page, "Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.
T4. K.L.Sharma, (1997) "Social Stratification in India: Issues and Themes", Jawaharlal Nehru University, New Delhi.

REFERENCE BOOKS:

R1. Sharma, Brij Kishore, "Introduction to the Constitution of India: Prentice Hall of India, New Delhi.
R2. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.
R3. R.N. Sharma, "Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19HE3072	CAREER GUIDANCE LEVEL - III Personality, Aptitude and Career Development	2	0	0	0
Pre-requisite		None	Syllabus version 1			

Course Objectives:

- Solve Logical Reasoning questions of easy to intermediate level [SLO 6]
- Solve Quantitative Aptitude questions of easy to intermediate level [SLO 7]
- Solve Verbal Ability questions of easy to intermediate level [SLO 8]
- Display good writing skills while dealing with essays [SLO 12]

Expected Course Outcome:

Enable students to solve Aptitude questions of placement level with ease, as well as write effective essays.

Student Learning Outcomes (SLO): 6, 7, 8, 12

Module:1 Logical Reasoning **6 hours** **SLO:6**

Clocks, calendars, Direction sense and Cubes

- Clocks
- Calendars
- Direction Sense
- Cubes

Data interpretation and Data sufficiency

- Data Interpretation – Tables
- Data Interpretation - Pie Chart
- Data Interpretation - Bar Graph
- Data Sufficiency

Module:2 Quantitative Aptitude **7 hours** **SLO: 7**

Time and work

- Work with different efficiencies
- Pipes and cisterns
- Work equivalence
- Division of wages

Time, Speed and Distance

- Basics of time, speed and distance
- Relative speed
- Problems based on trains
- Problems based on boats and streams
- Problems based on races

Profit and loss, Partnerships and averages

- Basic terminologies in profit and loss
- Partnership
- Averages
- Weighted average

Module:3 Verbal Ability **5 hours** **SLO: 8**

Sentence Correction

- Subject-Verb Agreement
- Modifiers
- Parallelism

- Pronoun-Antecedent Agreement
- Verb Time Sequences
- Comparisons
- Prepositions
- Determiners

Sentence Completion and Para-jumbles

- Pro-active thinking
- Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues)
- Fixed jumbles
- Anchored jumbles

Module:4 Writing skills for placements **2 hours** **SLO:** 12

Essay writing

- Idea generation for topics
- Best practices
- Practice and feedback

Total Lecture hours: 20 hours

Mode of Evaluation: Assignments, 3 Assessments with End Semester (Computer Based Test)

Recommended by Board of Studies

Approved by Academic Council Date

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Programme	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.TECH.	19HE3073	LEADERSHIP MANAGEMENT SKILLS	1	0	0	0

Course Objectives

1. To know about the leadership skills that is to be acquired for success.
2. To become a teamwork expert, real world problem solver, your views will be challenged
3. To gain global perspective and becoming an effective communicator
4. To understand about learning, negotiation and decision making
5: To get first hand information about the skills we possess and to work on improvement.

Module	Description	Instructional Hours
1.	Strategic thinking skills	
2.	Planning and Delivery skills	
3.	People management skills (Delegation)	
4.	Change management and Innovation skills	
5.	Communication skills	
6.	Persuasion and influencing skills	
7.	Learning Agility	
8.	Motivation	
9.	Personality	
10.	Emotions	
11.	Perception	
12.	Negotiation	
13.	Decision making	
14.	Problem solving	
15.	Building trust	
	Total Instructional Hours	**15**

Course Outcome

CO1: To practice essential leadership skills in day to day operations
CO2: To work on leadership skills in the study environment
CO3: To understand and develop the skills consciously.
CO4: To know about the real worth of all the skills for success
CO5: To Analyze the real worth of the person and suggestion for improvement

TEXT BOOKS

T1: A REVIEW OF LEADERSHIP THEORY AND COMPETENCY FRAMEWORKS, Bolden, R., Gosling, J., Marturano, A. and Dennison, P. June 2003
T2: LEADING FROM WITHIN: Building Organizational Leadership Capacity-David R. Kolzow, PhD, 2014

REFERENCE BOOKS

R1: Seven habits of highly effective people – Stephen R.Covey
R2: The Art of Business Leadership: Indian Experiences – G.Balasubramaniam
R3: DEVELOPING the LEADER WITHIN YOU-JOHN C. MAXWELL

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IV SEMESTER

Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19FT4201R	FUNDAMENTALS OF HEAT AND MASS TRANSFER	3	1	0	4

Course Objectives

To understand and apply the principles in heat transfer phenomena
To understand and apply the principles in mass transfer phenomena
To design heat and mass transfer equipments.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**Heat Transfer – Conduction:** Introduction to unsteady state heat transfer by conduction and transient flow. Basic transfer processes – heat, mass and momentum – heat transfer process - conductors and insulators – Steady state - 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:** Newton Rikhman'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 – shape factor - 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. Concept of mass transfer coefficients, Interphase mass transfer and over all mass transfer coefficients in binary systems.	12
	TOTAL INSTRUCTIONAL HOURS	**60**

COURSE OUTCOMES

CO1 - Understanding the concept of steady state and unsteady state and application of Fourier law of conduction
CO2 - Understanding free and forced convection and application of Newtons law of cooling
CO3 - Understanding the different types of heat exchangers and its application
CO4 - Understand and apply the concepts of radiation and Stephan boltzman's law
CO5 - Understand the mass transfer phenomena using Fick's law of molecular diffusion

TEXT BOOKS:

1. Bellaney, P.L. "Thermal Engineering". Khanna Publishers, New Delhi, 2001
2. Geankoplis C.J. "Transport Process and Unit Operations". Prentice-Hall of India Private Limited, New Delhi, 1999

REFERENCES:

1. Jacob and Hawkins. "Elements of Heat Transfer".John Willey and Sons Inc. New York, 1983
2. EcKert, E.R.G. "Heat and Mass Transfer". McGraw Hill Book Co., New York, 1981
3. Holman, E.P. "Heat Transfer". McGraw-Hill Publishing Co. New Delhi, 2001
4. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th Edition, Vol. I & II, Butterworth – Heinman (an imprint of Elsevier), 2004.
5. 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.	19FT4203R	ENGINEERING PROPERTIES OF FOOD MATERIALS	3	0	0	3

Course Objectives

- To interpret the physical properties of agricultural materials
- To elaborate the thermal properties and its application
- To outline the optical and electromagnetic properties
- To recognize the rheological properties of food materials
- To infer textural properties and color measurements of food materials

UNIT	DESCRIPTION	INSTRUCTIONAL 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_s refractometer, 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. Applications of rheological properties in food processing.	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. Applications of textural properties in food processing.	9
	TOTAL INSTRUCTIONAL HOURS	45

COURSE OUTCOMES

CO1 - Interpret the physical properties of agricultural materials
CO2 - Elaborate the thermal properties and its application
CO3 - Outline the optical and electromagnetic properties
CO4 - Recognize the rheological properties of food materials
CO5 - Infer textural properties and color measurements of food materials

TEXT BOOKS:

1. Rao M. A. and Rizvi S.S.H., —Engineering Properties of Foodsl, Mercel Dekker Inc., New York, 1998.
2. Mohesnin N.N., —Physical Properties of Plant and Animal Materialsl, Volume I, Gordon and Breach Science Publishers, New York, 1970.

REFERENCE BOOKS:

1. Stroshine R., —Physical Properties of Agricultural Materials and Food Productsl, West Lafayette, IN., Purdue University, 2000.
2. Mathur D.S., —Properties of Matterl, S. Chand & Co, New Delhi, 1997.
3. Singh R. Paul and Heldman Dennis R., —Introduction to Food Engineeringl, 3rd Edition, Gulf Publishing USA, 2001.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT4204	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 – Eco friendly refrigerants. Ozone depletion potential. Reversed Carnot cycle. Limitations of reversed Carnot systems. Psychrometry-terms-psychrometric chart- sensible heating- sensible cooling process -by-pass factor-	9
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.	9
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	9
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.	9
V	**COLD CHAIN:** Introduction, Components of cold chain. Refrigerated Transport, Handling and Distribution – refrigerated vans (reefer vans), 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.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1-I 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-Hill Publishing 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. Roy J. Dossat, Principles of Refrigeration, Pearson Education Asia, 4th Edition, 2009.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19FT4251	FOOD CHEMISTRY	2	0	2	3

COURSE OBJECTIVES

- To interpret the nutritional importance of foods and water
- To summarize the nutritional importance of vitamins and minerals
- To recognize the changes in food components during cooking, processing and storage
- To modify the carbohydrates, proteins and fats based on its functional properties
- To apply the different methods of food preservation

UNIT	DESCRIPTION	INSTRUCTIONAL 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, RecommendedDietary 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 fatsoluble vitamins, sources, functions and deficiency symptoms. Extraction and estimation of polyphenolsExtraction and estimation of flavonoids.	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 retrogradation of starch, proteins and lipids; parboiling of rice; enzymatic browning reactions; nonenzymatic browning reactions - caramelization, Maillard reaction. **Estimation of non-enzymatic browning in foods. Isolation of protein from milk and egg.**	9+5=14
IV	**Modification of Biomolecules:** Modified starches, resistant starch. Starch hydrolysates – Maltodextrins and dextrins. Modification of proteins – chemical and enzymatic methods. Modificationof fats - Hydrogenation - cis and trans isomers, interesterification, winterization. Biochemical changesduring processing of foods - pickling, malting, drying and baking. **Determination of peroxide value of oil. Determination of TBA value of oil.**	9+5=14
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. **Extraction and estimation of chlorophyll. Extraction and estimation of carotenoids and lycopene**	9+5=14
	TOTAL INSTRUCTIONAL HOURS	**45+15=60**

COURSE OUTCOMES

CO1- Interpret the nutritional importance of foods and water
CO2 - Summarize the nutritional importance of vitamins and minerals
CO3 - Recognize the changes in food components during cooking, processing and storage
CO4 - Modify the carbohydrates, proteins and fats based on its functional properties
CO5 - Apply the different methods of food preservation

TEXT BOOKS

1. Belitz H.D., Grosch W. and Schieberle P., —Food Chemistryl, 3rd Edition, Springer-Verley, Berlin, 2004
2. Sivasankar B., —Food Processing and Preservationl, Prentice Hall of India, New Delhi, 2005.

REFERENCE BOOKS

1. Fennema, Owen R., Srinivasan Damodaran, and Kirk L. Parkin. "Introduction to food chemis In Fennema's Food Chemistry, Fifth Edition, pp. 1-16. CRC Press, 2017.
2. Srilakshmi B., —Nutrition Sciencel, 3rd Edition, New Age International Ltd., New Delhi, 2011.
3. Damodaran, Srinivasan, and Kirk L. Parkin. Fennema's food chemistry. CRC press, 2017.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19MA4152	STATISTICS & NUMERICAL METHODS	3	0	2	4

Course Objectives

- To illustrate the relation between two random variables by using correlation concepts along with R studio
- To employ some basic concepts of statistical methods for testing the hypothesis together with R studio.
- To analyze the design of experiment techniques to solve various engineering problems accompanying with R studio
- To apply various methods to find the intermediate values for the given data
- To explain concepts of numerical differentiation and numerical integration of the unknown functions.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**CORRELATION AND REGRESSION** Correlation – Karl Pearson's correlation coefficient – Spearman's Rank Correlation – Regression lines(problems based on Raw data only). **Introduction to R programming ,Applications of Correlation and Regression**	9+3
II	**HYPOTHESIS TESTING** Tests based on t (for single mean and difference of means) - F distribution – for testing difference of variance, Chi – Square test for Contingency table (Test for Independency) – Goodness of fit **Application of F test, Application of Chi – square test**	9+6
III	**ANALYSIS OF VARIANCE** Introduction, analysis of variance, completely randomized design, randomized block design, Latin square design. **ANOVA – completely randomized design** **ANOVA – randomized block design**	9+3
IV	**INTERPOLATION** Interpolation: Newton's forward and backward difference formulae Lagrangian interpolation for unequal intervals – Divided differences-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 rules.	9
	TOTAL INSTRUCTIONAL HOURS	**45+15=60**

COURSE OUTCOMES

CO1- Compute correlation and predict unknown values using regression together with R studio.
CO2 - Understand the concepts of statistical methods for testing the hypothesis along with R studio.
CO3 - Apply Design of Experiment techniques to solve various engineering problems in addition with R studio.
CO4 - Understand the concept of interpolation in both cases of equal and unequal intervals.
CO5 - Identify various methods to perform numerical differentiation and integration.

TEXT BOOKS:

T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd.,New Delhi,2018.
T2 - Medhi J," stochastic Processes", New Age International Publishers,New Delhi,2014

REFERENCE BOOKS :

1. R1 - 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. R2 - Grewal B.S. and Grewal J.S. "Numerical Methods in Engineering and Science ", 6thEdition , Khanna

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19FT4001	UNIT OPERATIONS LABORATORY	0	0	3	1.5

Course Objectives

- To impart the knowledge on heat and mass transfer phenomena
- To provide the knowledge on performance of pipes, valves and other accessories
- To demonstrate the principles of free and forced convection

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

COURSE OUTCOMES

CO1 Evaluate the process/performance parameters for mass transfer operations (distillation column, leaching)

CO2 Determine diffusivity and Stefan Boltzman constant using fundamental principles

CO3 Calculate the individual and overall heat transfer coefficient of heat exchangers

CO4 Determine the discharge coefficient using variable area flow meters and variable head flow meters

CO5 Assess the flow of fluids through closed conduits, open channels, valves and pipe fitting

REFERENCES:

R1. McCabe W.L., Smith J.C. and Harriot P., —Unit Operations of Chemical Engineeringl, 7th Edition, McGraw Hill, New York, 2005.

R2. Perry Robert, —Perry's Chemical Engineers Hand Bookl, 8th Edition, McGraw Hill, New York, 2007.

Treybal R.E., —Mass Transfer Operationsl, 3rd Edition, McGraw Hill, New York, 1981.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19FT4002	FOOD PROCESS EQUIPMENT DESIGN LABORATORY	0	0	3	1.5

Course Objectives

- Impart knowledge on basic principles of designing equipment for food processing
- Become familiar with design and manufacture of storage tanks, pulpers, heat exchangers, driers etc.
- Provide an idea about devising cold storage units, freezers etc.

LIST OF EXPERIMENTS:

1. Studies of symbols and materials used for design and drawing
2. Design of a pressure vessel
3. Design and drawing of storage tanks
4. Design of an extruder
5. Design of a sterilizer
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 tray dryer
10. Design and drawing of freeze dryer
11. Design and drawing of spray drier
12. Design and drawing of belt conveyor

COURSE OUTCOMES	CO1 Adapt symbols in plant layout and design CO2 Design pipes, process vessels and supports CO3 Design heat transfer equipments and dryers CO4 Apply and design different drying equipments for food products CO5 Understand, apply and design conveying equipments to transfer agriculture produce

REFERENCES:

R1. Joshi M.V. and Mahajan V.V., —Process Equipment Designl, 4th Edition, MacMillan India, New Delhi, 2009.
R2. Dawande S.D., —Process Equipment Design Volume 1 and 2l, 5th Edition, Denett and Company, India, 2015.
R3. Perry R.H. and Green D.W., —Chemical Engineers Handbookl, 8th Edition, McGraw-Hill, New York, 2007.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	19MC4191	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE/VALUE EDUCATION	2	0	0	0

Course Objectives:

1) The course aims at imparting basic principles of thought process, reasoning and inferencing.
2) Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature.
3) Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions.
4) The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view, basic principles of Yoga and holistic health care system, Indian philosophical traditions,Indian linguistic tradition and Indian artistic tradition.

UNIT	DESCRIPTIVE	INSTRUCTIONAL HOURS
UNIT I :	Basic Structure of Indian Knowledge System	4
UNIT II :	Modern Science and Indian Knowledge System	4
UNIT III :	Yoga and Holistic Health care	4
UNIT IV :	Philosophical tradition	4
UNIT V:	Indian linguistic tradition (Phonology, Morphology, Syntax and semantics), Indian artistic tradition and Case Studies.	4

TOTAL INSTRUCTIONAL HOURS: 20

Course Outcomes:

1) Ability to understand the structure of Indian system of life.
2) Connect up and explain basics of Indian Traditional knowledge in modern scientific perspective.
3) Understanding the holistic life style of yoga.
4) Understanding the tradition of philosophy.
5) Understanding the Indian linguistic and artistic tradition.

REFERENCE BOOKS:

R1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014
R2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan
R3. Fritzof Capra, Tao of Physics
R4. Fritzof Capra, The wave of Life.
R5. V N Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation, Velliarnad, Amaku,am
R6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta.
R7. GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi, 2016.
R8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakasham, Delhi, 2016.
R9. P R Sharma (English translation), Shodashang Hridayam.

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Programme	Course code	Course title	L	T	P	C
B.TECH.	19HE4072	CAREER GUIDANCE LEVEL IV Personality, Aptitude and Career Development	2	0	0	0
Pre-requisite		None	Syllabus version 1			

Course Objectives:

- Solve Logical Reasoning questions of easy to intermediate level [SLO 6]
- Solve Quantitative Aptitude questions of easy to intermediate level [SLO 7]
- Solve Verbal Ability questions of easy to intermediate level [SLO 8]
- Crack mock interviews with ease [SLO 13]
- Be introduced to problem-solving techniques and algorithms [SLO 14]

Expected Course Outcome:

Enable students to solve Aptitude questions of placement level with ease, as well as write effective essays.

Student Learning Outcomes (SLO): 6, 7, 8, 13, 14

Module:1 Logical Reasoning **3 hours** **SLO:**6

Logical connectives, Syllogism and Venn diagrams

- Logical Connectives
- Syllogisms
- Venn Diagrams – Interpretation
- Venn Diagrams - Solving

Module:2 Quantitative Aptitude **6 hours** **SLO:** 7

Logarithms, Progressions, Geometry and Quadratic equations

- Logarithm
- Arithmetic Progression
- Geometric Progression
- Geometry
- Mensuration
- Coded inequalities
- Quadratic Equations

Permutation, Combination and Probability

- Fundamental Counting Principle
- Permutation and Combination
- Computation of Permutation
- Circular Permutations
- Computation of Combination
- Probability

Module:3 Verbal Ability **2 hours** **SLO:** 8

Critical Reasoning

- Argument – Identifying the Different Parts (Premise, assumption, conclusion)
- Strengthening statement
- Weakening statement
- Mimic the pattern

Module:4 Recruitment Essentials **1 hour** **SLO:** 12

Cracking interviews - demonstration through a few mocks

Sample mock interviews to demonstrate how to crack the:

- HR interview
- MR interview
- Technical interview

Cracking other kinds of interviews

- Skype/ Telephonic interviews
- Panel interviews
- Stress interviews

Resume building – workshop

A workshop to make students write an accurate resume

Module:5 **Problem solving and Algorithmic skills** **8 hours** **SLO:** 12

- Logical methods to solve problem statements in Programming
- Basic algorithms introduced

Total Lecture hours: 20 hours

Mode of Evaluation: Assignments, Mock interviews, 3 Assessments with End Semester (Computer Based Test)

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19HE4073	IDEATION SKILLS	1	0	0	0

Course Objective

- To study the importance of ideation.
- To learn about the various tools for Ideation.
- To provide an insight in Prototyping and its significance.

Unit	Description	Instructional Hours
	IDEATION: INTRODUCTION TO DESIGN THINKING METHODOLOGY	
I	Design Thinking Methodology and how it can be used as a powerful tool for developing new and innovative solutions - Inspiration – Implementation - Disruptive technology.	4
	IDEATION: TOOLS FOR IDEATION	
II	Various resources to kindle new ideas for innovation. Explore the types of ideas in the past – Effect of the ideas and innovation of past on the world – Innovation Thinking – Case studies.	4
	IDEATION: INTRODUCTION TO CUSTOMER DISCOVERY	
III	Intro to Customer Discovery - development of customer discovery plan that can lead to powerful business innovation - Customer Discovery Plan	4
	PROTOTYPING AND PRODUCT IDEATION	
IV	Introduction to Prototyping - minimum viable product - High fidelity prototype vs low fidelity prototype – Prototyping tools	3
	Total Instructional Hours	**15**

Course Outcome

Upon completion of the course, students will be able to
CO1: Develop a strong understanding and importance of ideation
CO2: Learn about the different kinds of tools for Ideation.
CO3: Learn the need and significance of prototyping and its significance.

TEXT BOOKS:

T1 - Mark Baskinger and William Bardel, "Drawing Ideas: A Hand-Drawn Approach for Better Design",2013
T2 - Nigel Cross, "Design Thinking", Kindle Edition

REFERENCE BOOKS:

R1 - Kurt Hanks and Larry Belliston, "Rapid Viz : A New Method for the Rapid Visualitzation of Ideas", 2008.
R2 - Kathryn McElroy , "Prototyping for Designers: Developing the Best Digital and Physical Products", 2017.

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V SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5201	BAKING AND CONFECTIONERY TECHNOLOGY	3	0	0	3

Course Objectives

- To understand and remember the technology of baking and confectionery
- To understand the important role of essential ingredients in baking
- To analyze the different uses of bakery equipments
- To understand the production process of bakery products
- To apply and analyze the different methods of confectionery production

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 IN BAKERY TECHNOLOGY:** 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	**BAKERY PRODUCT PREPARATION I:** 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 PREPARATION II:** 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 recrystallization 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 pretreatment 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- Apply the principles of baking and analyze the role of ingredients in baking
CO2- Illustrate and analyze the processing parameters of baking machineries
CO3- Understand the processing of bread and applying on the production process
CO4 -Understand the role of ingredients in bakery products
CO5 - Apply the production process for different types of 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.	19FT5202	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- To understand the principles of chemical preservation of foods

CO2- To understand the role of different food additives in the processing of different foods

CO3- To know the specific functions of different food additives in improving the shelf life, quality, texture and other physical and sensory characteristics of foods

CO4- To expose the different food additives in improving the physical and sensory characteristics of foods

CO5- To know the regulations and the monitoring agencies involved in controlling the safer use of additives in foods

TEXT BOOKS:

1.Lal and Siddappa., "*Fruit and Vegetable preservation*", ICMR 1986.

2. ManoranjanKalia and Sangita, "*Food preservation and processing*". Kalyani Publishers. Ludhiana 1996.

REFERENCES BOOKS:

1.Fellows, P.J, "*Food Processing Technology*" 2001.

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.Titus A. M. Msagati. "The Chemistry of Food Additives and Preservatives", Wiley-Blackwell, 2013.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5203	POULTRY, MEAT AND FISH PROCESS TECHNOLOGY	3	0	0	3

Course Objectives

- Impart the processing technologies and equipment used for meat, fish and Poultry
- Understand the preservation and value addition of meat, egg and poultry products
- Assess the quality assurance, sanitation and Packing techniques for meat,fish and Poultry products

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. Packaging of Eggs and Egg Products - Low Cholesterol-cum-Designer Eggs.	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.	9
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.	9
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, Safety standards in meat, poultry and egg industry: HACCP/ISO/MFPO/FSSAI/Kosher/Halal.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

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

TEXT BOOKS:

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

2.Gunter Heinz and Peter Hautzinger, —Meat Processing Technologyl, 1st Edition, Rap Publication, Monteplier, 2007.

REFERENCES BOOKS:

1.Ionnis S. Boziaris, —Seafood Handbook: Technology, Quality and Safetyl, Wiley Blackwell, UK, 2014.

2.Mead G.C., —Poultry Meat Processing and Qualityl, 1st Edition, CRC Press, London, 2004.

3.Alan R. Sams, —Poultry Meat Processingl, 1st Edition, CRC Press, London, 2001.

4.Joseph Kerry, John Kerry and David Ledwood. —Meat Processingl, Woodhead Publishing Limited, England (CRC Press), 2002.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5204	PRINCIPLES OF FOOD PROCESSING	3	0	0	3

Course Objectives

1. To understand the principles of food processing and their impact on the shelf life and quality of food materials and products
2. To learn various methods of food processing viz., drying, milling, freezing, thermal treatments etc.
3. To introduce novel food processing techniques

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**HIGH AND LOW TEMPERATURE PROCESSING OF FOODS:** Methods of applying heat to food - Blanching, Pasteurization, Sterilization - thermo bacteriology, commercial sterility, calculation of process time - General method- Ball's formula method- methods of sterilization - equipment. Methods of low temperature preservation - Chilling, Freezing, freeze drying and freeze concentration - theory and principles.	12
II	**DRYING, DEHYDRATION AND EVAPORATION:** Drying - principles, theory of drying, equilibrium moisture content, methods of moisture determination and source of heat. Drying - types of dryers. Dehydration-Osmotic dehydration-theory and principles. Water activity - sorption behaviour of foods - water activity and food stability - Relationship between water activity and moisture - Equilibrium moisture content. Evaporation - definition - single and multiple effect evaporation-types, application and performances of evaporators and boiling point elevation - steam economy, mass and heat balance.	12
III	**PROCESSING AND PRESERVATION OF FOODS BY CHEMICALS:** Food preservation by sugar, salt, acid - Principles - mechanism- antimicrobial activity. Preservation by chemicals- type of chemical preservatives- sulphur dioxide, benzoic acid, etc; use of other chemicals like acidulants, antioxidants, mold inhibitors, antibodies, etc. Factors affecting antimicrobial activity of preservatives.	6
IV	**NON-THERMAL PROCESSING:** Food Irradiation - High Pressure Processing- Pulsed electric field processing, pulsed light treatment and Ultrasound - Theory and Principles - effect on microorganisms- Application in Processing of foods.	9
V	**NOVEL METHODS OF FOOD PROCESSING:** UV treatment, Ozone treatment, dielectric heating- microwave, radio frequency, ohmic and infrared heating theory, equipment, applications and effect on foods. Hurdle technology and Nano-technology - principle - application in food processing.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Apply different methods of high and low temperature processing techniques over raw foods and analyze the process time of that food properties of food

CO2- Understand and apply the suitable dryers to different food to increase the shelf life and analyse the performance of the evaporators and their features.

CO3-Analyze the shelf life of foods processed and preserved by natural and chemical agents.

CO4- Understand the operations and features of different non-thermal processing techniques and applying to improve the shelf life of product.

CO5- Apply the principle of advanced novel techniques in food processing industries.

TEXT BOOKS:

1. Fellows P.J., —Food processing Technology: Principles and Practicel, 3rd Edition, Woodhead Publishing Ltd., New Delhi, 2009
2. Da-Wen Sun, Emerging Technologies for food processing, 2nd Edition, Academic Press, 2014.
3. Earle R.L., —Unit Operations in Food Processingl, Web Edition, Pergamon Press, UK, 2004.
4. G.W. Gould. New methods of Food Preservation, Springer, Boston, MA, 1995.

REFERENCES BOOKS:

1. James G Brennan, —Food Processing Handbookl, 2nd Edition, Wiley VCH, Weinheim, 2011.
2. Paul Singh R and Dennis R. Heldman, —Introduction to Food Process Engineeringl, 5th Edition, Academic Press, USA, 2014
3. Sahay K.M. and Singh K.K., —Unit Operations of Agricultural Processingl, 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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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5205	UNIT OPERATIONS IN FOOD PROCESSING	3	0	0	3

Course Objectives

- To understand and remember the concept of food processing and also to know the mechanisms
- Familiarize with operational skill of equipment and imparting knowledge on entrepreneurship.
- Impart knowledge on different unit operations and its significance in food Industry.

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 equipment - Crushers, Hammer mills, Fixed head mills, Ball mills, Plate mills and Roller mills. Cutters - Slicers, Dicers, Shredder and Pulper. Size reduction in liquids	9
II	**MECHANICAL SEPARATION:** Sedimentation in liquids - Gravitational sedimentation – Floatation - Sedimentation of particles in gas. Centrifugal separation – Velocity of particles – Radius of neutral zone – Equipment. Filtration – Constant rate and Constant pressure filtration - Equipment, Sieving effectiveness and Applications	9
III	**CRYSTALLIZATION:** Crystallization Equilibrium – Nucleation – Meta stable region – Seed Crystals. Heat of Crystallization - Rate of crystal growth. Stage equilibrium crystallization. Equipment - Types – Applications.	9
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 equipment - Liquid Mixers, Powder and Particle Mixers, Dough and Paste Mixers.	9
V	**EXTRUSION**: Theory - Rheological properties and Operating Characteristics. Single and Twin-screw extruders - Ancillary Equipment. 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.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1 - Understand and apply the size reduction techniques to convert solids and liquids into uniform particles

CO2 - Understand and apply the mechanical separation process like sedimentation, centrifugation, and filtration to separate solids, liquids and gas in food processing

CO3 - Understanding the mechanism of crystallization process and applying the principles of crystallization for the production of crystals

CO4 - Applying mixing equipment for the uniform mixing of solids, semi solids and liquids

CO5- Apply the extrusion process for the preparation of extruded products and its texture analysis and understanding the material handling process with its application.

Total: 45 Hours

TEXT BOOKS:

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

REFERENCES BOOKS:

1. James G Brennan, —Food Processing Handbookl, 2nd Edition, Wiley VCH, Weinheim, 2011.
2. Paul Singh R and Dennis R. Heldman, —Introduction to Food Process Engineeringl, 5th Edition, Academic Press, USA, 2014
3. Sahay K.M. and Singh K.K., —Unit Operations of Agricultural Processingl, 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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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5001	BAKING AND CONFECTIONERY TECHNOLOGY LABORATORY	0	0	4	2

Course Objectives

- To understand the practical knowledge about the concepts of baking and confectionery
- To understand the components of bakery flour
- To identify the dough raising capacity
- To develop bakery and confectionery products

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
- Understand the properties of the flour
- Understand the dough raising capacity using leavening agent
- Understand the quality parameters of the bakery products
- Understand the quality parameters of the confectionery products

REFERENCE BOOKS:

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5002	UNIT OPERATIONS IN FOOD PROCESSING 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, porosity, angle of repose for grain sample, and coefficient of friction for grain sample
3.	Determination of separation efficiency of centrifugal separator
4.	Determination of collection efficiency in cyclone separator
5.	Determination of efficiency of liquid solid separation by filtration
6.	Determination of particle size of granular foods by sieve analysis
7.	Determination of performance characteristics in size reduction using the burr mill
8.	Determination of energy requirement in size reduction and performance evaluation using ball mill
9.	Determination of energy requirement in size reduction using hammer mill
10.	Performance evaluation of a steam distillation process
11.	Experiment on paddy dehusker to determine the shelling efficiency
12.	Determination of conveying efficiency and power requirement of screw conveyor
13.	Determination of economy and thermal efficiency of evaporator
	Total Practical Hours 30

Course Outcomes

Upon completion of the course, students can be able to

CO1 - Understand the Engineering mechanisms of equipment and properties of foods
CO2 - Understand the separation and collection efficiency in different separators.
CO3 - Apply various mills for the size reduction of food materials into different sizes.
CO4 - Analyze the performance of different mills and distillation equipment.
CO5 - Analyze the conveying efficiency of screw conveyors and bucket elevators for designing equipment.

REFERENCES BOOKS:

1. James G Brennan, —Food Processing Handbookl, 2nd Edition, Wiley VCH, Weinheim, 2011.
2. Paul Singh R and Dennis R. Heldman, —Introduction to Food Process Engineeringl, 5th Edition, Academic Press, USA, 2014
3. Sahay K.M. and Singh K.K., —Unit Operations of Agricultural Processingl, 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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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19HE5071	SOFT SKILLS - I	1	0	0	1

Course Objectives:

1. To employ soft skills to enhance employability and ensure workplace and career success.
2. To enrich students' numerical ability of an individual and is available in technical flavor.
3. To interpret things objectively, to be able to perceive and interpret trends to make generalizations and be able to analyze assumptions behind an argument/statement.

Unit	Description	Instructional Hours
I	**Introduction to Soft Skills:** Introduction- Objective -Hard vs Soft Skills - Measuring Soft Skills- Structure of the Soft Skills -Self Management-Critical Thinking-Reflective thinking and writing- p2p Interaction	3
II	**Art of Communication:** Verbal Communication - Effective Communication - Active listening –Paraphrasing - Feedback - Non-Verbal Communication – Roles-Types- How nonverbal communication can go wrong- How to Improve nonverbal Communication - Importance of feelings in communication - dealing with feelings in communication.	4
III	**World of Teams:** Self Enhancement - importance of developing assertive skills- developing self-confidence – developing emotional intelligence - Importance of Team work – Team vs. Group - Attributes of a successful team – Barriers involved - Working with Groups – Dealing with People- Group Decision Making.	3
IV	**Quantitative Aptitude:** Averages - Profit and loss - Partnerships - Time and work - Time, Speed and Distance - Problems based on trains - Problems based on boats and streams	3
V	**Logical Reasoning:** Clocks - Calendars - Direction Sense - Data Interpretation: Tables, Pie Chart, Bar Graph - Data Sufficiency	2

Course Outcome:

- CO1: Students will have clarity on their career exploration process and to match their skills and interests with a chosen career path.
- CO2: Students will develop knowledge, skills, and judgment around human communication that facilitate their ability to work collaboratively with others
- CO3: Students will understand how teamwork can support leadership skills
- CO4: Students will be able to make sense of problems, develop strategies to find solutions, and persevere in solving them.
- CO5: Students will demonstrate an enhanced ability to draw logical conclusions and implications to solve logical problems.

REFERENCE BOOKS:

R1: Soft Skills Training: A Workbook to Develop Skills for Employment - Frederick H. Wentz
R2: How to prepare for data interpretation for CAT by Arun Sharma.
R3: How to Crack TEST OF REASONING in all competitive examinations by Jaikishan and Premkishan.
R4: A New Approach To Reasoning Verbal & Non-Verbal By B.S. Sijwali
R5: Quantitative Aptitude for Competitive Examinations - Dr. R.S. Aggarwal, S. Chand

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19HE5072	DESIGN THINKING	1	0	0	1

Course Objective

OBJECTIVES:

- To expose students to the design process
- To develop and test innovative ideas through a rapid iteration cycle.
- To provide an authentic opportunity for students to develop teamwork and leadership skills

Unit	Description	Instructional Hours
I	**DESIGN ABILITY** Asking Designers about what they Do – Deconstructing what Designers Do – Watching what Designers Do – Thinking about what Designers Do – The Natural Intelligence of Design Sources	4
II	**DESIGNING TO WIN** Formula One Designing – Radical Innovations – City Car Design – Learning From Failures – Design Process and Working Methods	4
III	**DESIGN TO PLEASE AND DESIGNING TOGETHER** Background – Product Innovations – Teamwork versus Individual work – Roles and Responsibilities – Avoiding and Resolving Conflicts.	4
IV	**DESIGN EXPERTISE** Design Process – Creative Design - Design Intelligence – Development of Expertise – Novice to Expert. Critical Thinking – Case studies: Brief history of Albert Einstein, Isaac Newton and Nikola Tesla	3
	Total Instructional Hours	15

Course Outcome

Upon completion of the course, students will be able to
CO1: Develop a strong understanding of the Design Process
CO2: Learn to develop and test innovative ideas through a rapid iteration cycle
CO3: Develop teamwork and leadership skills
CO4: Analyze the difference between teamwork versus individual work
CO5: Understand the concept and process of design expertise and intelligence

TEXT BOOKS:

T1 - 1. Nigel Cross, "Design Thinking", Kindle Edition.

REFERENCE BOOKS:

R1 - Tom Kelley, "Creative Confidence", 2013.
R2 - 3. Tim Brown, "Change by Design", 2009.

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VI SEMESTER

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6201	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 – carbon dioxide 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 using drum and spray dryer, probiotics.	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. Applications of Non thermal processing in dairy industry.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

- CO1- Remember the constituents and properties of milk
- CO2- Understand the pre-handling and quality analysis of milk
- CO3- Understand and apply the concepts of designing the equipment's for processing of milk
- CO4- Understand the different unit operations involved in processing of milk using flow diagrams
- CO5- Understand the cleaning and sanitation procedures in the 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". Jane Selia dos Reis Coimbra & Jose A. Teixeir, CRC Press, 2009.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6202	PLANTATION CROPS AND SPICES PRODUCTS TECHNOLOGY	3	0	0	3

Course Objectives

- Understand the importance and scope of plantation of major spices
- Remember the appropriate techniques for processing of minor spices
- Study the processing of tea, coffee and Cocoa
- Study the processing of coconut, oil palm, arecanut and cashew
- Analyze various method of analysis of quality of spices, uses of packaging and grading system

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**PROCESSING OF MAJOR SPICES** Spices – production and importance – stage of harvesting and harvesting methods - processing of major spices – pepper, cardamom, chilli, turmeric, ginger, garlic and onion. - Unit operations involved – equipment – principle and construction.	9
II	**PROCESSING OF MINOR SPICES:** Production and importance – stage of harvesting and harvesting methods - processing of minor spices –Herbs, leaves, spartan, clove, coriander, cumin, nutmeg, curry leaves vanilla annatto– seed spices-unit operations involved – cryogenic grinding – equipment – principle and construction.	9
III	**PROCESSING OF COFFEE, TEA AND COCOA:** Coffee- Chemical constituents - harvesting - fermentation of coffee beans. Processing of coffee, - wet and dry method –equipment used. Process flow sheet for the manufacture of coffee powder- Instant coffee, technology-Chicory chemistry- Quality grading of coffee. Processing of tea- types – green, oolong, CTC- methods and equipment - grading of tea – methods – instant tea processing - grades of tea- packaging of tea - Cocoa - Chemistry of the cocoa bean - changes taking place during fermentation of cocoa bean - Processing of cocoa bean - cocoa powder - cocoa liquor manufacture-Chocolate - Types - Chemistry and technology of chocolate manufacture - Quality control of chocolates.	9
IV	**PROCESSING OF COCONUT, OILPALM, ARECANUT, CASHEW:** Processing of plantation crops – production and importance – Coconut-harvesting - Processing technology of Virgin Coconut oil- Coconut SAP and sugar-Desiccated Coconut, Milk Cream, Nata-de-Coco, Packed Tender Coconut Water- Vinegar and Activated Carbon. Processing of oil palm, arecanut – harvesting and stages of harvest – drying, cleaning and grading – production of value-added products – packaging and storage of produces. Cashew-harvesting- products - uses of cashew & CSNL- cashew nut processing -methods of roasting - shelling - grading-packaging- infestation- Hygiene and safety.	9
V	**PACKAGING, GRADING AND QUALITY ANALYSIS OF SPICES & PLANTATATION:** Cleaning and grading - packaging and storage of spices & plantation crops – quality specifications -processes involved in the manufacture of oleoresins and essential oils – quality analysis of spices & plantation crops and their derivatives – flavor extraction techniques and standard specifications. Functional packaging of spices & plantation crops and its products & By-products.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Remember and understand the steps involved in processing of major spices

CO2- Understand and demonstrate the principle and processing of minor spices

CO3- Understand and apply the appropriate techniques for processing of coffee, tea, cocoa and analyze the bioactive compounds present

CO4- Applying the different unit operations for the processing of various tuber crops and following the guidelines of hygiene and food safety

CO5- Analyze and evaluate the quality components of the spices and plantation crops

TEXT BOOKS:

1. Pandey P.H., —Post-Harvest Engineering of Horticultural Crops through Objectivesl, Saroj Prakasam, Allahabad, 2003.

2. Kumar K., Md Abdul Kadar JBM., Rangaswamyi P. and Irulappan I., "Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plantsl, Oxford and IBH Publishing, 2006.

REFERENCES BOOKS:

1. Minifie Bernard W., —Chocolate, Cocoa and Confectionery Technologyl, 3rd Edition, Springer Netherlands, 2012.

2. Shanmugavelu K.G., Kumar N. and Peter K.V., —Production Technology of Spices and Plantation Cropsl, Jodhpur Agrobios (India) Agro House, 2005

3. National Institute of Industrial Research (NIIR) Board, —Handbook on Spicesl, Asia Pacific Business Press Inc., New Delhi, 2004.

4. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1st Edition. Academic Press Inc., New York, USA. 2011.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6203	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	**HARVESTING, HANDLING AND STORAGE OF FRESH FRUITS AND VEGETABLES** Physical, Textural characteristics, structure and composition. Harvesting of important fruits and vegetables. Maturity standards; Importance, methods of Maturity determinations maturity indices for selected 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 freeze burn. Handling and packaging of fruits and vegetables.	9
II	**REFRIGERATING FRUITS & VEGETABLES** Introduction to Refrigeration - Unit of Refrigeration and C.O.P– Desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical. Cryogenics, application of cryogens in food. Production of low temperatures Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization. Chloroflouro Carbon (CFC) refrigerants - effect on environmental pollution - alternate refrigerants - application of refrigeration.	9
III	**FREEZING & DEHYDRATION OF FRUITS AND VEGETABLES:** General preprocessing, different freezing methods and equipment, problems associated with specific fruits and vegetables; Dehydration – General preprocessing, 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	**MINIMAL PROCESSING AND CANNING:** Primary processing: Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables, Minimal Processing of Fruits and Vegetables. Canning - principles, types of cans - preparation of canned products - packing of canned products - spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations. General considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit. Indian Food Regulation and Quality assurance: Fruit Juice / pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic, Vegetable Purees/ pastes - General and specific processing, different packing including aseptic.	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, Onion: Dried, 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.	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.	19FT6181	PROFESSIONAL ETHICS IN ENGINEERING	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.	19FT6001	DAIRY ENGINEERING LABORATORY	0	0	3	1.5

Course Objectives

- To understand the practical knowledge about the processing of dairy products
- To analyze the chemical composition 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 of homgenizer.
7.	Estimation of surface tension of milk.
8.	Design of dairy equipment – homogenizer/spray dryer.
9.	Determination of churning efficiency of butter churner.
10.	Determination of efficiency of spray dryer.
11.	Experiment on preparation of different dairy products (ice cream, milk powder etc.) and sensory analysis using 9-point hedonic scale.
12.	Experiment on construction and working of cream separator.

Total Practical Hours 45

Course Outcomes

Upon completion of the course, students can be able to

CO1 - Analyze the presence of macro components in milk and detect the adulterants in milk
CO2 - Find the pasteurization efficiency of milk using different methods of pasteurization
CO3 - Demonstrate the construction details and milk flow pattern of plate heat exchanger
CO4 - Evaluate the efficiency of various equipment for the processing of milk
CO5 - Determine the drying efficiency of different dryers for the production of milk powder

REFERENCE BOOKS:

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

2. Robinson R.K., —Modern Dairy Technology: Advances in Milk Productsl, Volume 2, Springer London Ltd., 2012.

3. Hui.Y.H,, —Dairy Science and Technology Handbook: Applications Science, Technology and Engineeringl, Volume 3, Wiley, New Delhi, 2014.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6002	FRUITS AND VEGETABLE PROCESSING LABORATORY	0	0	3	1.5

Course Objectives

- Understand the knowledge on extraction, pulping, dehydration, and preparing fruit/vegetable-based products
- Understand different methods of fruits and vegetable processing
- Understand quality evaluation of fruit and vegetable products

S.No.	DESCRIPTION
1.	Estimate the maximum % yield efficiency of the prepared fruit pulp
2.	Experiment on osmotic dehydration of fruits and vegetables and also calculate its effect on drying kinetics
3.	Demonstration on minimal processing of fruits and vegetables viz. blanching, CAS, MAP, and vacuum packaging
4.	Experiment on preparation of jam/jelly (Plain or mixed fruits), sauce and its estimation of total soluble solids (TSS)
5.	Experiment on preparation of squash and its estimation of total soluble solids (TSS) with sensory analysis of the prepared sample
6.	Experiment on Ready to Serve (RTS) beverages preparation and its sensory analysis
7.	Experiment on canning of fruits and vegetables and its analysis on shelf life of the end product
8.	Experiment on preparation of fruit preserve, marmalade and candy and its sensory analysis
9.	Experiment on tomato puree and ketchup preparation and its sensory analysis
10.	Determination of pectin content from fruit and vegetable waste and its estimation of active compounds
11.	Estimation of ascorbic acid content in the given fruit samples using quantitative analysis
12.	Experiment on drying characteristics of curry leaves using Fluidized bed dryer and quality analysis of the end product
13.	Determination of drying rate of fruits and vegetables using Tray dryer
	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 - Impart knowledge on value addition of food products

CO3 - Demonstrate methods to prevent or reduce deterioration and loss of nutritional quality of vegetables and fruits

CO4 - Implement dehydration methods to produce dehydrated fruits and vegetables

CO5 - Demonstrate the production of fermented products like pickles, sauerkraut from fruits and vegetables

REFERENCE BOOKS:

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

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Programme	Course Code	Course Title	L	T	P	C
B.TECH.	19HE6071	SOFT SKILL-II	1	0	0	1

Course Objectives:

1. To make the students aware of the importance, the role and the content of soft skills through instruction, knowledge acquisition, demonstration and practice.
2. To learn everything from equations to probability with a completely different approach.
3. To make the students learn on an increased ability to explain the problem comprehensively.

Unit	Description	Instructional Hours
I	**Group Discussion & Presentation Skills:** GD skills – Understanding the objective and skills tested in a GD – General types of GDs – Roles in a GD – Do's & Don'ts – Mock GD & Feedback. - Presentation Skills – Stages involved in an effective presentation – selection of topic, content, aids – Engaging the audience – Time management – Mock Presentations & Feedback	4
II	**Interview Skills and Personality Skills:** Interview handling Skills – Self preparation checklist – Grooming tips: do's & don'ts – mock interview & feedback - Interpersonal skills-creative thinking-problem solving-analytical skills	3
III	**Business Etiquette & Ethics:** Etiquette – Telephone & E-mail etiquette – Dining etiquette – do's & Don'ts in a formal setting – how to impress. Ethics – Importance of Ethics and Values – Choices and Dilemmas faced – Discussions from news headlines.	3
IV	**Quantitative Aptitude:** Permutation, Combination - Probability - Logarithm - Quadratic Equations - Algebra - Progression - Geometry - Mensuration.	3
V	**Logical Reasoning:** Logical Connectives - Syllogisms - Venn Diagrams – Cubes - Coded inequalities - Conditions and Grouping	2

Course Outcome:

- CO1: Students will have learnt to keep going according to plan, coping with the unfamiliar, managing disappointment and dealing with conflict
- CO2: Students will Actively participate meetings, Group Discussions / interviews and prepare & deliver presentations
- CO3: Students will define professional behavior and suggest standards for appearance, actions and attitude in a business environment
- CO4: Students will be able to apply quantitative reasoning and mathematical analysis methodologies to understand and solve problems.
- CO5: Students will excel in complex reasoning.

REFERENCE BOOKS:

R1: Bridging the Soft Skills Gap: How to Teach the Missing Basics to Todays Young Talent- Bruce Tulgan
R2: Quantitative Aptitude for Competitive Examinations (5th Edition) - Abhjit Guha
R3: How to crack test of Reasoning - Jaikishan and Premkishan
R4: The hand on guide to Analytical Reasoning and Logical Reasoning - Peeyush Bhardwaj

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Programme	Course Code	Course Title	L	T	P	C
B.TECH.	19HE6072	INTELLECTUAL PROPERTY RIGHTS (IPR)	1	0	0	1

Course Objectives:

1. To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.
2. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects.
3. To disseminate knowledge on copyrights and its related rights and registration aspects.
4. To disseminate knowledge on trademarks and registration aspects.
5. To disseminate knowledge on Design, Geographical Indication (GI) and their registration aspects.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO INTELLECTUAL PROPERTY** Introduction, Types of Intellectual Property, International Organizations, Agencies and Treaties, Importance of Intellectual Property Rights.	3
II	**PATENTS** Patents -Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application -Non -Patentable Subject Matter -Registration Procedure, Rights and Duties of Patentee, Assignment and license.	3
III	**COPYRIGHTS** Purpose And Function Of Trade Marks, Acquisition Of Trade Mark Rights, Protectable Matter, Selecting And Evaluating Trade Mark, Trade Mark Registration Processes.	3
IV	**TRADEMARKS** Concept of Trademarks -Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) -Non-Registrable Trademarks - Registration of Trademarks.	3
V	**DESIGN AND GEOGRAPHICAL INDICATION** Design: meaning and concept of novel and original -Procedure for registration. Geographical indication: meaning, and difference between GI and trademarks -Procedure for registration.	3

Course Outcome:

- CO1: Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
- CO2: Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development.
- CO3: Identify, apply and assess ownership rights and marketing protection under intellectual property law as applicable to information, ideas, new products and product marketing.
- CO4: Identify different types of trademarks and procedure for registration.
- CO5: Recognize the concept of design, geographical indication and procedure for registration.

TEXT BOOKS:

T1- Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
T2- V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt. Ltd, 2012.

REFERENCE BOOKS:

R1- Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
R2- Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

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PROFESSIONAL ELECTIVE

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5301	TECHNOLOGY OF FATS AND OIL	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 Productsl, 6th Edition, Wiley - Interscience, New Jersey, 2005.

2. Richard D. O'Brien, —Fats and Oils: Formulating and Processing for Applicationsl, 3rd Edition, CRC Press, London, 2010.

REFERENCES BOOKS:

1. Casimir C. Akoh and David B. Min, —Food Lipids: Chemistry, Nutrition and Biotechnologyl, CRC Press, USA, 2008.

2.Wolf Hamm and Richard J. Hamilton, —Edible Oil Processingl, Wiley - Blackwell, UK, 2013.

3. Kanes K. Rajah, —Fats in Food Technologyl, Sheffield Academic Press, UK, 2002.

4. Gunstone, Frank D. "The Chemistry of Oils and Fats Sources, Composition, Properties and Uses" Blackwell Publishing, 2004.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5302	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	**GRAIN STORAGE AND MANAGEMENT:** Grain storage types of storage structures - traditional, improved and modern storage structures in current usage. Ideal seeds and commodities storage conditions. Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Pest Birds – role and its management. Control of infestation by insect pests, mites and microorganisms. Preventive measures-Hygiene/sanitation, disinfestations of stores/receptacles, legal methods.	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 Grainsl, Satish Serial Publishing House, New Delhi, 2009.

2. Nair K.R., —Integrated Production and Pest Managementl, DK Publishers and Distributors, Delhi, 2007.

REFERENCES BOOKS:

1. Hagstrum D.W., and Subramanyam B., —Fundamentals of Stored Product Entomologyl American Association of Cereal Chemists Inc., 2006

2.Subramanyam B., —Integrated Management of Insects in Stored Productsl, CRC Press, 1995.

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

4.Chakravarty et al Handbook of Post-Harvest Technology Marcel Dekker. 2003.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5303	REFRIGERATION AND COLD CHAIN MANAGEMENT	3	0	0	3

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.	9
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.	9
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	9
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.	9
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.	9
	Total Instructional Hours	**45**

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-conditioningl, 3rd Edition, S.K. Kataria and Sons (Publishers), Delhi, 2012.

2. Dellino C.V.J., —Cold and Chilled Storage Technologyl, 2nd Edition, Springer, US, 2011.

REFERENCES BOOKS:

1. Arora C.P., —Refrigeration and Air Conditioningl, 2nd Edition, Tata McGraw-Hill Publishing Company Ltd., Delhi, 2008

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

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

4. Roy J. Dossat, Principles of Refrigeration, Pearson Education Asia, 4th Edition, 2009.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT5304	POST HARVEST TECHNOLOGY	3	0	0	3

Course Objectives

- To understand and identify the specific processing technologies used for different foods and the various products derived from these materials.
- To understand the application of scientific principles in the processing technologies specific to the 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, pre treatments, modified atmosphere packaging, chilling. General pre-processing, different freezing methods and equipment, problems associated with specific fruits and vegetables; Dehydration– General pre processing, 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 – Pasteurisation, homogenisation, 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 Qualityl, 1st Edition, CRC Press, London, 2004.
3. Sukumar De, —Outlines of Dairy Technologyl, 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.	19FT5305	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 9disadvantages. 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 BY PRODUCTS:** 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 Industryl, 2nd Edition, Elsevier Publishing Company, New York, 1989.
2. Baikow V.E., —Manufacturing and Refining of Raw Cane Sugarl, 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 Beetl, Read Books, New York, 2007.
2. Ram BehariLal and Mathur, —Hand Book of Cane Sugar Technologyl, 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 Facilitiesl, 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.	19FT5306	MILLING TECHNOLOGY FOR FOOD GRAINS	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 PULSES:** 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. Chakravarthy A., —Post-Harvest Technology of Cereals, Pulses and Oil Seedsl, 3rd Edition, Oxford IBH Publishing Co. Pvt. Ltd., New Delhi, 2008.
2. Sahay K.M. and Singh K.K., —Unit Operations of Agricultural Processingl, 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 Spicesl, Marcel Dekker, Inc., New York, 2003.
2. Kulp K. and Pont J.G., —Handbook of Cereal Science and Technologyl, 2nd Edition, Marcel Dekker, Inc., New York, 2000.
3. Richard D. O'Brien, —Fats and Oils: Formulating and Processing for Applicationsl, 3rd Edition, CRC Press, London, 2008.
4.Delcour, Jan A. and R. Carl Hoseney. "Principles of Cereal Science and Technology". 3rd Edition. American Association of Cereal Chemists, 2010.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6301	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	**CARBONATED BEVERAGES:** Procedures- carbonation equipment-ingredients-preparation of syrups-Filling system-packaging containers and closures	9
IV	**NON-CARBONATED BEVERAGE:** Coffee bean preparation-processing-brewing-decaffeination- instant coffee-Tea types- 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. Shankunthala Manay, N. and Shadakdharaswamy, M, "Foods – Facts and Principles", New Age International Pvt. Ltd, 3rd revised edition 2000.
4. Charles, W.Bamforth, "Food, fermentation and microorganisms", Blackwell Science Publishing Ltd. 2005

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6302	TECHNOLOGY OF SNACKS AND EXTRUDED FOODS	3	0	0	3

Course Objectives

- To study about the snack products by extrusion process and also the health aspects of organic foods

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	**TOTAL: 45**

Course Outcomes

Upon completion of the course, students can be able to

CO1-Understand the preprocessing operations
CO2-Understand the mechanism behind extrusion
CO3-Understand the concepts of extruded foods
CO4-Understand the preparation of corn, rice and paddy products
CO5-Understand the heath aspects of organic foods

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. Davidar, Ruth N. "Indian Food Science A Health and Nutrition Guide to Traditional Recipes, East West Books, 2001.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6303	FOOD BIOTECHNOLOGY	3	0	0	3

Course Objectives

- To understand application of biotechnology in food processing industries, understand downstream processing concepts, process involving production of enzymes

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION TO BIOTECHNOLOGY** Introduction -Biotechnology relating to the food industry – application of genetics to food production – role of bio process engineering in biotechnology industry. Regulatory and Social aspects of biotechnology of foods.	9
II	**MICROBIALGENETICS** Microbial genetics – mutation – induction of mutation – conjugation, transformation, transduction – heterokaryoses – paraesexuality – General mechanism of gene transfer techniques in genetic engineering. Principles of immunology – Antigen and antibody reaction – Development of vaccines – Microbial products and industrial application of microorganisms in foods.	9
III	**PRODUCTIONOF PRIMARY AND SECONDARY METABOLITE** The process of production of some commercially important organic acids – citric acid, lactic acid, acidic acid, gluconic acid, amino acids and alcohol– Bio products for food industries – Natural bio-preservatives – Nisin.	9
IV	**DOWNSTREAM PROCESSING** Principle of downstream processing –stages in downstream processing- solid liquid separation flotation-flocculation-filtration-types-centrifugation-cell disruption-concentration-evaporation liquid - liquid extraction-membrane filtration- precipitation-adsorption-purification by chromatography.	9
V	**APPLICATION OF BIOTECHNOLOGY TO TRADITIONAL FERMENTED. FOODS** Milk derivatives- fermented milks-past, present and future-plant derivatives-biotechnology application in cassava processing-animal derivatives-fish meat sausage-human health safety and nutrition considerations-future directions.	9
	Total Instructional Hours	**TOTAL: 45**

Course Outcomes

Upon completion of the course, students can be able to

CO1 - Understand the introduction to biotechnology
CO2 - Remember the concepts of microbial genetics
CO3 - Understand the production of primary and secondary metabolites
CO4 - Remember the operations behind downstream processing
CO5 - Understand the application of biotechnology to traditional fermented foods

TEXT BOOKS:

1. Rita Singh, "Food Biotechnology". Global vision publication house, Delhi 2004.
2. Sarah Elderidge, "Food Biotechnology; Current issues and perspectives". Nova science pub. Inc. 2003.

REFERENCES BOOKS:

1. Kalaichelvan, P.T, "Bioprocess technology", MJP publishers,Chennai 2007.
2. Sathnarayana U, "Biotechnology", Arunavhazan publishers, kolkatta 2006.
3. National Research Council, "Application of biotechnology to traditional fermented foods", National academy press, Washington 1992.
4. Najafpour, D. Ghasem. "Biochemical Engineering & Biotechnology". Elsevier, 2007

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6304	BIOPROCESS ENGINEERING	3	0	0	3

Course Objectives

- To study the immobilization, inhibition process of microbes

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 STERILIZATION:** 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	**REACTOR TYPES & MODES OF OPERATION** Batch, fed batch and continuous cultivation. Simple unstructured kinetic models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics - leudeking- piret models. Types of reactor- Air Lift Reactor, Bubble Column Reactor, Immobilized enzyme reactors- packed bed, fluidized bed, membrane reactors.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1-Understand the enzymes concept
CO2-Understand the microbial stains
CO3-Understand the stoichiometry of cell growth
CO4-Understand the process of fermentation
CO5-Understand the knowledge for reactor

TEXT BOOKS:

1 .Shuler, M.L. and Kargi, F. "Bioprocess Engineering Basic Concepts", 3rd Edition, PHI, 2017

2.Palmer, Trevor "Enzymes Biochemistry, Biotechnology, Clinical Chemistry", AffiliatedEast- West Press Pvt. Ltd., 2004.

REFERENCES BOOKS:

1. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 3rd Edition, Butterworth – Heinemann (an imprint of Elsevier), 2016.

2.Doran, P.M. "Bioprocess Engineering Principles", 2nd Edition Academic Press, 2013.

3.Najafpour, D. Ghasem. "Biochemical Engineering & Biotechnology". Elsevier, 2007.

4.Bryce, C.F.A and EL. Mansi. "Fermentation Microbiology & Biotechnology, 1999.

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6305	ENZYME TECHNOLOGY	3	0	0	3

Course Objectives

- To know about Isolation and Purification of enzymes, understand the concept of enzyme immobilization techniques and the application of enzymes in food industries.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**INTRODUCTION** Introduction-Definition-Historical highlights-classification of enzymes nomenclature-structural features of enzyme-Methods of extraction and purification of enzymes.	9
II	**MECHANISMOF ENZYME ACTION** Specificity-types of specificity-role of 3D structure -active site-substrate and enzyme concentration relationships-different effects –pH and temperature.	9
III	**ENZYMEKINETICS** MM equation, Lineweaver 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	**APPLICATION OF 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- Understand the appropriate staining techniques
CO5- Understand the cell production mechanism

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

REFERENCES BOOKS:

1. Colowick,S.P.and Kalpan,N.O.(Eds), "*Methods of enzymology*" Academic press 1977.

2. Tauber 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.	19FT6306	CROP PROCESS ENGINEERING	3	0	0	3

Course Objectives

- To Study the storage and handling techniques of cereals
- To Gain knowledge on processing and milling of pulses
- To Understand the post harvest processing on application oriented

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**ENGINEERING PROPERTIES AND MOISTURE CONTENT** Post harvest losses in field crops - optimum stage of harvest, properties of grains - physical, thermal, electrical and aerodynamic properties, moisture content - measurement - direct and indirect methods - moisture meters, equilibrium moisture content - equilibrium relative humidity, relationship and isotherm models, methods of determination.	9
II	**THRESHING, SHELLING, CLEANING, GRADING AND DRYING** Threshing - threshers, types, cleaning and grading- principles, types, efficiency of separation, performance index, shelling and decortication - principles, maize sheller, husker sheller, groundnut decorticator and castor sheller, psychrometry - properties of air - water vapour mixture, grain drying - principles, types, heat sources, performance of dryers.	9
III	**RICE AND PULSES PROCESSING** Rice processing - parboiling, drying, dehusking, polishing, modern rice mill machineries - construction details and adjustments, layout of modern rice mills, manufacture of beaten rice, expanded rice and puffed rice, traditional and improved methods, processes and equipments, material handling equipment - types, construction and working - pulse milling - wet and dry method.	9
IV	**STORAGE** Storage of food grains - factors affecting storage, traditional methods, types - bag and bulk storage, storage structure, storage losses - estimation, storage of grains in large bins, modified atmosphere storage of grains - facilities, construction, operation and maintenance.	9
V	**WASTE UTILIZATION** Waste materials, sources and classification - crop residues, farm and industrial wastes and by-products, utilization - production of paper and paperboards, particle board, fuel briquettes - production of fibre, activated carbon, furfural and adhesive from tamarind kernel powder.	9
	Total Instructional Hours	**45**

Course Outcomes

Upon completion of the course, students can be able to

CO1- Demonstrate different engineering properties of grains and the method to determine moisture content

CO2- Select suitable equipment for threshing, cleaning and drying of grains and oilseeds

CO3- Summarize the operations involved in rice and pulse processing

CO4- Apply the knowledge on the various storage methods to minimize the loss and extend the shelf life of the grains

CO5- Use different ways to utilize the waste into useful by products and value-added products

TEXT BOOKS:

1.Chakraverty,A., Post-Harvest Technology of cereals, pulses and oilseeds, Third Edition, Oxford & IBH publishing & Co. Pvt. Ltd., New Delhi, 2000

2.Sahay, K.M. and K.K. Singh. Unit operations in Agricultural Processing, Vikas Publishing House Pvt. Ltd., New Delhi, 1994

3. Henderson, S.M. and R.L.Perry, Agricultural process engineering, John Willey and Sons, New York, 1995.

REFERENCES BOOKS:

1. Pande, P.H., Principles of agricultural processing, Kalyani Publishers, Ludhiana, 1994.

2. McCabe, W.L. and J.C.Smith, Unit operations in chemical engineering, McGraw Hill Kogakusha Ltd., Tokyo, 2001.

3.Mohsenin, N.N., Physical properties of plant and animal materials, Gordon and Breach publishers, New York, 1986

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OPEN ELECTIVE

Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	19FT6401	TRADITIONAL FOODS	3	0	0	3

Course Objectives

- Understand the importance of traditional foods and food habits
- Know the traditional processing of snack, sweet and dairy food products
- Infer the wide diversity and common features of traditional Indian foods and meal patterns.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
I	**TRADITIONAL METHODS OF FOOD PROCESSING:** Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.	9
II	**SWEETS, SNACKS AND DAIRY PRODUCTS:** Production, formulation, preparation and processing of Indian traditional sweet and snack food products: - Rasgolla, Gulabjamun; formulation and preparation of namkeen, papads, vada, potato chips, banana chips, samosa etc. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing; milk-based puddings/ desserts	9
III	**FERMENTED FOOD PRODUCTS:** Idli, Tempe, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol-based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing procedures to reduce loses of nutrients	9
IV	**COMMERCIAL PRODUCTION:** Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods ¢-types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters	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.	9
	Total Instructional Hours	45

Course Outcomes

Upon completion of the course, students can be able to

CO1- Justify the processing methods of traditional foods in terms of its health benefits
CO2- Assess the production methods of traditional sweets, snacks and dairy products
CO3- Differentiate Traditional fermented foods products based on its raw material
CO4- Implement a large-scale production of tradition foods for its increased consumption
CO5- Compare the health aspects of traditional foods with modern foods

TEXT BOOKS:

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes." East West Books, 2001.

REFERENCES BOOKS:

1. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
2. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

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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

1. To provide basic knowledge about engineering Ethics, Variety of moral issues and Moral dilemmas,Professional Ideals and Virtues.
2. To provide basic familiarity about Engineers as responsible Experimenters, Codes of Ethics.
3. To provide basic knowledge on Industrial Standards, Exposure to Safety, Risk Benefit Analysis.
4. To have an idea about the Collegiality and Loyalty, Confidentiality, Occupational Crime, Professional,Employee, Intellectual Property Rights.
5. To have an adequate knowledge about MNC's, Business, Environmental, Computer Ethics, Honesty,Moral Leadership, sample Code of Conduct.

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 –MoralAutonomy–Kohlberg"stheory–Gilligan"stheory–ConsensusandControversy–Modelsof professionalroles-Theoriesaboutrightaction–Self-interest–CustomsandReligion–Usesof Ethical Theories	9
III	**ENGINEERING AS SOCIAL EXPERIMENTATION** Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – ABalanced 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 Outcome

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

CO1: The students will understand the basic perception of profession, professional ethics, various moralissues & uses of ethical theories.

CO2: The students will understand various social issues, industrial standards, code of ethics and role ofprofessional ethics in engineering field.

CO3: The students will be aware of responsibilities of an engineer for safety and risk benefit analysis.

CO4: The students will be aware of professional rights and responsibilities of an engineer.

CO5: The students will acquire knowledge about various roles of engineers in variety of global issuesand able to apply ethical principles to resolve situations that arise in their professional lives

TEXT BOOKS:

T1 - Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
T2 - Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCE BOOKS:

R1 - Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
R2 – Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases",Cengage Learning, 2009.
R3 - John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.

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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 sweeteners

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 Objectivesl, Saroj Prakasam, Allahabad, 2003.
2. Kumar K., Md Abdul Kadar JBM., Rangaswamyi P. and Irulappan I., "Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plantsl, Oxford and IBH Publishing, 2006.

REFERENCES BOOKS:

1. Minifie Bernard W., —Chocolate, Cocoa and Confectionery Technologyl, 3rd Edition, Springer Netherlands, 2012.
2.Shanmugavelu K.G., Kumar N. and Peter K.V., —Production Technology of Spices and Plantation Cropsl, Jodhpur Agrobios (India) Agro House, 2005.
3.National Institute of Industrial Research (NIIR) Board, —Handbook on Spicesl, 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 of a pressure vessel
3.	Design and drawing of storage tanks
4.	Design of an extruder
5.	Design of a sterilizer
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 tray dryer
10.	Design and drawing of freeze dryer
11.	Design and drawing of spray drier
12.	Design and drawing of belt conveyor

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

CO2 - Analyze the process parameters of equipment and design pressure vessels, storage tanks and pulper

CO3 - Select the suitable products and materials for designing heat exchangers and evaporator

CO4 - Design and analyze the performance of dryers and extruders

CO5 - Analyze and determine the parameter for designing size reduction and conveying equipment

REFERENCE BOOKS:

1. Joshi M.V. and Mahajan V.V., —Process Equipment Designl, 4th Edition, MacMillan India, New Delhi, 2009

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

3.Perry R.H. and Green D.W., —Chemical Engineers Handbookl, 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.	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.

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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 Instrumentationl, 6th Edition, Central Techno Publications, Nagpur, 2011.

2.Eckman D.P., —Industrial Instrumentationl, Wiley Eastern Ltd, New Delhi, 2004.

REFERENCES BOOKS:

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

2.Coughanowr Donald R., —Process Systems Analysis and Controll, 3rd Edition, McGraw Hill, New York, 2009.

3.Singh S.K., —Industrial Instrumentation and Controll, 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 Processingl, 1st Edition, CRC Press, Florida, 2001.
2.Robin Guy, —Extrusion cooking: Technologies and Applicationsl, 1st Edition, CRC Press, Florida, 2001.

REFERENCES BOOKS:

1.Panda H., —The Complete Technology Book on Snack Foodsl, National Institute of Industrial Research, New Delhi, 2003.
2.Sergio O. Serna-Saldivar, —Industrial Manufacture of Snack Foodl, Woodhead Publishing, New Delhi, 2008.
3.Mian N. Riaz., —Extruders in Food Applicationl, 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.

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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 dryingl, 3rd Edition, CRC press, Taylor and Francis group.UK.2007.

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

REFERENCES BOOKS:

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

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

3.Toledo R.T., —Fundamentals of Food Process Engineeringl, Springer, 2007.

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

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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 Processingl, 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 Foodl, 1st Edition, John Wiley and Sons Ltd., UK, 2011.

REFERENCES BOOKS:

1.Han, Jung H., —Packaging for Non-thermal Processing of Foodl, Wiley-Blackwell, Oxford, 2007.

2.Mujumdar A.S., —Handbook of Industrial dryingl, 4th Edition, CRC Press, UK, 2014.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	16FT8303	MODELLING, SIMULATION AND SOFT TOOLS FOR FOOD TECHNOLOGISTS	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 Engineersl, 2nd Edition, McGraw Hill Book Co., New York, 1990.

2.Tijskens L.M.M., Hertog T.M. and Nicolai B.M., —Food Process Modelingl, CRC Press, 2001

REFERENCES BOOKS:

1.Babu B.V., —Process Plant Simulationl, Oxford University Press, New Delhi, 2004.

2.Farid M.M., —Mathematical Modeling of Food Processingl, CRC Press, 2010.

3.Jun S. and Irudayaraj J.M., —Food Processing Operations modeling: Design and analysisl, 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 Analysisl, 2nd Edition, Himalaya Publications, Bombay, 2003.

2.Willard H.H, Merritt L.L, Dean J.A, and Settle F.A., —Instrumental Methods of Analysisl, 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 Introductionl, 7th Edition, South-Western, Australia, 2000.

2.Rouessac F., —Chemical Analysis: Modern International Method and Techniquesl, 3rd Edition, Wiley, New Delhi, 1999.

3.Banwell G.C., —Fundamentals of Molecular Spectroscopyl, 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 Principlesl, 3rd Edition, John Wiley and Sons Inc., New York, 2011.

2.Roussel Ronald W., -Handbook of Separation Process Technologyll, John Wiley, New York, 2008

REFERENCES BOOKS:

1.Scott K. and Hughe R., – Industrial Membrane Separation Technologyll, Blackie Academic and Professional Publications, Glasgow, 1996.

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

3.Humphrey Jimmy L., George E. Keller II., -Separation Process Technologyll, 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-Productsl, CRC Press, 2013.

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

REFERENCES BOOKS:

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

2.Green J.H. and Kramer A., —Food Processing Waste Managementl, AVI Publishing Company, Malaysia,1981.

3.Nelson L. Nemerow and Franklin J. Agardy, —Strategies of Industrial and Hazardous Waste Managementl, 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 Managementl, 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 ELECTIVE

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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SEMESTER VII

16HE7101 Professional Ethics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	2	3	3	2	2		2	1		3	3	1
CO2	3	3	2	3	3	2	2		2	1		3	3	1
CO3	2	3	2	2	1	3	1		2	3	1	3	3	3
CO4	1	3	1	2		3	1		2	3	1	3	3	2
CO5	2	2	1	1	1	3	1		2	1	1	3	3	2
Avg	**2.2**	**2.8**	**1.6**	**2.2**	**2**	**2.6**	**1.4**		**2**	**1.8**	**1**	**3**	**3**	**1.8**

16FT7201 Food Additives

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	-	2	3	1	2	2	-	-	-	-	1	1	1
CO2	1	-	2	2	2	2	2	-	-	-	-	1	2	1
CO3	1	-	2	1	1	2	2	-	-	-	–	1	2	1
CO4	1	-	2	2	2	2	2	–	-	-	-	1	1	1
CO5	1	-	3	2	2	2	2	-	-	-	-	1	2	1
Avg	**1**	**-**	**2.2**	**2**	**1.6**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**1.6**	**1**

16FT7202 Plantation crops & Spices Product Technology

PO& PSO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O 2	
CO1	3	2	3	2	1	1	-	1	1	-	1	1	1	2	3
CO2	3	2	3	2	1	1	1	1	3	1	2	1	1	2	3
CO3	3	2	3	2	1	1	1	1	1	1	1	1	1	2	3
CO4	3	2	3	2	1	1	1	1	1	1	2	1	1	2	2
CO5	3	2	3	2	1	1	2	1	1	1	2	1	1	2	2
Avg	**3**	**2**	**3**	**2**	**1**	**1**	**1.25**	**1**	**1.5**	**1**	**1.75**	**1**	**1**	**2**	**3**

16FT7306 Technology of Snacks and Extruded Products

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2			2							3	2
CO2	3	1	2										3	2
CO3		1	2	2									3	1
CO4	3		2										3	2
CO5	1	3	3	3									3	2
Avg	**2.5**	**1.75**	**2.4**	**2.5**		**2**							**3**	**1.8**

16FT7308 Food Process Plant Layout and safety

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2			2							3	2
CO2	3	1	2										3	2
CO3		1	2	2									3	1

CO4	3		2									3	2
CO5	1	3	3	3								3	2
Avg	**2.5**	**1.75**	**2.4**	**2.5**		**2**						**3**	**1.8**

16FT7001 Food Process Equipment Design Laboratory

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	2	2	-	1	-	-	-	-	3	-	-	2	-	1
CO2	1	-	2	-	-	-	-	-	3	-	-	2	-	2
CO3	1	-	3	2	2	-	-	-	2	-	-	2	-	-
CO4	2	-	-	-	2	-	-	-	2	-	-	3	2	2
CO5	2	1	-	2	-	-	-	-	3	-	-	3	2	3
Avg	**1.6**	**1.5**	**2.5**	**1.7**	**2**	**-**	**-**	**-**	**2.6**	**-**	**-**	**2.4**	**2**	**2**

16FT7401 Post-Harvest Technology of Fruits and Vegetables

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	3	2	2	2	2	2		2			3	3	3
CO2	3	2	2	2	1	2	2		2	1		3	3	1
CO3	3	2	2	2	2	2	1		2	1		3	3	2
CO4	2	2	1	1	1	2	1		2	1		3	3	2
CO5	3	2	2	2	1	3	1		2	1		3	3	2
Avg	**2.8**	**2.2**	**1.8**	**1.8**	**1.4**	**2.2**	**1.4**		**2**	**1**		**3**	**3**	**2**

SEMESTER VIII

16FT8312 Total Quality Management

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	2	3	1	1	-	1	-	2	3	1	1
CO2	3	3	2	2	1	1	1	-	1	-	2	2	1	1
CO3	3	3	2	-	2	1	1	-	1	-	1	2	1	1
CO4	3	2	-	1	3	1	1	-	1	-	1	2	1	1
CO5	3	2	3	1	2	1	1	-	1	-	2	2	1	1
Avg	**3**	**2.6**	**2.5**	**1.5**	**2.2**	**1**	**1**	**-**	**1**	**-**	**1.6**	**2.2**	**1**	**1**

16FT8308 Emerging Technologies in Food Processing

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	2	3	1	1	-	1	-	2	3	1	1
CO2	3	3	2	2	1	1	1	-	1	-	2	2	1	1
CO3	3	3	2	-	2	1	1	-	1	-	1	2	1	1
CO4	3	2	-	1	3	1	1	-	1	-	1	2	1	1
CO5	3	2	3	1	2	1	1	-	1	-	2	2	1	1
Avg	**3**	**2.6**	**2.5**	**1.5**	**2.2**	**1**	**1**	**-**	**1**	**-**	**1.6**	**2.2**	**1**	**1**

Mapping of Course Outcome and Programme Outcome:

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12
I	I	16MA1101 Engineering Mathematics – I(Matrices and calculus)	1	1.4	1	1.2	1	1.4	1.2	1.2	1.8	3	1	2.2
		16PH1101 Engineering Physics	3	3	3	2.6	2.8	-	-	-	-	-	-	2
		16CY1101 Engineering Chemistry	3	2.2	2	1.6	2	1.3	-	-	-	-	-	1
		16HE1101 English for Engineers – I	3	2	2	2	2	1	1	-	-	-	-	1

		16GE1103 Problem Solving and Python Programming	3	1	1	-	-	1	-	-	-	-	-	1
		16GE1102 Engineering Graphics	2	3	3	-	2	-	-	-	2	-	-	2
		16PS1001 Physical Sciences Lab – I	2.8	3	2.6	1	1	2	1	-	-	1	1	1
		16GE1004 Problem Solving and Python Programming Lab	3	3	3	2.6	2.8	-	-	-	-	-	-	2
		16GE1002 Engineering Practices Lab												
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
I	**II**	16MA2101 Engineering Mathematics – II	1.6	1.6	1	1	1.2	2	1.8	1.8	2.2	3	1	2.8
		16PH2102 Physics of Materials	3	3	3	2.4	2.4	-	-	-	-	-	-	2
		16FT2101 Fundamentals of Biochemistry	3	2.4	1.2	1.8	1.8	1	2	-	-	-	-	1
		16HE2102 Essential English for Engineers - II	2	1	1.7	-	-	1	2	3	2	-	-	2
		16GE2101 Engineering Mechanics	1	2	1				1			1		1
		16CY2102 Environmental Science	2	3	3.0	-	2	-	-	-	-	-	-	2
		16PS2001 Physical Sciences Laboratory – II	3		3		3				1			
		16FT200 Biochemistry Lab												

Year	**Sem**	**Course code & Name**	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
II	**III**	16MA3111 Fourier Analysis and Z Transforms	3	2.8	3	1.4	1.4	2	-	-	-	-	-	2.2	2.2	2.2
		16FT3201 Fluid Mechanics	2.8	1.8	1	1.3		1						1	1	1
		16FT3202 Food Process Calculations	2.8	1.8	1	1.3		1						1	1	1
		16FT3203 Food Microbiology	2.8	1.8	1	1.3		1						1	1	1
		16FT3204 Food Chemistry	2.5	2	2.3	2	3	2	2				3		1.3	2.8
		16FT3001 Food Microbiology Laboratory	2	1.7	1.7	2	2		2					2	2	2

		16FT3002 Food Production Analysis Laboratory	2	1	1	1	2	2	2	-	1	1	-	2	1.2	0.4
Year	**Sem**	**Course code & Name**	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
II	**IV**	16MA4112 Applied Statistics & Numerical Methods	1	1.25	1.75	1	4				1			1.6	1	2.4
		16FT4201 Engineering Properties of Food Materials	1	1.25	2	1.6	1.5				2			2.2	3	2.6
		16FT4202 Fundamentals of Heat and Mass Transfer materials	2	1.2	2.2	2.5		2						2	3	2.6
		16FT4203 Food Process Engineering - I	2.8	1.8	1	1.3		2.2	2.8	1.6	2.2	2	2.6	1.4		2
		16FT4204 Food Analysis	3	2.8	3	2	2							2.2	2.2	2
		16HE4101 Total Quality Management	1.6	1.5	2.5	1.7	2				2.6			2.4	2	
		16FT4001 Food Analysis Laboratory	2.25	2.75	2.5	1.66	3		1.6						1	2.75
		16FT4001 Food Analysis Laboratory	1	1.25	1.75	1	1				1			1.6	1	2.4
Year	**Sem**	**Course code & Name**	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
II	V	16FT5201 Food Process Engineering - II	3	2	3	1	2	2	1.25				1.75	1	1	2
		16FT5202 Food Quality Assurance and Control	1		2.8			2	1	1				1	2.2	1
		16FT5203 Baking and Confectionery Technology	2.25	2.75	2.5	1.66	3		1.6						1	2.75
		16FT5204	2.5	1.75	2.2	2.5	0	2						1	3	1.8
		16FT5205 Unit Operations in Food Processing	1	1.25	1.75	1	1				1			1.6	1	2.4
		16FT5306 Milling Technology for Food Materials	1	2	1.2				1.25			1		1	1.6	
		16FT5001 Baking and Confectionery Technology Laboratory	2.25	2	2	2.25		1	1	2			1	2.25	1.5	2.25

		16FT5002 Food Process Engineering Laboratory	2.5	1.75	2.2	2.5								1	3	1.8
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
III	VI	16FT6201 Dairy Engineering	3	2	3	1	2	2	1.25				1.75	1	1	2
		16FT6202 Food Packaging	3	1	2	2		2						2	3	2.6
		16FT6203 Poultry, Meat and Fish Process Technology	2.5	1.75	2.2	2.5		2						1	3	1.8
		16FT6204 Refrigeration and Cold chain Management	2.3	2	2.25	2.5		2						2	3	2.75
		16FT6301 Beverage Technology	1	2	1.2				1.25			1		1	1.4	
		16FT6401 Traditional Foods	2.2	2.0	1.8	2	-	1	1	2	-	-	1	2	1.4	3
		16FT6001 Food Packaging and Fruits & Vegetable Processing Laboratory	1.5	1.75	1.75	1	1	1	1		1	1		1	1.25	2
		16FT6002 Dairy Engineering Laboratory	2	1.5	2	2	2		2					2	2.5	2
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
IV	VII	16HE7101 Professional Ethics	2.2	2.8	1.6	2.2	2	2.6	1.4		2	1.8	1	3	3	1.8
		16FT7201 Food Additives	2.2	2.8	1.6	2.2	2	2.6	1.4		2	1.8	1	3	3	
		16FT7202 Plantation crops & Spices Product Technology	3	2	3	2	1	1	1.25	1	1.5	1	1.75	1	1	2
		16FT7306 Technology of Snacks and Extruded Foods	2.2	2.8	1.6	2.2	2	2.6	1.4		2	1.8	1	3	3	1.8
		16FT7308 Food Process Plant Layout and safety	2.5	1.75	2.4	2.5		2							3	1.8

		16FT7401 Food Product Development	2.8	2.2	1.8	1.8	1.4	2.2	1.4		2	1		3	3	2
		16FT7001 Food Process Equipment Design Laboratory	1.6	1.5	2.5	1.7	2	-	-	-	2.6	-	-	2.4	2	2
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
IV	VIII	16FT8306 Waste Management and By-product Utilization in Food Industries	3	2.6	2.5	1.5	2.2	1	1	-	1	-	1.6	2.2	1	1
		16FT8308 Emerging Non-Thermal Processing of Foods	3	2.6	2.5	1.5	2.2	1	1	-	1	-	1.6	2.2	1	1

CO. PO, PSO'S Mapping (R2019)
SEMESTER IV

19FT4201 Fundamentals of Heat and Mass Transfer

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1		1	1	1				1			2	1	2
CO2	1	2	2	1	1							1		2
CO3	1	1		1	1							2		3
CO4	1	1	1	1	1							1		2
CO5	1	1	3	1								2		3
Avg	**1**	**1.25**	**1.75**	**1**	**4**				**1**			**1.6**	**1**	**2.4**

19FT4202 Food Process Calculations

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1		1	1	1				2			2	3	2
CO2	1	2	2	2	1							3		3
CO3	1	1		2	3							3		3
CO4	1	1	2	2	1							1		2
CO5	1	1	3	1								2		3
Avg	**1**	**1.25**	**2**	**1.6**	**1.5**				**2**			**2.2**	**3**	**2.6**

19FT4203 Engineering properties of food materials

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2										3	2

CO2	3		2			2							3	2
CO3		1	2	2										3
CO4	3		2									2		3
CO5	1	3	3	3								2		3
Avg	**2**	**1.2**	**2.2**	**2.5**		**2**						**2**	**3**	**2.6**

19FT4251 Food Chemistry

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	2	2	1	1		1	1	2				1	1	2
CO2	2	1	2	2		1	1					2	1	2
CO3	3	3	2	3		1	1	1				2	1	2
CO4	2	3	2	1		1	1					2	1	2
CO5	2	1	2	3		1	1	3			1	3	1	2
Avg	**2.8**	**1.8**	**1**	**1.3**		**1**						**1**	**1**	**1**

19MA4152 Statistics and Numerical Methods

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	3	1	2	-	-	-	-	-	-	2	3	2
CO2	3	3	3	2	1	-	-	-	-	-	-	3	2	2
CO3	3	3	3	1	1	-	-	-	-	-	-	2	2	2
CO4	3	3	3	3	3		-	-	-	-	-	2	2	2
CO5	3	3	3	3	3		-	-	-	-	-	2	2	2
Avg	**3**	**2.8**	**3**	**2**	**2**							**2.2**	**2.2**	**2**

19FT4001 Unit Operations Laboratory

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2		1					3			2		
CO2	1		2						3			2		
CO3	1		3	2	2				2			2		
CO4	2				2				2			3	2	
CO5	2	1		2					3			3	2	
Avg	**1.6**	**1.5**	**2.5**	**1.7**	**2**				**2.6**			**2.4**	**2**	

19FT4002 Food Process Equipment Design Laboratory

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3							3			3		3
CO2	2		2						3			2		3
CO3	2		2						3			2		3
Avg	**2.33**	**3**	**2**						**3**			**2.3**		**3**

SEMESTER V

19FT5201 Baking and Confectionery Technology

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	3	2	1	1	-	1	1	-	1	1	1	2
CO2	3	2	3	2	1	1	1	1	3	1	2	1	1	2
CO3	3	2	3	2	1	1	1	1	1	1	1	1	1	2
CO4	3	2	3	2	1	1	1	1	1	1	2	1	1	2

CO5	3	2	3	2	1	1	2	1	1	1	2	1	1	2
Avg	3	2	3	2	1	1	1.25	1	1.5	1	1.75	1	1	2

19FT5202 Food Additives

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1			3			2	1	1				1	3	1
CO2	1		2			2		1				1	2	1
CO3	1		3			2		1				1	2	1
CO4			3			2	1	1				1	2	1
CO5	1		3			2	1	1				1	2	1
Avg	**1**		**2.8**			**2**	**1**	**1**				**1**	**2.2**	**1**

19FT5203 Poultry, Meat and Fish Process Technology

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1		2			3	2	3				3		2	3
CO2	2	3	3	2	3		2							3
CO3	2	3	3	1			2						1	3
CO4	3	2	1	2									1	3
CO5	2	3	3				1							2
Avg	**2.25**	**2.75**	**2.5**	**1.66**	**3**		**1.6**						**1**	**2.75**

19FT5204 Principles of Food Processing

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**

CO1	3	2	2									3	2
CO2	3	1	2			2						3	2
CO3		1	2	2								3	1
CO4	3		2								1	3	2
CO5	1	3	3	3							1	3	2
Avg	**2.5**	**1.75**	**2.2**	**2.5**	**0**	**2**					**1**	**3**	**1.8**

19FT5205 Unit Operations in Food Processing

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	1		1	1	1				1			2	1	2
CO2	1	2	2	1	1							1	1	2
CO3	1	1		1	1							2		3
CO4	1	1	1	1	1							1		2
CO5	1	1	3	1								2		3
Avg	**1**	**1.25**	**1.75**	**1**	**1**				**1**			**1.6**	**1**	**2.4**

19FT5306 Milling Technology for Food Materials

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	1	2	1	-	-	-	1	-	-	1	-	1	1	-
CO3	1	2	1	-	-	-	1	-	-	1	-	1	1	-
CO4	1	2	1	-	-	-	1	-	-	1	-	1	1	-

CO5	1	2	2	-	-	-	2	-	-	1	-	1	3	-
Avg	**1**	**2**	**1.2**				**1.25**			**1**		**1**	**1.6**	

19FT5001 Baking and Confectionery Technology Laboratory

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	2	2	1	1		1	1	2				1	1	1
CO2	2	1	2	2		1	1					2	1	2
CO3	3	3	2	3		1	1	1				2	1	2
CO4	2	3	2	1		1	1					2	1	2
CO5	2	1	2	3		1	1	3			1	3	3	3
Avg	**2.25**	**2**	**2**	**2.25**		**1**	**1**	**2**			**1**	**2.25**	**1.5**	**2.25**

19FT5002 Unit Operations in Food Processing Laboratory

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	2										3	2
CO2	3	1	2										3	2
CO3		1	2	2									3	1
CO4	3		2									1	3	2
CO5	1	3	3	3								1	3	2
Avg	**2.5**	**1.75**	**2.2**	**2.5**								**1**	**3**	**1.8**

SEMESTER VI

19FT6201 Dairy Engineering

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO**	**PSO**

													1	**2**
CO1	3	2	3	1	2	2	-			-	1	1	1	2
CO2	3	2	3	1	2	2	1				2	1	1	2
CO3	3	2	3	1	2	2	1				1	1	1	2
CO4	3	2	3	1	2	2	1				2	1	1	2
CO5	3	2	3	1	2	2	2				2	1	1	2
Avg	3	2	3	1	2	2	1.25				1.75	1	1	2

19FT6202 Plantation crops and Spices Products Technology

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	2										3	2
CO2	3		2			2							3	2
CO3		1	2	2										3
CO4	3		2									2		3
CO5	1	3	3	3								2		3
Avg	**3**	**1**	**2**	**2**		**2**						**2**	**3**	**2.6**

19FT6203 Fruits and Vegetable Processing Technology

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	2										3	2
CO2	3	1	2			2							3	2
CO3		1	2	2									3	1
CO4	3		2									1	3	2
CO5	1	3	3	3								1	3	2
Avg	**2.5**	**1.75**	**2.2**	**2.5**		**2**						**1**	**3**	**1.8**

19FT6181 Professional Ethics in Engineering

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2										3	2
CO2	3		2			2							3	2
CO3		1	2	2										3
CO4	3		2									2		3
CO5	1	3	3	3								2		3
Avg	**2.3**	**2**	**2.25**	**2.5**		**2**						**2**	**3**	**2.75**

19FT6301 Beverage Technology

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	2	1									1	1	
CO2	1	2	1				1			1		1	1	
CO3	1	2	1				1			1		1	1	
CO4	1	2	1				1			1		1	1	
CO5	1	2	2				2			1		1	3	
Avg	**1**	**2**	**1.2**				**1.25**			**1**		**1**	**1.4**	

19FT6401 Traditional Foods

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	1	1	-	1	1	2	-	-	-	1	1	2

CO2	2	1	2	2	-	1	1		-	-	-	2	1	2
CO3	3	3	2	3	-	1	1	1	-	-	-	2	1	2
CO4	2	3	2	1	-	1	1		-	-	-	2	1	2
CO5	2	1	2	3	-	1	1	3	-	-	1	3	3	2
Avg	**2.2**	**2.0**	**1.8**	**2**	**-**	**1**	**1**	**2**	**-**	**-**	**1**	**2**	**1.4**	**3**

19FT6001 Dairy Engineering Laboratory

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	1	1	1	-	-	1	1	-	1	1	-	1	2	-
CO2	1	1	1	-	1	1	1	-	1	1	-	1	2	-
CO3	1	2	1	-	-	1	1	-	1	1	-	1	1	-
CO4	2	2	2	1	1	1	1	-	1	1	-	1	1	2
CO5	2	2	3	1	1	1	1	-	1	1	-	1	1	-
Avg	**1.5**	**1.75**	**1.75**	**1**	**1**	**1**	**1**		**1**	**1**		**1**	**1.25**	**2**

19FT6002 Fruits and Vegetable Processing Technology Laboratory

PO& PSO	**PO1**	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O 1**	**PS O 2**	
CO1	2	2	2	3	2		2					2	2	2	2
CO2	2	1	2	2	2		2					2	3	2	2
CO3	2	2	2	2	2		2					2	2	2	2
Avg	**2**	**1.5**	**2**	**2**	**2**		**2**					**2**	**2.5**	**2**	**2**

Mapping of Course Outcome and Programme Outcome:

Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**

I	I	19HE1101/ TECHNICAL ENGLISH	1	1.4	1	1.2	1	1.4	1.2	1.2	1.8	3	1	2.2
		19MA1102/ CALCULUS AND LINEAR ALGEBRA	3	3	3	2.6	2.8	-	-	-	-	-	-	2
		19PH1151/ APPLIED PHYSICS	3	2.2	2	1.6	2	1.3	-	-	-	-	-	1
		19CY1151/ CHEMISTRY FOR ENGINEERS	3	2	2	2	2	1	1	-	-	-	-	1
		19ME1101/ BASIC OF CIV AND MECHANICAL ENGINEERING	3	1	1	-	-	1	-	-	-	-	-	1
		19CS1151/ PYTHON PROGRMMING PRACTICES	2	3	3	-	2	-	-	-	2	-	-	2
		19ME1152/ ENGINEERING DRAWING	2.8	3	2.6	1	1	2	1	-	-	1	1	1
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
I	II	19HE2101/ BUSINESS ENGLISH FOR ENGINEERS	1.6	1.6	1	1	1.2	2	1.8	1.8	2.2	3	1	2.8
		19MA2101/ DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES	3	3	3	2.4	2.4	-	-	-	-	-	-	2
		19PH2151/ MATERIAL SCIENCE	3	2.4	1.2	1.8	1.8	1	2	-	-	-	-	1
		19CY2151/ ENVIRONMENTAL STUDIES	2	1	1.7	-	-	1	2	3	2	-	-	2
		19FT2105/ PRINCIPLES OF MICRO BIOLOGY	1	2	1				1			1		1
		19IT2151/ PROGRAMMING IN C	2	3	3.0	-	2	-	-	-	-	-	-	2
		ENGINEERING PRACTICES	3		3		3				1			

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
II	III	19MA3102 Fourier Analysis and Transforms	3	2.8	3	1.4	1.4	2	-	-	-	-	-	2.2	2.2	2.2
		19FT3201	2.8	1.8	1	1.3		1						1	1	1

		Fluid Mechanics														
		19FT3101 Principles of Thermodynamics	2.8	1.8	1	1.3		1						1	1	1
		19FT3202 Food Microbiology	2.8	1.8	1	1.3		1						1	1	1
		19FT3251 Bio Chemistry	2.5	2	2.3	2	3	2	2				3		1.3	2.8
		19FT3001 Food Microbiology Laboratory	2	1.7	1.7	2	2		2					2	2	2
		19FT3002 Food Production Analysis Laboratory	2	1	1	1	2	2	2	-	1	1	-	2	1.2	0.4
		19FT4002 Food Process Equipment Design Laboratory	2.33	3	2						3			2.3		3
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
II	**IV**	19FT4201 Fundamentals of Heat and Mass Transfer	1	1.25	1.75	1	4				1			1.6	1	2.4
		19FT4202 Food Process Calculations	1	1.25	2	1.6	1.5				2			2.2	3	2.6
		19FT4203 Engineering properties of food materials	2	1.2	2.2	2.5		2						2	3	2.6
		19FT4251 Food Chemistry	2.8	1.8	1	1.3		1						1	1	1
		19MA4152 Statistics and Numerical Method	3	2.8	3	2	2							2.2	2.2	2
		19FT4001 Unit Operations Laboratory	1.6	1.5	2.5	1.7	2				2.6			2.4	2	
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
II	V	19FT5201 Baking and Confectionery Technology	3	2	3	1	2	2	1.25				1.75	1	1	2
		19FT5202 Food Additives	1		2.8			2	1	1				1	2.2	1
		19FT5203 Poultry, Meat and Fish Process Technology	2.25	2.75	2.5	1.66	3		1.6						1	2.75

		19FT5204 Principles of Food Processing	2.5	1.75	2.2	2.5	0	2						1	3	1.8
		19FT5205 Unit Operations in Food Processing	1	1.25	1.75	1	1				1			1.6	1	2.4
		19FT5306 Milling Technology for Food Materials	1	2	1.2				1.25			1		1	1.6	
		19FT5001 Baking and Confectionery Technology Laboratory	2.25	2	2	2.25		1	1	2			1	2.25	1.5	2.25
		19FT5002 Unit Operations in Food Processing Laboratory	2.5	1.75	2.2	2.5								1	3	1.8
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
III	VI	19FT6201 Dairy Engineering	3	2	3	1	2	2	1.25				1.75	1	1	2
		19FT6202 Plantation crops and Spices Products Technology	3	1	2	2		2						2	3	2.6
		19FT6203 Fruits and Vegetable Processing Technology	2.5	1.75	2.2	2.5		2						1	3	1.8
		19FT6181 Professional Ethics in Engineering	2.3	2	2.25	2.5		2						2	3	2.75
		19FT6301 Beverage Technology	1	2	1.2				1.25			1		1	1.4	
		19FT6401 Traditional Foods	2.2	2.0	1.8	2	-	1	1	2	-	-	1	2	1.4	3
		19FT6001 Dairy Engineering Laboratory	1.5	1.75	1.75	1	1	1	1		1	1		1	1.25	2
		19FT6002 Fruits and Vegetable Processing Technology Laboratory	2	1.5	2	2	2		2					2	2.5	2

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
IV	VII	19FT7201 Food Analysis and Quality Control	2.2	2.8	1.6	2.2	2	2.6	1.4		2	1.8	1	3	3	1.8
		19FT7202 Food Packaging	2.2	2.8	1.6	2.2	2	2.6	1.4		2	1.8	1	3	3	
		19FT7203 Food Plant Layout and Management	3	2	3	2	1	1	1.25	1	1.5	1	1.75	1	1	2
		19FT7307 Emerging Non-Thermal Processing of Foods	2.5	1.75	2.4	2.5		2							3	1.8
		19XX74XXOpen Elective – II	2.8	2.2	1.8	1.8	1.4	2.2	1.4		2	1		3	3	2
		19FT7001 Food Packaging Laboratory	1.6	1.5	2.5	1.7	2	-	-	-	2.6	-	-	2.4	2	2
		19FT7002 Food Analysis and Quality Control Laboratory	3	3	2	2	1	1						2	3	3
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
IV	VIII	19FT8312 Total Quality Management	3	2.6	2.5	1.5	2.2	1	1	-	1	-	1.6	2.2	1	1
		19FT8308 Emerging Technologies in Food Processing	3	2.6	2.5	1.5	2.2	1	1	-	1	-	1.6	2.2	1	1

CO'S, PO'S & PSO'S MAPPING-(R 2019 With Amendments)

Semester – I

Course Code & Name : 21HE1101/ TECHNICAL ENGLISH

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	1	1	1	2	-	1	2	1	2	3	1	3	3	2
CO2	1	2	1	1	1	2	1	1	1	3	1	2	2	3
CO3	1	2	1	1	1	2	1	1	2	3	1	2	2	2
CO4	1	1	-	1	1	1	1	1	2	3	1	2	3	3
CO5	-	1	1	1	1	1	1	2	2	3	1	2	2	2
Avg	1	1.4	1	1.2	1	1.4	1.2	1.2	1.8	3	1	2.2	2.4	2.4

Course Code & Name : 21MA1101/ CALCULUS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	2	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	1	2
CO4	3	3	3	3	3	-	-	-	-	-	-	2	2	1
CO5	3	3	3	2	3	-	-	-	-	-	-	2	2	2
Avg	3	3	3	2.6	2.8	-	-	-	-	-	-	2	1.8	2

Course Code & Name : 21MA1102/ CALCULUS AND LINEAR ALGEBRA

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	1	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	1
Avg	3	3	3	2.6	2.8	-	-	-	-	-	-	2	1.8	2

Course Code & Name : 21MA1103/ CALCULUS AND DIFFERENTIAL EQUATIONS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	1	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	1
Avg	3	3	3	2.6	2.8	-	-	-	-	-	-	2	1.8	2

Course Code & Name : 21PH1151/ APPLIED PHYSICS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	2	2	1	1	1	-	-	-	-	-	1	2	1
CO2	3	3	1	1	2	-	-	-	-	-	-	1	3	3
CO3	3	2	1	2	2	-	-	-	-	-	-	1	3	3
CO4	3	2	3	2	3	1	-	-	-	-	-	1	2	2
CO5	3	2	3	2	2	2	-	-	-	-	-	1	2	3
Avg	3	2.2	2	1.6	2	1.333333	-	-	-	-	-	1	2.4	2.4

Course Code & Name : 21CY1151/ CHEMISTRY FOR ENGINEERS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	2	2	-	2	1	1	-	-	-	-	1	1	1
CO2	3	2	2	-	2	1	-	-	-	-	-	1	1	-
CO3	3	2	2	-	2	1	1	-	-	-	-	1	1	-
CO4	3	2	2	2	2	1	-	-	-	-	-	1	1	1
CO5	3	2	2	-	2	1	-	-	-	-	-	1	1	1
Avg	3	2	2	2	2	1	1	-	-	-	-	1	1	1

Course Code & Name : 21ME1101/BASICS OF CIVIL AND MECHANICAL ENGINEERING

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	1	1	-	-	1	-	-	-	-	-	1	3	3
CO2	3	1	1	-	-	1	-	-	-	-	-	1	3	2
CO3	3	1	1	-	-	1	-	-	-	-	-	1	2	2
CO4	3	1	1	-	-	1	-	-	-	-	-	1	3	2
CO5	3	1	1	-	-	1	-	-	-	-	-	1	3	2
Avg	3	1	1	-	-	1	-	-	-	-	-	1	2.8	2.2

Course Code & Name : 21CS1151/PYTHON PROGRMMING PRACTICES

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	2	3	3	-	2	-	-	-	-	-	-	2	2	2
CO2	2	3	3	-	2	-	-	-	2	-	-	2	2	2

CO3	2	3	3	-	2	-	-	-	2	-	-	2	2	2
CO4	2	3	3	-	2	-	-	-	2	-	-	2	2	2
CO5	2	3	3	-	2	-	-	-	2	-	-	2	2	2
Avg	2	3	3	-	2	-	-	-	2	-	-	2	2	2

Course Code & Name : 21ME1152/ ENGINEERING DRAWING

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO11**	**PSO12**
CO1	2	3	2	-	1	-	1	-	-	1	1	1	1	2
CO2	3	3	2	1	1	-	1	-	-	1	1	1	1	2
CO3	3	3	3	-	1	1	1	-	-	1	1	-	1	1
CO4	3	3	3	1	1	2	1	-	-	1	1	1	1	1
CO5	3	3	3	1	1	3	1	-	-	1	1	1	1	1
Avg	2.8	3	2.6	1	1	2	1	-	-	1	1	1	1	1.4

Course Code & Name : 21EC1153/ ELECTRON DEVICES AND ELECTRIC CIRCUITS

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO11**	**PSO12**
CO1	3	3	3	2	2	1	1				1	2	3	3
CO2	3	3	2	2	2	1	1				1	2	3	2
CO3	3	2	3	2	2	1	1				1	2	2	2
CO4	3	3	3	2	2	1	1				1	2	3	2
CO5	3	3	3	2	2	1	1				1	2	3	2
Avg	3	2.8	2.8	2	2	1	1				1	2	2.8	2.2

Course Code & Name : 21EC1154/ BASICS OF ELECTRON DEVICES AND ELECTRIC CIRCUITS

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO11**	**PSO12**
CO1	**3**	**3**	**3**	**2**	**2**	**1**	**1**				**1**	**2**	**3**	**3**
CO2	**3**	**3**	**2**	**2**	**2**	**1**	**1**				**1**	**2**	**3**	**2**
CO3	**3**	**2**	**3**	**2**	**2**	**1**	**1**				**1**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**2**	**2**	**1**	**1**				**1**	**2**	**3**	**2**
CO5	**3**	**3**	**3**	**2**	**2**	**1**	**1**				**1**	**2**	**3**	**2**
Avg	**3**	**2.8**	**2.8**	**2**	**2**	**1**	**1**				**1**	**2**	**2.8**	**2.2**

Course Code & Name : 21EE1155/ BASICS OF ELECTRICAL ENGINEERING

PO& PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO11**	**PSO12**
CO1	3	3											3	3
CO2		2											3	0

CO3		1	2	1		2							3	3
CO4									1		1		3	0
CO5			1	1	1								3	0
Avg	3	3											3	3

Semester –II

Course Code & Name : 21HE2101/ BUSINESS ENGLISH FOR ENGINEERS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	1	2	1	1	1	2	1	2	2	3	-	3	1	-
CO2	2	1	1	1	1	2	2	2	2	3	-	2	-	1
CO3	2	2	1	1	1	2	2	2	2	3	1	3	1	-
CO4	2	2	1	1	2	2	2	2	3	3	1	3	1	1
CO5	1	1	1	1	1	2	2	1	2	3	1	3	1	1
Avg	1.6	1.6	1	1	1.2	2	1.8	1.8	2.2	3	1	2.8	1	1

Course Code & Name : 21MA2101/ DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	2
Avg	3	3	3	2.4	2.4	-	-	-	-	-	-	2	2	2

Course Code & Name : 21MA2102/ COMPLEX VARIABLES AND TRANSFORM CALCULUS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	2
CO4	3	3	3	3	3	-	-	-	-	-	-	2	1	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	1
Avg	3	3	3	2.6	2.8	-	-	-	-	-	-	2	1.8	1.8

Course Code & Name : 21MA2103/ LINEAR ALGEBRA, NUMERICAL METHODS AND TRANSFORM CALCULUS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	1
CO2	3	2	3	2	3	-	-	-	-	-	-	2	1	2
CO3	3	2	3	3	3	-	-	-	-	-	-	3	2	3
CO4	3	3	2	2	2	-	-	-	-	-	-	2	1	2
CO5	2	3	3	3	3	-	-	-	-	-	-	2	2	1
Avg	2.8	2.6	2.8	2.4	2.6	-	-	-	-	-	-	2.2	1.6	1.8

Course Code & Name : 21MA2104/ DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	3
CO3	3	3	3	3	2	-	-	-	-	-	-	2	2	2
CO4	3	3	3	3	2	-	-	-	-	-	-	2	2	2
CO5	3	3	3	3	2	-	-	-	-	-	-	2	2	2
Avg	3	3	3	2.6	2	-	-	-	-	-	-	2	2	2.2

Course Code & Name : 21PH2151/ MATERIAL SCIENCE

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	2	1	1	1	1	-	-	-	-	-	1	2	1
CO2	3	3	1	1	2	-	-	-	-	-	-	1	2	2
CO3	3	2	1	2	2	-	-	-	-	-	-	1	2	3
CO4	3	3	1	2	2	1	-	-	-	-	-	1	2	2
CO5	3	2	2	3	2	1	2	-	-	-	-	1	2	3
Avg	3	2.4	1.2	1.8	1.8	1	2	-	-	-	-	1	2	2.2

Course Code & Name : 21CY2151/ ENVIRONMENTAL STUDIES

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	2	-	-	-	-	2	3	3	2	-	-	2	-	-
CO2	2	-	-	-	-	2	3	3	2	-	-	2	-	-
CO3	2	1	1	-	-	2	3	3	2	-	-	2	-	-
CO4	2	1	2	-	-	2	3	3	2	-	-	2	-	-
CO5	2	1	2	-	-	2	3	3	2	-	-	2	-	-
Avg	2	1	1.7	-	-	1	2	3	2	-	-	2	-	-

Course Code & Name : 21ME2101/ ENGINEERING MECHANICS

PO&	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9		PO11			

PSO										PO10		PO12	PSO11	PSO12
CO1	3	3	1	-	-	-	1	-	-	-	1	1	1	2
CO2	3	3	2	1	-	-	1	-	-	-	1	1	1	2
CO3	3	3	1	-	-	1	1	-	-	1	1	-	1	1
CO4	3	3	2	1	-	2	1	-	-	1	1	1	1	1
CO5	3	3	2	1	-	3	1	-	-	1	1	1	1	1
Avg	3	3	1.6	1		2	1			1	1	1	1	1.4

Course Code & Name : 21EE2103/BEEE

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	3	3											3	3
CO2		2											3	0
CO3		1	2	1		2							3	3
CO4									1		1		3	0
CO5			1	1	1								3	0
Avg	3	3											3	3

Course Code & Name : 21AG2104/ PRINCIPLES OF FOOD SCIENCES

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	1	2			1	2	1		1				2	2
CO2	1	2	1	1	1	1							2	1
CO3	1	1	3		1	2							2	3
CO4	1	2	1	1	2	1							1	2
CO5	1	1	1	1	1	2	1		1				1	2
Avg	1	1.6	1.5	1	1.2	1.6	1		1				1.6	2

Course Code & Name : 21FT2105/ PRINCIPLES OF MICRO BIOLOGY

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	1	2	1				1					1	2	
CO2	1	2	1				1			1		1	1	
CO3	1	2	1				1			1		1	1	2
CO4	1	2	1				1			1		1	1	
CO5	1	2	1				1			1		1	3	
Avg	1	2	1				1			1		1	1.6	2

Course Code & Name : 21IT2151/ PROGRAMMING IN C

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO11	PSO12
CO1	2	3	3	-	2	-	-	-	-	-	-	2	2	2
CO2	2	3	3	-	2	-	-	-	2	-	-	2	2	2
CO3	2	3	3	-	2	-	-	-	2	-	-	2	2	2
CO4	2	3	3	-	2	-	-	-	2	-	-	2	2	2
CO5	2	3	3	-	2	-	-	-	2	-	-	2	2	2
Avg	2	3	3.0	-	2	-	-	-	-	-	-	2	2	2

Mapping of Course Outcome and Programme Outcome:

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12
I	I	21HE1101/ TECHNICAL ENGLISH	1	1.4	1	1.2	1	1.4	1.2	1.2	1.8	3	1	2.2
		21MA1102/ CALCULUS AND LINEAR ALGEBRA	3	3	3	2.6	2.8	-	-	-	-	-	-	2
		21PH1151/ APPLIED PHYSICS	3	2.2	2	1.6	2	1.3	-	-	-	-	-	1
		21CY1151/ CHEMISTRY FOR ENGINEERS	3	2	2	2	2	1	1	-	-	-	-	1
		21ME1101/ BASIC OF CIV AND MECHANICAL ENGINEERING	3	1	1	-	-	1	-	-	-	-	-	1
		21CS1151/ PYTHON PROGRMMING PRACTICES	2	3	3	-	2	-	-	-	2	-	-	2
		21ME1152/ ENGINEERING DRAWING	2.8	3	2.6	1	1	2	1	-	-	1	1	1
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
I	II	21HE2101/ BUSINESS ENGLISH FOR ENGINEERS	1.6	1.6	1	1	1.2	2	1.8	1.8	2.2	3	1	2.8
		21MA2101/ DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES	3	3	3	2.4	2.4	-	-	-	-	-	-	2
		21PH2151/ MATERIAL SCIENCE	3	2.4	1.2	1.8	1.8	1	2	-	-	-	-	1
		21CY2151/ ENVIRONMENTAL STUDIES	2	1	1.7	-	-	1	2	3	2	-	-	2

		21FT2105/ PRINCIPLES OF MICRO BIOLOGY	1	2	1				1			1		1
		21IT2151/ PROGRAMMING IN C	2	3	3.0	-	2	-	-	-	-	-	-	2
		ENGINEERING PRACTICES	3		3		3				1			

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
II	III	21MA3102 Fourier Analysis and Transforms	3	2.8	3	1.4	1.4	2	-	-	-	-	-	2.2	2.2	2.2
		21FT3201 Fluid Mechanics	2.8	1.8	1	1.3		1						1	1	1
		21FT3101 Principles of Thermodynamics	2.8	1.8	1	1.3		1						1	1	1
		21FT3202 Food Microbiology	2.8	1.8	1	1.3		1						1	1	1
		21FT3251 Bio Chemistry	2.5	2	2.3	2	3	2	2				3		1.3	2.8
		21FT3001 Food Microbiology Laboratory	2	1.7	1.7	2	2		2					2	2	2
		21FT3002 Food Production Analysis Laboratory	2	1	1	1	2	2	2	-	1	1	-	2	1.2	0.4
		21FT4002 Food Process Equipment Design Laboratory	2.33	3	2						3			2.3		3

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
II	IV	21FT4201 Fundamentals of Heat and Mass Transfer	1	1.25	1.75	1	4				1			1.6	1	2.4
		21FT4202 Food Process Calculations	1	1.25	2	1.6	1.5				2			2.2	3	2.6
		21FT4203 Engineering properties of food materials	2	1.2	2.2	2.5		2						2	3	2.6
		21FT4251 Food Chemistry	2.8	1.8	1	1.3		1						1	1	1
		21MA4152 Statistics and	3	2.8	3	2	2							2.2	2.2	2

		Numerical Method														
		21FT4001 Unit Operations Laboratory	1.6	1.5	2.5	1.7	2				2.6			2.4	2	
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
II	V	21FT5201 Baking and Confectionery Technology	3	2	3	1	2	2	1.25				1.75	1	1	2
		21FT5202 Food Additives	1		2.8			2	1	1				1	2.2	1
		21FT5203 Poultry, Meat and Fish Process Technology	2.25	2.75	2.5	1.66	3		1.6						1	2.75
		21FT5204 Principles of Food Processing	2.5	1.75	2.2	2.5	0	2						1	3	1.8
		21FT5205 Unit Operations in Food Processing	1	1.25	1.75	1	1				1			1.6	1	2.4
		21FT5306 Milling Technology for Food Materials	1	2	1.2				1.25			1		1	1.6	
		21FT5001 Baking and Confectionery Technology Laboratory	2.25	2	2	2.25		1	1	2			1	2.25	1.5	2.25
		21FT5002 Unit Operations in Food Processing Laboratory	2.5	1.75	2.2	2.5								1	3	1.8
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
III	VI	21FT6201 Dairy Engineering	3	2	3	1	2	2	1.25				1.75	1	1	2
		21FT6202 Plantation crops and Spices Products Technology	3	1	2	2		2						2	3	2.6
		21FT6203 Fruits and Vegetable Processing Technology	2.5	1.75	2.2	2.5		2						1	3	1.8
		21FT6181 Professional	2.3	2	2.25	2.5		2						2	3	2.75

		Ethics in Engineering														
		21FT6301 Beverage Technology	1	2	1.2				1.25			1		1	1.4	
		21FT6401 Traditional Foods	2.2	2.0	1.8	2	-	1	1	2	-	-	1	2	1.4	3
		21FT6001 Dairy Engineering Laboratory	1.5	1.75	1.75	1	1	1	1		1	1		1	1.25	2
		21FT6002 Fruits and Vegetable Processing Technology Laboratory	2	1.5	2	2	2		2					2	2.5	2

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
IV	VII	21FT7201 Food Analysis and Quality Control	2.2	2.8	1.6	2.2	2	2.6	1.4		2	1.8	1	3	3	1.8
		21FT7202 Food Packaging	2.2	2.8	1.6	2.2	2	2.6	1.4		2	1.8	1	3	3	
		21FT7203 Food Plant Layout and Management	3	2	3	2	1	1	1.25	1	1.5	1	1.75	1	1	2
		21FT7307 Emerging Non-Thermal Processing of Foods	2.5	1.75	2.4	2.5		2							3	1.8
		21XX74XXOpen Elective – II	2.8	2.2	1.8	1.8	1.4	2.2	1.4		2	1		3	3	2
		21FT7001 Food Packaging Laboratory	1.6	1.5	2.5	1.7	2	-	-	-	2.6	-	-	2.4	2	2
		21FT7002 Food Analysis and Quality Control Laboratory	3	3	2	2	1	1						2	3	3
Year	**Sem**	**Course code & Name**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
IV	VIII	21FT8312 Total Quality Management	3	2.6	2.5	1.5	2.2	1	1	-	1	-	1.6	2.2	1	1
		21FT8308 Emerging Technologies in Food Processing	3	2.6	2.5	1.5	2.2	1	1	-	1	-	1.6	2.2	1	1