



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
(Established by Govt. of A.P., ACT No.30 of 2008)
ANANTHAPURAMU – 515 002 (A.P) INDIA

M.Sc in FOOD TECHNOLOGY

COURSE STRUCTURE

SEMESTER – I

S. No.	Course Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21G13101	Advances in Food Chemistry	PC	4	-	-	4
2.	21G13102	Instrumental Methods in Food Analysis	PC	4	-	-	4
3.	21G13103	Advances Food Microbiology	PC	4	-	-	4
4.	21G13104	Research Methodology and Biostatistics	PR	4	-	-	4
5.	21G13105	Food additives and flavor technology	PC	4	-	-	4
6.	21G13106	Advances in Food Chemistry Lab	PC	-	1	2	2
7.	21G13107	Instrumental Methods in Food Analysis	PC		1	2	2
8.	21G13108	Advances in Food Microbiology Lab	PC	-	1	2	2
9.	21G13109	Biostatistics & Computer applications Lab	PC	-	1	2	2
		Total		20	4	8	28



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SEMESTER – II

S.No.	Course Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21G13201	Advances in Nutritional Biochemistry	PC	4	-	-	4
2.	21G13202	Advances in Technology of animal-based Foods	PC	4	-	-	4
3.	21G13203	Food Processing and Packaging Technology	PC	4	-	-	4
4.	21G13204	Advances in Spices, Condiments and Confectionary Foods	PC	4	-	-	4
5.	21G13205	Advances in Food Preservation and Processing	PC	4	-	-	4
6.	21G13206	Advances in Nutritional Biochemistry Lab	PC	-	1	2	2
7.	21G13207	Advances in Spices, Condiments and Confectionary Foods Lab	PC	-	1	2	2
8.	21G13208	Food Processing and Packaging Technology Lab	PC	-	1	2	2
9.	21G13209	Skill oriented course (Product design, development, packaging and marketing. Ex: Traditional foods, Pathiri rice based products, and local area products such as Tomato, groundnuts, millets etc) Mango seed utilization, Rice porridge dried in hot plate and coated with ghee and sugar	SC	-	1	2	2
		Total		20	4	8	28



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SEMESTER – III

S.No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21G13301	Advances in Cereals, Legumes and Oil Seed Technology	PC	4	-	-	4
2.	21G13302	Advanced Technologies of Fruits & Vegetables	PC	4	-	-	4
3.	21G13303	Food Laws and Regulations	PC	4	-	-	4
4.	21G13304	Food Industrial Waste Management	PC	4	-	-	4
5.	21G13305	Advances in Food biotechnology	PC	4	-	-	4
6.	21G13306	Advances in Cereals, Legumes and Oil Seed Technology Lab	PC	-	1	2	2
7.	21G13307	Advanced Technologies of Fruits and Vegetables Lab	PC		1	2	2
8.	21G13308	Food Quality Analysis Lab	PC	-	1	2	2
9.	21G13309	Co-curricular Activities					2
10	21DAC101a	English for Research Paper writing	MC	2	-	-	0
		Total		22	3	6	28



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SEMESTER - IV

S.No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21G13401a	Program Elective Food Product Development and Commercialization	PE	3	-	-	3
	21G13401b	Management of Food Processing					
	21G13401c	World Food Demand and Indian Scenario Business Management					
2.	21DOE301b	General Elective Industrial Safety	GE	3	-	-	3
	21DOE301a	Cost Management of Engineering					
	21DOE301e	Projects Waste to Energy					
3.	21G13402	Research Work				20	10
4.	21G13403	Comprehensive Viva voce		2			2
		Total		8	-	20	18


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M.Sc in FOOD TECHNOLOGY
DETAILED SYLLABI

Course Code	ADVANCES IN FOOD CHEMISTRY	L	T	P	C
21G13101		4	0	0	4
Semester		I			
Course Objectives:					
<p>This course aims</p> <ul style="list-style-type: none"> To study about the major and minor components of food and their properties and to know the classification, structure and chemistry of the various food components. To provide an optimum environment and opportunity for students to gain an understanding of the chemical bases of food component reactivity, functionality of food. To understand the experimenting with food systems to enhance their critical thinking skills through structured problem solving. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> To provide the basic understanding of the chemistry of carbohydrates in food (L2) Describe the general chemical structures of the major components of foods (proteins, carbohydrates, and lipids). (L2) Ability to use terminology, appropriate to the field of food chemistry, correctly and contextually and will. Learn the physical properties and reactivity of major food components. (L4) Will predict how processing conditions are likely to change the reactivity of food components. (L2) Through critical evaluation, it helps to determine approaches that may be used to control the reactivity of those food components which impact the overall quality of finished products. (L5) 					
UNIT - I	CARBOHYDRATES				
<p>Introduction, Classification and structure, functional properties of carbohydrates, Determination of the configuration of the monosaccharide. Ring structure of the monosaccharide. Glucose and fructose. Disaccharides: Structure and synthesis of Sucrose. Trisaccharides. Polysaccharides. Glycosides. Properties of Starch – gelatinisation, gel formation, syneresis, starch degradation, dextrinisation, retrogradation and Dietary Fiber – Definition, Sources and Functions, Cellulose and types and applications. Gums-Classification, sources, Composition and applications.</p>					
UNIT - II	AMINO-ACIDS AND PROTEINS				


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M.Sc in FOOD TECHNOLOGY

Nomenclature, sources, structure, functions, classification - essential and nonessential amino acids, Physical and chemical properties of proteins and amino acids, functional properties - denaturation, hydrolysis, changes in proteins during processing. Polypeptides. Peptide bonds.	
UNIT - III	OILS, FATS, WAXES
Introduction – Occurrence – Glycerides – Chemical composition of Fats – General Physical and Chemical properties – Hydrolysis – Hydrogenation – Hydrogenolysis – Trans esterification – Auto oxidation – Rancidification – Acid Value – Saponification value – Iodine value – Reichert. Meissl value – Uses of Oils/fats – Fixed and volatile oils – Mineral Oils – Drying Oils Waxes, Fat replacers, different types, applications in food industry.	
UNIT - IV	VITAMINS AND MINERALS
Introduction, Classification of vitamins, structure of vitamins, Functions of vitamins and minerals, Dietary Sources. Nutrient Interaction –interaction between vitamins and mineral-synergistic and antagonistic effects-fortification of food.	
UNIT - V	
Food Enzymes -Definition, importance, classification and properties; Enzymatic browning in foods, non-enzymatic browning and industrial applications of enzymes. Food pigments- Plant and animal origins, Food additives- Preservatives, coloring agents, sweetening agents etc., Water: Water in foods, Types of water in foods: Water activity-Definition, measurement of water activity, role and importance of water activity in foods	
Textbooks:	
<ol style="list-style-type: none"> 1. Krishna Prakashan, Organic Natural Products, Media (p) Ltd, vol 2, 2015. 2. Manay, N.S. Shadaksharaswamy, M. “Foods- Facts and Principles”, New age international Publishers, New Delhi,2004. 	
Reference Books:	
<ol style="list-style-type: none"> 1. Meyer, L.H. “Food Chemistry”. CBS publishers and Distributors, New Delhi,2002. 2. O.P.AGARWAL, Organic natural products, Goel publishing house, volume 1 &2 , 2015 . 3. Rama Rao, A.V.S.S.L.K. Book of Biochemistry, S. Publishers 5th edition, 1986. 4. Damodaran,S., Kirk L. Parkin, Fennema O R.“Fennema’s Food Chemistry”- CRC press, New York,4th edition,2007. 	



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Course Code	INSTRUMENTAL METHODS IN FOOD	L	T	P	C
21G13102	ANALYSIS	4	0	0	4
Semester		I			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> • Acquire basic principles of simple instrumental methods for estimation of organic/inorganic species. • Gain basic knowledge of limitations of analytical methods. • Characterize the Materials synthesized by chemical industry. • Understand the chromatographic techniques for the separation of impurities in the industrially synthesized compounds. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course student shall be able to</p> <ul style="list-style-type: none"> • Analyse the statistical data for the analysis in analytical chemistry. (L3) • Acquire enough knowledge on industrial processes and Identification of Products using different analytical and instrumental techniques. (L5) • Learn the basic principles of spectrophotometry like UV-Vis and IR. (L1) • Gain the knowledge on HPLC and GC (L1) • Learn the basic principles of GC-MS/MS and LC-MS/MS (L1) 					
UNIT - I	INTRODUCTION TO ANALYTICAL CHEMISTRY				
<p><i>Role of analytical chemistry in food technology –Volumetric and Gravimetric analysis. Preparation of standards, working standards and solutions of known concentration (percent, molar, molal, normal, ppm and ppb) and their dilution.</i></p> <p>Classical analytical techniques: Gravimetry, Titrimetry, Refractometry and Polarimetry: Principle, Instrumentation and applications of each technique in food analysis.</p>					
UNIT - II	CHROMATOGRAPHIC TECHNIQUES				
<p>Fundamentals of chromatographic separations and their classification. The plate theory, capacity factor and resolution factor, Chromatographic efficiency, Partition coefficient etc. Principle and applications of paper (Ascending, Descending, Radial, Two dimensional) Partition, Thin layer chromatography, HPTLC, size exclusion and ion exchange chromatography, Gas Chromatography.</p>					


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High performance Liquid Chromatography (HPLC): Basics of liquid chromatography, HPLC columns and Stationary phase, mobile phases, isocratic and gradient elution, Detectors, applications in food analysis.	
UNIT - III	SPECTROSCOPY
Introduction of spectroscopy. Basic components of a spectrometer. UV- Visible spectrometry; Beer-Lamberts law, Absorbance, Transmittance, Molar absorptivity. Components and functioning of an UV-vis spectrophotometer. Single beam and Double beam. Calibration curve. Introduction-origin of IR spectra-instrumentation, group frequencies, applications of IR spectra analysis spectral data of alcohols-aldehydes and ketones –carboxylic acids –amines –amino acids –proteins, applications of in food analysis.	
UNIT - IV	ATOMIC ABSORPTION, ATOMIC EMISSION SPECTROSCOPY & ICP-MS
Principles- Atomization process, atomic line widths and radiation sources for AAS, temperature gradients, cells detectors, interferences. Atomic Emission spectroscopy: Atomic spectra, sources, Merits, demerits and applications. Basic principles and instrumentation of ICP-MS. Application of ICP-MS for analysis of metallic contaminants in food, Applications in food analysis.	
UNIT - V	HYPHENATED TECHNIQUES & BIOLOGICAL TECHNIQUES
Introduction to Mass spectrometry. GC-MS/MS, LC-MS/MS. DNA/Protein based: Fundamental principles and instrumentation of the systems. Measurement techniques and result interpretations of Polymerase chain Reaction (PCR) technique, Applications in food analysis	
Textbooks:	
<ol style="list-style-type: none"> 1. Douglas A. Skoog, Donald M. West and F. James Holler, Analytical Chemistry and Introduction, Saunders college publishing, New York, 1990. 2. J. Bassett, R.C Denny, G. Jeffery and J. Mendham. Vogel's Text book of Inorganic Quantitative Analysis, 4th edition, Longman group Ltd, Harlow, 1985. 3. Sharma BK, Analytical chemistry, Krishan prakashan publication, vol 1, 2014 4. Gurudeep R, Chatwal and sham k, Anand, Instrumental Methods of Chemical Analysis, Himalyan publication house, vol 1, 2012. 	
Reference Books:	
<ol style="list-style-type: none"> 1. Pietrzyk and Frank. Analytical Chemistry, 1990. 2. Omachonu V.K. and Ross J.E. Principles of Total Quality, S.Chand & Co.Ltd., New Delhi, 1997. 3. Werner Funk, Vera Damman, Gerhild Donnervert. Quality Assurance in Analytical Chemistry VCH Publishers, New York, NY (USA), 1997. 4. Y. Anjaneyulu, Quality Assurance and GLP- IGNOU Publications, New Delhi-99. 	


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Course Code	ADVANCES FOOD MICROBIOLOGY	L	T	P	C
21G13103		4	0	0	4
Semester		I			
Course Objectives:					
<p>This course aims</p> <ul style="list-style-type: none"> To provide the knowledge of microorganisms (probiotic, pathogens and spoilage) Associated with foods and their origin and role. To familiarize the factors that determine the presence, growth and survival of Microorganisms in food. To train the students on general principles of food microbiology. To acquire the knowledge on various fermentation processes 					
Course Outcomes (CO): Student will be able to					
<p>At the end of this course, students will be able to</p> <ul style="list-style-type: none"> Explain the interactions between microorganisms and the food environment, and Factors influencing their growth and survival. (L2) Explain the significance and activities of microorganisms in food (L2) Describe the characteristics of foodborne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification. (L2) Explain why microbiological quality control programs are necessary in food Production (L2) Explain the effects of fermentation in food production and how it influences the microbiological quality and status of the food product. (L2) 					
UNIT - I					
Introduction to Biology-branches of biology-diversity among living organisms-classification system-(Two kingdoms, three kingdoms, five kingdoms) metabolism, catabolism, and anabolism. Origin of microbiology-definition, History, Scope of microbiology-Branches of microbiology. Microscopic Study of bacteria (Gram positive and Gram negative), yeast molds, viruses, with respect to morphology, reproduction growth, and nutritional requirements. Growth curve and reproduction.					
UNIT - II					
Culturing of microorganisms –methods of sterilization, disinfection and sanitation (Maintenance of aseptic conditions) Isolation, preservation and maintenance of pure culture. General and selective media for different types of microorganisms. Rapid methods of microbial analysis					



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UNIT - III		
Food microbiology - Microbes in manufacturing of important food ingredients. Factors affecting spoilage of foods; Micro flora associated with various food groups their spoilage potential & control. Microbiological spoilage problems associated with typical food products. Microorganisms in food fermentation.		
UNIT - IV		
Harmful /deleterious effects –food borne infections, food poisoning, Microbial toxins, newer pathogens. Detection methods for <i>E. coli</i> , <i>Staphylococci</i> , <i>Yersinia</i> , <i>Campylobacter</i> , <i>Cereus</i> , <i>Cl.botulinum</i> & <i>Salmonella</i> from food samples.		
UNIT - V		
Industrial productions – fermentations, machines, fermentation types, chemo stat. Industrial production of alcoholic, distilled beverages, citric acid, lactic acid bread enzymes (amylase), acetic acid. Microbial food products, mushrooms, single cell proteins, dairy products-yogurt, curd, cheese, flavored milk.		
Textbooks:		
<ol style="list-style-type: none"> 1. V. Ramesh, Food microbiology, MJP publishing, 2007. 2. W.C. Frazier, Food microbiology, Mc graw Hill Pub. Co. New York, 5th Edition, 2013; 3. J.M. Jay Modern Food Microbiology, CBS publisher, 2nd edition, 2005. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Atlas R.M, Basic and practical Microbiology, MacMillan Publication Company, New York, 1934. 2. Cruger J.G. Black J.G. and Davison V.E. Microbiology principles and applications Prentice Hall of India Pvt. Ltd., 1990: 3. Hary W.S. Paul J and Van Denmark Microbes in action – a laboratory manual of Microbiology. Tarpowalsd. B. & sons, & Co., Ltd., Bombay. 1972: 4. Brock & Brock Basic Microbiology, CBS Publishers & Distributors, Prentice – Hall (India) Ltd., New Delhi. 1996. 		



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Course Code	RESEARCH METHODOLOGY AND BIostatISTICS	L	T	P	C
21G13104		4	0	0	4
	Semester	I			
Course Objectives:					
<p>This course aims</p> <ul style="list-style-type: none"> To develop a research orientation among the students and acquaint them with fundamentals of research methods To have a knowledge about research and how research is conducted. To understand the data collection methods the sampling methods and the data analysis method. To create awareness about the importance of research in all fields. 					
Course Outcomes (CO): Student will be able to					
<ul style="list-style-type: none"> At the end of the course, the students will be able to Obtain knowledge on various kinds of research questions and research design (L2) Describe qualitative, quantitative and mixed methods research. (L2) Design a good quantitative purpose statement and hypotheses. (L6) Explain the various types of quantitative sampling techniques and conditions use. (L2) Describe the various steps involved in coding qualitative data. (L2) Apply the various statistical tools to test the hypothesis, drawing inferences and obtain knowledge on writing different types of report. (L3) 					
UNIT - I	RESEARCH METHODOLOGY				
Meaning, objectives and types of research. Research approaches, Significance of research, Research and scientific methods, Research process and Criteria of good research. Definition and Identification of a Research Problem – Selection of Research problem, Justification, Theory, Hypothesis, Basic assumptions, Limitations and delimitations of the problem.					
UNIT - II	RESEARCH DESIGN AND MEASUREMENT				
Explain the various types of quantitative sampling techniques and conditions use. Describe the various steps involved in coding qualitative data. Apply the various statistical tools to test the hypothesis & drawing inferences. Obtain knowledge on writing different types of report. Develop independent thinking for critically analyzing research reports.					
UNIT - III	SAMPLING AND DATA COLLECTION				



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Sampling Techniques – Probability and Non-probability sampling methods – Data Collection Types of data – Primary and Secondary data – Methods of primary data collection – Observation, Interview, Questionnaire and schedule – Construction of questionnaire – pilot study – case study, literature survey.

UNIT - IV

DATA PREPARATION, ANALYSIS AND STATISTICS

Data Preparation – editing – Coding – Data entry – Test of significance – Assumptions about Parametric and nonparametric tests. Parametric tests – Introduction ANOVA – Application of Statistical software for data analysis. Introduction to Descriptive Statistics – Hypothesis Testing – T-test – Analysis of Variance – Linear Regression.

UNIT - V

REPORT DESIGN AND WRITING

Introduction – Research Report – Research Proposal – Different types – Contents of report – Important Parts – Title, Table of Contents – Synopsis, bibliography – Introductory Section – Research Design – Result – Sampling Techniques – Probability and Non probability sampling methods – Data Collection – Types of data – Primary and Secondary data Methods of primary data collection – Observation, Interview, Questionnaire and Schedule – Construction of questionnaire – pilot study – case study.

Textbooks:

1. Kothari, C.R., "Research Methodology", Methods and Techniques, New Age International, 6th Edition, 2010.

Reference Books:

1. Panneerselvam, R., "Research Methodology", Prentice-Hall of India, New Delhi, 7th Edition, 2004.
2. Donald R. Cooper, Pamela S. Schindle and JK Sharma, Business Research Methods, 11th Edition, Tata McGraw Hill, New Delhi, 2012.


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Course Code	FOOD ADDITIVES AND FLAVOUR TECHNOLOGY	L	T	P	C
21G13105		4	0	0	4
Semester		I			
Course Objectives:					
<p>This course aims</p> <ul style="list-style-type: none"> To provide the knowledge of benefit of different types of additives and their estimation . To familiarize the antioxidants and their stability with applications. To train the students on general principles of food additives and flavor technology. To acquire the knowledge on various sweeteners, emulsifiers and food colours in food preparation processes 					
Course Outcomes (CO): Student will be able to					
<p>At the end of this course, students will be able to</p> <ul style="list-style-type: none"> Explain the different types of food additives and preservatives and their factors.L2 Explain the significance and functions of preservatives and flavouring agents in food L2 Describe the functional aspects of enzyme action and applications.L2 Explain why food additives and flavoring agents necessary in food L2 Production Explain the Quality control of flavourings and their raw materials with their applications.L2. 					
UNIT - I					
Introduction: Types of additives, benefits of additives, risk of additives, regulations. Estimation of food additive intake- NOEL, ADI, toxicological classification of food additives Nutritional additives: Vitamins- chemistry, units and requirements, properties, commercial forms, amino acids, fatty acids, minerals and trace minerals, regulations and nutritional additives. FSSAI permitted food additives and their limits					
UNIT - II					
Preservatives (antimicrobials): Chemical and biological preservatives. Mechanisms of action. Antioxidants: phenolic antioxidants- applications, natural antioxidants; oxidation and use of antioxidants. Oxidation measurement, oxidative stability and antioxidant effectiveness, analysis of antioxidants, regulation of phenolic antioxidants.					
UNIT - III					



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Sweeteners: theory of sweetening, non-nutritive sweeteners, nutritive sweeteners, choice of sweeteners.

Food colours: History of the use of colours, role and use of colorants, types of colorants, toxicological considerations.

Emulsifiers: Emulsifier chemistry, emulsifier function and mechanism of action, emulsifier selection.

Application in foods: Cereal-based products, dairy products, candy products and miscellaneous applications.

Polysaccharides in foods: Starch, chemically modified starches, glycogen, cellulose and hemicelluloses, pectic substances, plant gums.

UNIT - IV

Enzymes: Functional aspects, mechanism of enzyme action, application of enzymes in the food, industry, regulations on the use of enzymes, toxicology.

Acid, bases and buffers (pH control agents)

Miscellaneous food additives: Firming agents, formulation aids, processing aids, propellants, solvents, chelating agents, synergists.

Methods used in safety evaluation. Hypersensitivity to food additives. Risks and benefits of food additives.

UNIT - V

Flavour technology: Flavouring agents- flavours – their nature, creation and production. Function of flavours and their utilization, flavour regulations, flavour safety.

Flavour enhancers: Chemical properties, function in food, use of glutamate in food and regulations, toxicology, applications. Synthetic ingredients of food flavourings.

Quality control of flavourings and their raw materials, beverage flavourings and their applications.

Fruit juices, flavouring of confectionery and bakery products, flavours of snack and crisps. Thermal process of flavourings. Dairy flavourings.

Textbooks:

1. NIIR Board of Consultants and Engineers, Food Colours, Flavours and Additives Technology Handbook, National Institute of Industrial Research.
2. Wood, R., Foster, L., Damant, A., & Key, P, Analytical methods for food additives. Elsevier, 2004.

Reference Books:

1. Attokaran Mathew, Natural Food Flavors and Colorants © Blackwell Publishing Ltd. And Institute of Food Technologists, 2011, ISBN: 978-0-813-82110-8
2. Mahindru, S.N, *Food Analysis: Characteristics, Detection and Estimation*. APH Publishing Corporation, 2008.



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3. Msagati, T. A, The chemistry of food additives and preservatives. John Wiley & Sons, 2012.
4. Rahman, M.S, Handbook of Food Preservation, 2nd edn. CRC Press, 2007.


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Course Code	ADVANCES IN FOOD CHEMISTRY LAB	L	T	P	C
21G13106		0	1	2	2
	Semester	I			
Course Objectives:					
<p>This course aims</p> <ul style="list-style-type: none"> • To demonstrate equipment's and procedures required for food chemistry lab. • To provide knowledge on food analysis. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> • Gain knowledge and understand how food analysis fits into the food industry.L2 • Gain experience with proximate analysis of foods.L3 • Able to learn qualitative analysis of carbohydrates, amino acids, protein and lipids.L3 • Familiar with precision and accuracy through experiences with components of analysis and reporting results.L4 • Demonstrate oral and written communication skills to effectively communicate scientific Ideas related to food analysis L2 					
List of experiments					
<ol style="list-style-type: none"> 1. Determination of Moisture by hot air oven method and vacuum oven method. 2. Estimation of protein by Kjeldhal method 3. Estimation of fat by Soxhlet method 4. Estimation of ash, sulphated ash and acid insoluble ash by muffle furnace method. 5. Determination of carbohydrate and Energy value by calculation method 6. Determination of acidity and pH in foods. 7. Estimation of Vitamin C in foods 8. Determination of Reducing and non-reducing sugars 9. Estimation of Crude Fiber, soluble and insoluble. 10. Estimation of free radical scavenging activity in foods by DPPH method. 					
Reference Books:					
Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema. Fennema's. Food Chemistry, CRC Press, Taylor and Francis group, USA, – 4 th Edition 2007.					



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Course Code	INSTRUMENTAL METHODS IN FOOD ANALYSIS	L	T	P	C
21G13107	LAB	0	1	2	2
Semester		I			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> • The experiment is intend to know the conductance and potentiality of metals • TLC method is able to separate the amino acids and sugars. • Isolation methods are used to analyse the various organic compounds. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course student shall be able to</p> <ul style="list-style-type: none"> • Student will be able to measure conductance and potentiality of various essential metals.L3 • Separation of amino acids and sugars by TLC method will be known to the student.L3 • Student will be able to analyze various organic compounds by isolation and spectrophotometric method.L3 					
List of experiments					
<ol style="list-style-type: none"> 1. Conduct metric titrations. 2. Potentiometric titrations. 3. Separation of amino acids and Sugars by TLC/Paper chromatography. 4. Isolation of plant pigments by column chromatography 5. Verification of Beer's law and determination of molar extinction coefficient using p-nitro phenol. 6. Isolation and spectrophotometric characterization of plant pigments. 7. Isolation of amino acids by Electrophoresis. 8. Measurement of refractive index of oil sample. 9. Estimation of food sample by HPLC techniques 10. Estimation of fatty acids by GC. 					
Reference Books:					
<ol style="list-style-type: none"> 1. Analytical Chemistry: Theory and Practice by Verma R.M 3rd edition ,2007. 2. Ms. Pooja R.Popat Practical book of Analytical Chemistry First Edition,2012. 					


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M.Sc in FOOD TECHNOLOGY

Course Code	ADVANCES IN FOOD MICROBIOLOGY LAB	L	T	P	C
21G13108		0	1	2	2
Semester		I			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> • Acquire knowledge about microbiologically based laboratory equipment. • Cultivate and enumerate microorganisms from various food samples. 					
Course Outcomes (CO): Student will be able to					
<p>At the end of each unit of learning, students will be able to</p> <ul style="list-style-type: none"> • Illustrate the role of microorganisms in food safety.L2 • Identify the microorganisms found in food.L2 • Experiment the techniques in control of food spoilage.L4 • Practice the methods for microbial examination for food.L2 • Able to detect microbial spoilage in foods.L2. 					
List of experiments					
<ol style="list-style-type: none"> 1. Preparation of media for culturing autotrophic and heterotrophic microorganisms (agar medium, nutrient medium, Mcconkey agar and Blood agar). 2. Microscopic observation of lactic acid bacteria. 3. Estimation of alcohol during fermentation. 4. Isolation of microorganisms from spoiled fruits and vegetables. 5. Isolation of microorganisms from meat and meat products. 6. Enumeration and identification of E.coli from different water samples. 7. Enumeration and identification of coli forms in food samples. 8. Detection of food borne pathogens. 					
Reference Books:					
<ol style="list-style-type: none"> 1. Ahmed E. Yousuf, Carolyn carlstrom ,Food microbiology: A laboratory Manual, Wiley – inter science. edition 1,2003. 2. Karl. Mathews, Kalmia E.Kniel, Thomas J. Montville, Food Microbiology, ASM press; Edition 4,2017. 					



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M.Sc in FOOD TECHNOLOGY

Course Code	BIostatistics & Computer Applications	L	T	P	C
21G13109	LAB	0	1	2	2
Semester		I			
Course Objectives:					
<p>This course provides an introduction to</p> <ul style="list-style-type: none"> • A variety of statistical methods of use in describing and analyzing biological data. • It includes a laboratory component in which biological data are analyzed using statistical software. 					
Course Outcomes (CO): Student will be able to					
<p>At the end of each unit of learning, students will be able to...</p> <ul style="list-style-type: none"> • Recall the basic components of computer.L1 • Explain how computer is used in various phases of research.L2 • Summarize the advantages and disadvantages of use of computers in research.L2 • Can calculate the mean, mode of median.L4 • Able to perform 't' test and X^2 test.L3 					
List of experiments					
<ol style="list-style-type: none"> 1. Selection of random sample, using tippets random number tables. 2. Preparation of questionnaire 3. Preparation of research proposal 4. Tabulation of data <ol style="list-style-type: none"> i) Calculation of averages-arithmetic mean, mode of median ii) Calculation of standard deviation. 5. Calculation of 't' test to give inference for small sample and large sample 6. Calculating X^2 test to find the significance of association. 7. Analysis of one way Anova and two way Anova 8. Basics of SAP(System Applications and Products). 9. Basics of SPSS(System Applications and Products). 					
Reference Books:					
Sharma S.R "statistical methods in educational research", Anmol publications p(ltd), New-Delhi,1994					


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M.Sc in FOOD TECHNOLOGY

Course Code	ADVANCES IN NUTRITIONAL BIO-CHEMISTRY	L	T	P	C
21G13201		4	0	0	4
Semester		II			
Course Objectives:					
<p>This course provides an introduction to</p> <ul style="list-style-type: none"> • The students will learn how nutrients effect biochemical process and nutritionally related diseases. • To review the biological system of energy metabolism and the chemical/biochemical properties and metabolic pathways of carbohydrates, lipids, and proteins. --- • To examine the regulatory mechanisms of macronutrient metabolism and associated signaling pathways. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> • Capable of describing biochemical pathways relevant in nutrient metabolism.L2 • To understand biochemical techniques that are relevant for the investigation of the nutrient metabolism.L2 • Able to define the types and biosynthesis and the digestion, absorption and transports in blood circulation of nutrients.L1 • Able to understand nutrition deficiency disorders and helps in its prevention and able to define the nutrition and healthy diet planning.L2. 					
UNIT - I					
<p>Introduction to biochemistry, sub cellular components and functions Enzymes - General Properties, Classification, Co-enzymes and co-factors, Kinetics and Mechanisms of action Michalias Menten reactions, factors responsible for catalytic efficiency of enzymes, examples inhibitors and activators.</p>					
UNIT - II					
<p>Carbohydrate metabolism: Digestion, absorption and biochemical functions of carbohydrates, glycolysis, TCA cycle, oxidative phosphorylation and elements of bioenergetics. Lipid Metabolism: Digestion, absorption and functions of lipids, Oxidation of fatty acids, Biosynthesis of fatty acids.</p>					


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UNIT - III		
<p>Protein metabolism: - Digestion, Absorption and functions. End products of protein metabolism. Hormones Definition, Classifications, functions, mode of action, special emphasis for gastrointestinal hormones.</p> <p>Mineral Metabolism:- Biochemical functions of minerals. Active transport and ion absorption. Calcium, Phosphorous and Iron metabolism.</p>		
UNIT - IV		
<p>Functions of Food, energy value of Food. Nutritive value of Foods nutritional significance of Carbohydrate, Proteins, Fats, vitamins and minerals. Deficiency diseases. Fortification of foods. Nutritional requirements – Balanced diets – Food tables. Nutrition of infants, preschool children, adolescent and adult, expectant and nursing mothers, geriatric and industrial workers. Recommended Dietary Allowances.</p>		
UNIT - V		
<p>Supplementary and special dietetic foods. Effect of cooking and processing on the nutritive value of Foods. Causes and prevention of malnutrition. Social psychology and Philosophy of Food habits. Theoretical aspects of techniques in nutrition research. Activities of international Organizations in the field of nutrition.</p>		
Textbooks:		
<ol style="list-style-type: none"> 1. Vioet and Vioet, Principles of Biochemistry. John Willey & Sons, 5th edition, 2018. 2. Swami Nathan. Essentials of Food and Nutrition by .The Bangalore Printing and Publishing Company,vo 1,1991. 3. U.Satyanarayana and U.Chakrapani.Text book of Biochemistry by, generic, 5th edition, 2019. 4. Harper’s Illustrated Biochemistry by Murray, Bender, Botham, Kennelly, Rodwell, and Well. McGraw Hill Publishers, 29th edition, 2019. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Martin etal.Principles of Biochemistry .CBS Publishers, vol 2, 1990 2. Rama Rao, A.V.S.S.L.K. S.Text Book of Biochemistry Publishers 5th edition, 1986 3. Wilson, K. and Goulding, K.H. Abiologists Guide to principles and Techniques of Practical Biochemistry, 3rd Edition, 1986. 4. M. Zubay, Maxwell. Text Book of Biochemistry, MacMillan.2ndedition, 1989. 5. Passmore, R and East Wood, M.A. Davidson’s. Text Book of Biochemistry , Nutrition and Dietetics , M.A. Longman publications,8th edition,1986. 		


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M.Sc in FOOD TECHNOLOGY

Course Code	ADVANCES IN TECHNOLOGY OF ANIMAL BASED FOODS	L	T	P	C
21G13202		4	0	0	4
Semester		II			
Course Objectives:					
<p>This course provides an introduction to</p> <ul style="list-style-type: none"> To understand of the chemistry of milk constituents and animal based foods. To learn the milk and various dairy products and meat, sea food their chemical, physical and biological changes that occur during processing of dairy products and animal based foods. To understand the post mortem changes in animal based foods. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> Describe the composition of milk, identify the approximate content of individual types present, and describe physicochemical characteristics of the main components.L2 Explain how dairy products such as fluid milk, yogurt, butter, powder, cheese) are made and the key functions of the processing steps involved.L2 Describe the changes that occur during the post mortem and rigor mortis of meat.L2 Discuss the methods of preservation of animal based foods.L3 Explain the hygiene and quality standards of milk and animal based foods.L2. 					
UNIT - I					
<p>Meat preservation by refrigeration and freezing, thermal processing, dehydration, irradiation, Chemicals and Antibiotics. Meat byproducts. Cold Storage and Freezing, canning, Smoking, curing and pickling of marine products – Fish pastes, Sauces, Oils, Protein concentrates, meal and other products. Preservation and processing of Shrimp, Lobsters. Packaging of meat and meat products.</p>					
UNIT - II					
<p>Introduction on meat and poultry industry. Glossary of market terms for meat animals and birds. Effect of feed, breed and environment on production of meat and its quality. Anti mortem examination of Meat Animals. Slaughter of meat animal and dressing carcasses. Modern abattoir practices. Post-mortem examination of meat, retail and whole sale cuts, grading, factors influencing quality of fresh and cured meat. Meat hygiene, quality control of meat production, processing, specification of meat products</p>					



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M.Sc in FOOD TECHNOLOGY

<p>Poultry processing's. Egg and Egg products: Preservation and measures of Egg quality. Dehydrated egg powder, frozen egg, Packaging of egg and egg products.</p>		
UNIT - III		
<p>Introduction to milk – Milk composition and nutritive value, – physical and chemical properties of milk, processing of Milk – Receiving of milk, platform tests, filtration, clarification, Homogenization. Definitions – standardization of milk(calculations for different types of milk), single toned, double toned flavored milk. Microbiology of milk, pasteurization.</p>		
UNIT - IV		
<p>Cream – Cream separation– Factors governing richness of cream and fat percentage. Butter – Introduction, composition – Process involved, cream neutralization, addition of starter, cream ripening, churning, working of butter,– Factors influencing churning, over run in butter, butter defects, their causes and prevention. Cheese: Introduction-History-Definition-Classification, composition, Nutritive value, Manufacture of processed cheese, Swiss cheese, cottage cheese & Cheddar Cheese, their defects and control.</p>		
UNIT - V		
<p>Condensed Milk: History-Composition-Types of condensed milk. Methods of manufacture, vacuum, pan, condensing, defects in condensed milk, Dry Milk (Milk Powder): History- Types of dry milk, composition of each dry milk -Methods of manufacture - Drum drying , Spray drying, Freeze drying, proportion of dry milk bulk density, solubility, solubility index, wettability, dispensability – defects in dry milk. Ice Cream: History- Definition- Classification- Composition- Ingredients used- Sweeteners, Stabilizers- Flavors etc. - Preparation of Ice cream, Pasteurization of milk, homogenization, ageing, freezing. Defects and over run in ice cream., Packaging of milk and milk products</p>		
Textbooks:		
<ol style="list-style-type: none"> 1. Pauline C. Paul and Helen H. Palmer 'Food Theory and Applications'. John Wiley and Sons, New York, 5th Edition, 1972. 2. Vijaya Khader Text Book of Food Science and Technology, ICAA, New Delhi .vol (2).2001. 3. Sukumar De, Outlines of Dairy Technology, Mc grath Oxford;1st edition,2001. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Walstra, J. T. M. Wouters and T. J Geurts. Taylor &Francis. Dairy Science and Technology, Second Edition 2006. 		



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2. Shahidi F and Botta JR, Seafoods: Chemistry, Processing, Technology and Quality, Blackie Academic & Professional, London, 1994.
3. M.K.Srivastava. Hand book analysis on Milk .CBS publication & distributors, 1nd Edition, 2015.
4. Fidel toldra .Dry cured meat Products. Wiley-Blackwell, 1st edition, 2005.


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M.Sc in FOOD TECHNOLOGY

Course Code	FOOD PROCESSING AND PACKAGING TECHNOLOGY	L	T	P	C
21G13203			4	0	0
Semester		II			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> To apply engineering principles to design process in food process engineering To emphasize the various unit operations, processing technologies and material handling equipment used in food processing industries. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> Demonstrate the concept of heat and mass transfer in food processing and its integration to actual process design. L2 Able to understand different unit operations and equipment needed for it in food industry.L2 Analyze the complexity of fluid flow problems associated with food operations.L3 Design and estimate the performance of food processing equipment.L6 Interpret the properties of materials used for food processing equipment and corrosion control.L3 					
UNIT - I					
FLUID FLOW					
Types of flow, Reynolds number, Viscosity, Concept of boundary layer, basic equations of fluid flow, valves, flow meters, manometers and measurement of flow and pressure. Material handling systems; Liquid handling: Classification of pumps, Gas handling: Classification of fans, blowers and compressors, Solid handling: Bins, Bunkers, Conveyors					
HEAT TRANSFER					
Sources of heat, heat transfer by conduction, convection and radiation, with examples, steady state and unsteady state heat conduction individual and overall heat transfer co-efficient. Heat exchange equipment's, types, relative merits and demerits.					
UNIT - II					
EVAPORATION AND DRYING					
Types of evaporators, single effect and multiple effect evaporators. Freezing and Thawing principles, applications and equipment. Moisture content and mechanism of drying, equilibrium moisture content, rate of drying and time of drying calculations. Classification and types of dryers. Dryers used in food industries and special drying methods.					


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M.Sc in FOOD TECHNOLOGY
SIZE REDUCTION and MIXING

Definition, objectives of size reduction, factors affecting size reduction, laws governing energy and power requirements of mill, types of mills including ball mill, hammer mill, fluid energy mill etc. Properties of particulate solids, screening and industrial screening equipment-sieves and screens, magnetic separators, electrostatic separators, froth flotation. Sink and Float Method. Theory of mixing, mixing time, power used in agitated vessels, powers consumption of mixing, rate of mixing viscous materials and pastes. Solid-solid, solid-liquid and liquid-liquid mixing equipment's

UNIT - III
FILTRATION, CENTRIFUGATION AND CRYSTALLIZATION

Theory of filtration, filter aids, filter media, industrial filters including filter press, rotary filter, edge filter, etc. Factors affecting filtration.

Introduction, Principles of sedimentation and centrifugation, equations for centrifugal force, equations for rate of settling in centrifuge, industrial centrifugal filters- tubular, disc bowl filters, gas- solid cyclone separators and centrifugal sedimenters.

Characteristics of crystals like, purity, size, shape, geometry, habit, forms size and factors affecting it. Super saturation theory and its limitations. Nucleation mechanisms, Crystal growth. Classification of crystallizers.

UNIT - IV

Introduction to packaging – Definition and types of food packaging – Factors involved in the creation of food package, designing successful packaging – Packaging materials and forms – Testing of packaging materials, paper, paper board, plastics(PET,LDPE,HDPE, PVC, PP,PS,PC), glass packaging, metal packaging (tin and aluminum). Vacuum and modified atmosphere packaging, Packaging regulations (FSSAI)

UNIT - V

Packaging Machinery, Production and packaging line requirements – Bottling, layout of bottling line and details of individual steps on the automatic line – wrapping operations – form, fill and seal machines, liquid filling, paste filling machines, labeling machines, shrink and stretch packaging.

Textbooks:

1. D.G Rao, "Fundamentals of Food Engineering" PHI Learning Private Limited, New Delhi. 2010.
2. J.S. Subrahmanyam, J.Timmasetty et al. Pharmaceutical Engineering Unit operations, Delhi vallabah prakashan, Delhi.second edition. 2011.
3. Warren, L. McCabe, J.C. Smith and Harriot, "Unit Operations of Chemical Engineering



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McGraw Hill International Edition, Singapore, ISBN-007-424740-6, 2005.

Reference Books:

Earle, R.L, “Unit Operations in Food Processing”. Pergamon.2nd edition, UK,2003.

2 Coles, R., Dowell, D.M., Kirwan, J, Food Packaging Technology, Black Well Publishing Ltd., 2009.


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M.Sc in FOOD TECHNOLOGY

Course Code	ADVANCES IN SPICES, CONDIMENTS AND CONFECTIONERY FOODS	L	T	P	C
21G13204			4	0	0
Semester		II			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> • The objective of this course is to make students aware of various techniques involved in processing of spices, condiments, confectionery foods and their value addition. • Analyze chemical composition of spices and condiments. • To provide knowledge of confectionery raw materials. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> • Understand scope, processing and production of spices L2 • Suggest a technology for extraction of essential oils from different spices L2 • Can develop value added confectionery foods.L6 • Able to explain chocolate manufacturing process and can develop candies.L2 • Able to explain different processing techniques in confectionery preparation.L2 					
UNIT - I					
<p>Flavoring materials of natural origin: Natural flavors and flavorings, sources of natural flavoring materials – Herbs and spices, standards of purity and sensory assessment of herbs and spices, classification of herbs and spices, Culinary Herbs, Spice processing; milling, Microbiology of spices, gas sterilization of spices, gamma irradiation, Heat treatment, Distillation or Extraction. Distillation of volatile oils, Spice essential oils, Application of spice essential oils, Essential oil content of spices. Oleoresins; Extraction, Quality and, Application of oleoresins.</p>					
UNIT - II					
<p>Plants as source of essential oils Citrus Fruits-Citrus essential oils, Composition of Citrus oils, processed citrus oils, methods of deterpenization, Citrus leaf and Flower oils. The Mints: Peppermint - Cultivation and Distillation, Rectification. Corn mint- Cultivation and Distillation, Demethylation. Spearmint-Blended Peppermint, Composition of Mint oils. Other Commercially Important Sources- Fruit, Fruit Juices and Concentrates.</p> <p>Vanilla –Introduction, Curing Process, Classification, Flavor, The Chemistry of Vanilla flavor, Precursors and the Development of Flavor, Beverage flavors – Cacao, Chocolate, Coffee, Tea, and Aromatic vegetables.</p>					



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UNIT - III		
<p>Introduction to sugar confectionery. Types of sugar and their manufacturing process. Ingredients of confectionery- sugars, starch, Glucose syrups and starch hydrolysates. Color and flavor- colors for the sugar confectioner, Flavorings flavor strength, functions of carrier solvents and powders, factors affecting stability of flavoring compounds, refined glucose syrups, Gums, gelling agents and thickenings – properties and its applications.</p>		
UNIT - IV		
<p>Manufacture of high-boiled sweets, ingredients, prevention of re-crystallization and stickiness, manufacturing methods for high boiled sweets, product types. Caramel, toffee and fudge, ingredients, structure of toffee, formulation, processing, toffee stability, fudge. Cocoa, chocolate and related products: Cocoa beans, cocoa fruit, pulp, fermentation, drying Sequence of processes chocolate receipts, cocoa powder, mixing, refining, conching and tempering of chocolate. Aerated confectionery; methods of aeration, marshmallow, Nougat.</p>		
UNIT - V		
<p>Bakery Raw Materials; General Ingredients-Wheat Flour-Manufacturing and Characteristics of wheat flour for Bakery industry. Sugar and its uses, Shortenings, Milk, yeast-Uses and specifications-Salt and its uses-Egg and Egg Products-Chemical Leavening Agents, Cocoa Chocolate, Flavors, Emulsifiers, lecithin, Bread improvers, Enriching agents, Water and miscellaneous Ingredients, Bread making process. Biscuits; Classification, dough consistency, baking techniques and Packaging. Cookies and Crackers; ingredients, formulation aspects, baking, decoration, production aspect of different cookies-sugar, coconut, anise cookies and sugar wafers, Packaging of biscuits, bread and baked foods.</p>		
Textbooks:		
<ol style="list-style-type: none"> 1. Vijaya Khader, Text Book of Food Science and Technology. ICAA, New Delhi.2001 2. Spices: Morphology, History, Chemistry, J W Parry, Chemical Publishing Co., New York 3. Shanmugavelu K G. Spices and PlantationCrops. Oxford& IBH Publishing Co., New Delhi 4. Manufacturing of snacks food, namkeen, pappad and potato products- EIRI Publications, Delhi. 9th edition, 2001. 		
Reference Books:		
<ol style="list-style-type: none"> 1. EE.B. Jackson, Sugar Confectionery Manufacture, Blackie Academic and Professional Glasgow, 2nd Edition, 1996. 2. R.Loos .Sugar Confectionery and Chocolate Manufacture, Leonard Hill Books, International Text Book Company Limited 2nd edition, 1973. 		



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3. R.Gordan Booth separation- Snack food .A scientific approach-Meera Rao Patankar , Anmol Publications New Delhi.4 th edition,2004.
4. The chemistry and technology of cereal food and feed-Samuel, CBS publications,4th edition.2001.
5. Biscuit, cracker and cookies recipes for the food industry, Duncan Manley, Wood head Publishes, Cambridge, England, 5th edition.1990.


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M.Sc in FOOD TECHNOLOGY

Course Code	ADVANCES IN FOOD PRESERVATION AND PROCESSING	L	T	P	C
21G13205		4	0	0	4
Semester		II			
Course Objectives:					
<ul style="list-style-type: none"> To acquaint students with the industrial techniques used to preserve and process foods, extend their shelf-life and improve their palatability characteristics To familiarize students with advances in food processing techniques 					
Course Outcomes (CO): Student will be able to					
After completion of the course, the student should be able to <ul style="list-style-type: none"> Describe the significance in food preservation.L2 Explain various thermal preservation techniques.L2 Describe the different freezing technquest.L2 Discuss the methods of preservation of animal based foods.L3. Explain the comprehend the processing techniques utilized in food industries.L2 Identify various preservative methods for food in industrial settings L2 					
UNIT - I	INTRODUCTION TO FOOD PRESERVATION				
Principles of Food Preservation, Water Activity and its significance in food preservation, Overview of the Traditional Methods of Food Preservation, Natural and Chemical Food Preservatives – types, permissible limits, safety aspects, Psychrometric Charts					
UNIT - II	THERMAL PRESERVATION				
Blanching, Pasteurization, Sterilization, Canning, Extrusion Cooking, Baking, Roasting, Grilling Dehydration, Concentration, Evaporation, Intermediate Moisture Foods					
UNIT - III	PRESERVATION BY THE USE OF LOW TEMPERATURES				
Refrigeration, Freezing, Lyophilisation, Cryogenic Freezing, Dehydrofreezing, Freeze Concentration, IQF					
UNIT - IV	NON-THERMAL PRESERVATION				
Microwave Processing, Hurdle Technology, Irradiation, Pulsed Electric Field Electroporation , Modified Atmosphere, Biopreservation, High-Pressure Food Preservation, Membrane Technology, Cold Plasma Technology					


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M.Sc in FOOD TECHNOLOGY

Enzymes and Microbes in Food Preservation	
UNIT - V	FOOD PROCESSING
<p>Definition and Difference between Food Processing and Food Preservation; Functions, Benefits and Drawbacks of Food Processing , Primary Processing Techniques – dicing, slicing, mincing, macerating, liquefaction, emulsification, Novel Food Processing – mushrooms, algae, leaf protein concentrates, protein from petroleum yeast, food analogues, edible insects, Performance Parameters for Food Processing – hygiene, energy efficiency, minimization of waste, labour, Overview of the types of food processing industries.</p>	
Textbooks:	
<ol style="list-style-type: none"> 1. Bhat R, Alias AK, and Paliyath G, Progress in Food Preservation. First Edition. Wiley-Blackwell, 2012. 2. Ivasankar B. 2009. Food Processing and Preservation. First Edition. PHI Learning, 2009. 	
Reference Books:	
<ol style="list-style-type: none"> 1. Desrosier NW, Fellows PJ. 2016. Food Processing Technology Principles and Practice. Fourth Edition. Woodhead Publishing . 2. Ramaswamy HS and Marcotte M. 2005. Food Processing: Principles and Applications. Taylor & Francis 3. Shapton DA and Shapton NF. 1998. Principles and Practices for the Safe Processing of Foods. Butterworth-Heinemann 	


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M.Sc in FOOD TECHNOLOGY

Course Code	ADVANCES IN NUTRITIONAL BIO-CHEMISTRY LAB	L	T	P	C
21G13206			0	1	2
Semester		II			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> To gain knowledge of practices for proper literature reviews and evaluation of appropriate methods for food analysis. To interpret various methodologies for analysis of components in foods. 					
Course Outcomes (CO): Student will be able to					
<p>Learners who successfully complete this course will be able to:</p> <ul style="list-style-type: none"> Demonstrate the presence of protein, lipid, and carbohydrate in food using chemical methods.L2 Aware of how analytical techniques used to determine food composition and quality L1 Able to carry out qualitative analysis of carbohydrates, proteins, lipids.L3 Apply their knowledge in food biochemistry and nutrition in designing new range of products with improved nutritional characteristics L3 Able to isolate and quantify proteins.L3 					
List of Experiments.					
<ol style="list-style-type: none"> Preparations: Albumin from egg. Casein from milk, starch from potato. Estimation of protein by biuret method. Estimation of amino acids by Ninhydrin method. Estimation of sugar by Dinitrosalysilate / Nelsonsomogyi method. Estimation of phosphorous in food sample. Estimation of Calcium in food sample. Estimation of beta carotene in food sample Estimation of Lycopene in tomato and tomato products. Estimation of Iron in foods. 					
Reference Books:					
<ul style="list-style-type: none"> ArunbBahl and B. S. Bahl: Advanced Organic Chemistry, Vol (2), S. Chand publications, 2019. 					


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M.Sc in FOOD TECHNOLOGY

Course Code	ADVANCES IN SPICES, CONDIMENTS & CONFECTIONERY FOODS LAB	L	T	P	C
		21G13207	0	1	2
Semester		II			
Course Objectives:					
<p>This course aims</p> <ul style="list-style-type: none"> To develop an awareness of various processing procedure for major spices & minor spices. To provide knowledge how on the machinery and process involved in the baking and confectionery process. To understand the various types of sugar and its grades. 					
Course Outcomes (CO): Student will be able to					
<p>At the end of this course, students will be</p> <ul style="list-style-type: none"> Able to develop value added products from plantation products and spices.L6 To demonstrate appropriate technique for the extraction of spice oil and oleoresin with able to identify adulterants in spices.L2 Measure proximate analysis for bakery and confectionery foods.L3 To evaluate the steps involved in the process and improve existing technologies.L5 To design and create newer process and products that are better economically, nutritionally like gluten free foods.L6 					
List of Experiments.					
<ol style="list-style-type: none"> Proximate analysis for different variety of spices Detection of adulterants in spices Preparation of condiments (ketchups and sauces) Preparation of different spice powders Packaging of spices Analysis of Confectionery products. Preparation of RTS beverages Milling of spices Shelf life studies of spices Drying of Spices (different techniques) Identification of insects in spice products Estimation of active principles present in spices 					



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Reference Books:

1. Handbook on Spices, National Institute of Industrial Research (NIIR) Board, Asia Pacific BusinessPress Inc., New Delhi 2004
2. Stanley Cauvain and Linda S. Young, “Technology of Bread making”, Springer, ISBN: 038785657,9780387385655, 2007.
3. Gupta S. Hand Book of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi. 2016.


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Course Code	FOOD PROCESSING & PACKAGING TECHNOLOGY LAB	L	T	P	C
21G13208			0	1	2
Semester		II			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> • To know the various types of equipment's used in the food industry. • To learn the operation and utilization of equipment's involved. • To choose suitable techniques for the food processing operation. • To identify the factors that will affect the design of equipment's 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> • To select the critical variables for the design of equipment's. L6 • To compute the moisture content and drying characteristics of food materials.L4 • To describe and demonstrate the humidity and psychometric charts.L2 • To find out filtration rate and efficiency and factory affecting it.L1 					
List of Experiments.					
Food Process Engineering					
<ol style="list-style-type: none"> 1. Evaluation of filter media, determination of rate of filtration and study of factors affecting filtration including filter aids. 2. Determination of Humidity – use of dry bulb and wet bulb thermometers and psychometric charts. 3. Determination of rate of drying, free moisture content and bound moisture content. 4. Experiments to illustrate the influence of various parameters on the time of drying. 5. Estimation of heat coefficient by natural/forced convection 6. Studies in separation by sink and float method 7. Estimation of average particle size using any crushers/ball mill 					
Packaging Technology					
<ol style="list-style-type: none"> 8. Measurement of thickness, basis weight, grease resistance, bursting strength and tear resistance of paper/paperboard. 9. Determination of Water vapour transmission rate(WVTR) of packaging material. 					



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10. Determination of Impact breakage, thermal shock resistance for glass material
11. Determination of continuity and porosity of tin coating
12. Performance evaluation of tertiary packages.

Note: Minimum Eight experiments have to performed with minimum four from each subject

Reference Books:

1. Paul Singh R, and Dennis R.Heldman "Introduction to Food Engineering". Academic Press – ElsevierIndia Private Ltd. New Delhi," 4th Edition 2008.
2. EIRI Board of Consultants and Engineers, New Delhi; Modern Packaging Technology
3. Coles, R., Dowell, D.M., Kirwan, J, Food Packaging Technology, Black Well Publishing Ltd., 2009.


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M.Sc in FOOD TECHNOLOGY

Course Code	ADVANCES IN CEREALS, LEGUMES AND OIL-SEED TECHNOLOGY	L	T	P	C
21G13301		4	0	0	4
Semester		III			
Course Objectives:					
This course aims to provide the student to					
<ul style="list-style-type: none"> • To develop good expertise on the technical aspects of dhal milling, oil milling and various legumes and oil seeds. • To prepare cereals, legumes and oil seed-based products and preservation 					
Course Outcomes (CO): Student will be able to					
At the end of this course, students will be able to					
<ul style="list-style-type: none"> • Understand the basic composition and structural parts, importance of physio-chemical properties of food grains. L2 • Understand the basics of milling operations and to identify the problems associated with milling of food grains and their solutions.L2 • To know about different pulses processing aspects and preparation of products with pulses L4 • To learn about different oil seeds, oil milling by expellers, solvent extraction of oils, refining of oils and utilization of oil seed meals for different food uses.L1 • To learn processing food grains into value added products.L1 					
UNIT - I					
<p>Rice: Chemical composition and structure. Methods of quality assessment, Methods of parboiling, milling operations, changes during ageing, cooking quality, methods for accelerated ageing rice, drying of rice.</p> <p>Wheat: Nature of Grain, Chemical constituents and processing quality. Milling of wheat, Operations and fractionation, and utilization of products of milling. Dough rheology.</p> <p>Millet and millet based products.</p> <p>Preparation of wheat products, dalia Karah parathas and maize fried products: gulgappas-popcorn-bhelpuri-expanded and extruded snacks</p>					
UNIT - II					
<p>Milling of pulses, wet milling and dry milling, commercial milling of pulses, traditional milling methods. Dhall milling equipment and effect on quality, principal products.</p> <p>Storage, handling and transportation of pulses.</p> <p>Processing Legumes and pulses. Legume based foods: raw materials, -papads, vadia, besan laddoos,</p>					



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chikki, sevan, Packaging of whole grain and milled grain products		
UNIT - III		
Position of oilseeds and oils in India, Sources and classification of Oils and Fats- Structure and composition of oils and fats Definition, distinction between oils and fats – Simple and mixed triglycerides, mono-and di-glycerides Non-glyceride components of oils and fats: - Phosphatides, sterols, carotenoid pigments, Tocopherols and other antioxidants – Vitamin A, D and E.		
UNIT - IV		
Post harvesting technology of oil seeds. Storage and pretreatment of oilseeds, Oil seed milling, Mechanical expression of oil, Solvent extraction. Oil extraction:traditional methods, Ghani, power ghani,Hydraulic press, expellers. Solvent extraction process, pretreatments, breaking, creaking, flaking, factors effecting extraction process		
UNIT - V		
Refining and Bleaching: - Degumming, alkali refining, (Batch process), Miscella refining, refining losses – Bleaching by Absorption – Continuous bleaching. Hydrogenation: - Mechanism – Selectivity – continuous process – preparation of Raney Nickel catalyst. Fat splitting (Twitch ell and Autoclave methods), Distillation of fatty acid.		
Textbooks:		
<ol style="list-style-type: none"> 1. Bailey's Industrial Oils and Fats products, by Ed. D. Sworn, Wiley-Inter Science Publications, N.Y., John Wiley & Sons (1982). 2. Post-harvest technology of Cereals, Pulses and Oilseeds by Chakravarti A. Oxford & IBH Publishing Co. Ltd., Calcutta. 3. Shukla B D Srivastava P K and Gupta R K. Oilseed Processing Technology. Central Institute of Agricultural Engineering, Bhopal. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Watson SA; Ramstad PE. Corn: Chemistry and Technology, AACC, 1988. 2. K.M. Singh and K.K. Sahay Unit Operations of Agricultural Processing, Vikas publishing house ltd, 2004. 3. Manuals on Rice and its processing by CFTRI Mysore and IIT Kharagpur. 4. Potter NN Cereal Technology, AVI Publication. 5. Neelam Khatarpaul, Rajbala Grewal & Sudesh Jood, Bakery Science & Cereal Technology, Daya publishing house, 2012. 6. Matz SA, Bakery Technology and Engineering, CBS Publication, 2008. 		


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Course Code	ADVANCES IN TECHNOLOGIES OF FRUITS & VEGETABLES	L	T	P	C
21G13302			4	0	0
Semester		III			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> To acquaint with the proper handling technologies of fruits and vegetables to reduce post-harvest losses and acquaint with principles. To provide better understanding with methods of preservation of fruits and vegetables into various products. 					
Course Outcomes (CO): Student will be able to					
<p>At the end of this course, students will be able to</p> <ul style="list-style-type: none"> The students acquire knowledge of the different physical, chemical and nutritional properties of fruits and vegetable based products.L2 The students acquire insight in the various chemical and biochemical changes which can occur during processing and which can influence the functional properties of the possible end properties.L2 The students know how fruits and vegetables are industrially processed. They learn various ways of designing and monitoring processing chains with the emphasis on how quality, safety, authenticity, etc. of raw materials, processes and products are preserved.L6 					
UNIT - I					
Introduction of Fruits and vegetables: Definition structure, origin, classification Fruits, General properties of Fruit & Vegetables chemical composition, Nutritive value its importance their stability in processing. Physiology and biochemistry of fruits and vegetables – Introduction of Fruit ripening , ripening agents & their effects, ripening changes, enzymatic action, deterioration Factors & their control. Desirable characteristics of Fruits & vegetables for processing, Quality changes in Fruits and Vegetables.					
UNIT - II					
Preservation by Drying & Dehydration of Fruits & Vegetables – changes in drying & Dehydration. Humidity & temperature control problem in drying process of Fruits & Vegetables. Preservation by Freezing, Refrigeration of Fruits & Vegetables, and Metabolic function of Refrigeration, principles					



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of Freezing, Methods of Freezing.

Technology of cold storage, equipment for Freezing & Refrigeration. Freezing techniques & problems encountered in Freezing of Food & Vegetables.

UNIT - III

Preservation of Fruits & Vegetables – Introduction method of Heat preservation. Fruits & Vegetable canning introduction – principles in canning, details of individual steps in canning process, preparation of syrups & brines Method of canning, problems in canning, Nutritive changes in canning.

Chemical preservation-Preservatives used for storage of Fruits & Vegetables and its products by chemical ,additives acids, salt, sugar, SO₂, benzoic acid etc. Preservation by Fermentation – Types, importance special preservation methods – control atmosphere storage, modified atmospheric storage, pickling, irradiation, combined preservation methods, packaging of fruits and vegetables.

UNIT - IV

Fruits & Vegetable juices, syrups, squashes, cordials & nectars, fruit concentrates, jams & jellies, marmalades, preserves, butter & candied fruit preparation & manufacturing. pickles and chutneys – introduction, types, pickling process of Fruit & Vegetables and its methods, quality control and its related problems.

Vinegar – General properties, types, preparation, industrial method of manufacturing, various uses of Vinegar.

UNIT - V

Details of Plant & Machineries used in Fruits & Vegetables processing – Design of plant & its economy. Quality control / quality assurance of Fruit & Vegetables-FSSAI specification, Hygienic requirements. Waste utilization of fruits and vegetables

Textbooks:

1. Cruess, Commercial Fruit & Vegetable products processing, Agro bios publications, 2012.
2. R.P.Srivastava, Fruit& Vegetables preservation principles & practices 3rd revised Edition 2002.

Reference Books:

1. Fruits & Vegetables processing Hand book – Engineers India Research Institute.
2. R.B.H.Wills, Post-harvest – An Introduction to physiology & Handling of Food & Vegetables – UNSW press, 5th edition, 2007.
3. Food processing Industries –small Industry research institute.



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4. Processing, dehydration, canning preservation of Fruit & Vegetables, NIIR Board.
5. Modern technology on food preservation – NIIR BOARD.
6. Victoriano Valpuesta Fruits & Vegetables biotechnology, Woodhead Publishing, 2002.



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Course Code	FOOD LAWS AND REGULATIONS	L	T	P	C
21G13303		4	0	0	4
Semester		III			
Course Objectives:					
This course aims to provide the student to					
<ul style="list-style-type: none"> • To study importance of Food Safety • To understand the regulating authorities for food safety world over 					
Course Outcomes (CO): Student will be able to					
After completion of the course, the student should be able to					
<ul style="list-style-type: none"> • To understand the regulations followed in various food industries.L2 • To define the food labeling patterns.L1 • To analyze the safety operations involved in food system L3 • To prepare HACCP standards for food industries.L2 • To learn CIP, Hygiene practices in plant.L2. 					
UNIT - I					
Introduction to concepts of food quality, food safety, food quality assurance and food quality management; objectives, importance and functions of quality control					
UNIT - II					
Role of national and international regulatory agencies, Bureau of Indian Standards (BIS), AGMARK, Food Safety and Standards Authority of India (FSSAI), Introduction to WTO agreements: SPS and TBT agreements, Codex Alimentarius Commission, USFDA, International organization for standards (ISO) and its standards for food quality and safety (ISO 9000 series, ISO 22000, ISO 15161, ISO 14000)					
UNIT - III					
Quality assurance, Total Quality Management; GMP & GHP; GLP, GAP; Sanitary practices; HACCP; Quality manuals, documentation and audits; Export import policy, export documentation; Laboratory quality procedures and assessment of laboratory performance; Applications in different food industries; IPR.					
UNIT - IV					



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Food Standards and Laws: International and national food laws.

Food adulteration: Definition, common adulteration in natural and processed foods, contamination, and methods of detection. Prevention of Food Adulteration (FSSAI).

UNIT - V

Food labeling – Safety issues – Labeling of organic and GM foods – Approach of US and EU and Food safety.

Effluent treatment and laws governing the same.

Textbooks:

1. A Hand Book of Food packaging by EIRI publications, vol (6), 2001.
2. Coles, R., Dowell, D.M., Kirwan, J, Food Packaging Technology, Black Well Publishing Ltd., 2009.

Reference Books:

1. Stanley Sacharow and Roger C. Griffin .Principles of Food packaging, AVI Publishing Company, Estport, 2nd Edition.1994.
2. M.Mathlouthi (Edited) Food Packaging and Preservation., Blackte Academic Professional, Chapman &Hall, 1994.
3. Jung H. Han, Innovations in Food Packaging, Academic Press, 2014.
4. Scott A. Morris, Food and Package Engineering, Wiley-Blackwell Publishing, 2011.


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Course Code	FOOD INDUSTRIAL WASTE MANAGEMENT	L	T	P	C
21G13304			4	0	0
Semester		III			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> • Understanding of problems of food processing industrial waste • Knowledge of legal, institutional and financial aspects of management of food wastes. • Become aware of Environment and health impacts food waste mismanagement. • Understand engineering, financial and technical options for waste management. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course student shall be able to</p> <ul style="list-style-type: none"> • To-do sampling and characterization of food waste; L2 • Analysis of hazardous waste constituents including QA/QC issues; L3 • Understand health and environmental issues related to food waste management; L2 • Apply steps in food waste management-waste reduction at source, collection techniques, materials and resource recovery/recycling, transport, optimization of food waste transport, techniques; L3 • Innovative food products development by industrial food waste and innovate ideas and techniques to convert food waste to industrial use.L6. 					
UNIT - I					
Types and formation of by-products; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.					
UNIT - II					
Concept, scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD & COD), fat, oil and grease content, metal content, forms of phosphorous and Sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues					
UNIT - III					
Waste utilization in various industries, furnace sand boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization,					


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UNIT - IV		
Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons.		
UNIT - V		
Tertiary treatments: Advanced waste water treatment process using sand, coal and activated carbon filters. Removal of heavy metals, Phosphorous, Sulphur, nitrogen. Assessment, treatment and disposal of solid waste; and biogas generation. Effluent treatment plants, Environmental performance of food industry to comply with ISO-14001 standards.		
Textbooks:		
<ol style="list-style-type: none"> 1. Abbas Kazmi, Peter Shuttleworth. "The Economic Utilization of Food Co Products", Royal Society of Chemistry Publishing. 2013. 2. A.M. Martin. "Bioconversion of Waste Materials to Industrial Products", Springer Science & Business Media Publishing.2012. 3. Marcos von Sperling. "Basic Principles of Wastewater Treatment", IWA Publishing ,2007. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Kreit F & Goswami DY, Energy Management and Conservation Handbook. CRC Press, 2nd edition, 2016 2. Murphy WR &Mc kay G, Energy Management. Butterworth- Heinemann ltd,1981 3. Patrick DR., Fardo SW, Richardson RE & Steven, Energy Conservation Guidebook. The Fairmont Press, 3rd edition, 2015 4. Wulfinghoff DR. Energy Efficiency Manual, Energy Institute Press, 1999 		


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Course Code	ADVANCES IN FOOD BIOTECHNOLOGY	L	T	P	C
21G13305		4	0	0	4
Semester		III			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> • Understanding structure of DNA & RNA, DNA replication, gene, nature of gene, genetic code, gene expression. • Knowledge of legal Natural antimicrobials for food preservation. • Become aware of routes to food flavour production- microbial, enzymatic. • Understand Biotechnology for food security. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> • To understand the DNA and RNA, structure of DNA and gene expression.L2 • To define the Natural antimicrobials for food preservation.L1 • To analyze the role of Phyto-alexins, essential oils and their components in food preservation L3 • To prepare food ingredients biogums, bio-colours, organic acids and sweeteners.L2 • To learn safety of GM food.L1 					
UNIT - I					
<p>Introduction to biotechnology- DNA and RNA, structure of DNA, Watson and Crick model, DNA replication, gene, nature of gene, genetic code, gene expression, protein synthesis. Genetic engineering: Restriction enzymes, PCR, cloning, DNA sequencing, genetic engineering and improvement of food crops, genetically modified plants and animals for enhanced food production; safety of GM food.</p>					
UNIT - II					
<p>Natural antimicrobials for food preservation: Phyto-alexins, essential oils and their components; bacteriocins: nisin, pediocins, etc.; use of bacteriocins in food systems as bio-preservatives.</p>					
UNIT - III					
<p>Protein engineering in food technology: methods, applications of protein engineering to produce enzymes- glucose isomerase, Lactobacillus beta-galactosidase and peptide antibiotic- nisin. Biotechnological routes to food flavour production- microbial, enzymatic</p>					



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UNIT - IV		
Biotechnology and food ingredients: biogums, fat substitutes, bio-colours, organic acids and sweeteners. Transgenic plant foods: Golden rice, Bt-brinjal, maize, tomato, potato, soybean		
UNIT - V		
Biotechnology for food security: prospects and problems, ethical issues concerning GM foods; trade related aspects of biotech foods and bio-piracy problems; effect of biotech foods on the food business of developing and developed countries		
Reference Books:		
<ol style="list-style-type: none">1. Alexandru Mihai Grumezescu, Alina Maria Holban (2018). Advances in the biotechnology of food industry.2. Byong H Lee (2015). Fundamentals of Food Biotechnology. Wiley-Blackwell.3. Debasis Bagchi, Francis C. Lau, Dilip K. Ghosh (2010). Biotechnology in Functional Foods and utraceuticals. CRC Press.4. Kuddus, M. (Ed.). (2018). <i>Enzymes in food biotechnology: production, applications, and future prospects</i>. Academic Press.5. Rai, Ravishankar. (2016). Advances in food biotechnology. Wiley- Blackwell		


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Course Code	ADVANCES IN CEREALS, LEGUMES PROCESSING AND OIL SEED TECHNOLOGY LAB	L	T	P	C
21G13306		0	1	2	2
Semester		III			
Course Objectives:					
This course aims to provide the student to					
<ul style="list-style-type: none"> • To study the physico-chemical properties of food grains • Preparation of malt. • To Determine gluten content in wheat flour • Processing of value-added products from cereals and pulses 					
Course Outcomes (CO): Student will be able to					
At the end of this course, students will be able to					
<ul style="list-style-type: none"> • Understand the basic composition and structural parts of food grains.L2 • Aware the importance of physico-chemical properties of food grains L1 • Understand the basics of milling operations for food grains L2 • Identify the problems associated with milling of grains and their solution.L2 • Know processing food grains into value added products L3 					
LIST OF EXPERIMENTS					
<ol style="list-style-type: none"> 1. Determination of moisture content of legumes and oil-seeds 2. Study of mini-dhal mill and pre-treatments 3. Cereals and millets processing- effects of different processing methods –soaking, malting, germination. 4. Pulses processing - effects of different processing methods –soaking, malting, germination 5. Preparation of breakfast cereals, evaluation of readily available cooked products (ready to eat foods) in the market. 6. Determination of gluten in the flour 7. Determination of Acid Value of the oil. 8. Determination of alcoholic acidity in cereal flours. 9. Determination of Iodine Value 10. Determination of peroxide value 11. Determine the purity of groundnut oil by bellier turbidity test(BTT). 					



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|---|
| 12. Determination of Specific gravity and refractive index for oils.
13. Test to detect adulteration of mustard oil. |
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Reference Books:

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| <ul style="list-style-type: none">• Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and TechnologyMercel Dekkar, 1st edition, 1991.• Sahay K M, and Singh K K. Unit operations of Agricultural Processing. Vikas Publishing House, Pvt Ltd, 2nd edition, 2004. |
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Course Code	ADVANCES IN TECHNOLOGIES OF FRUITS AND VEGETABLES LAB	L	T	P	C
21G13307		0	1	2	2
Semester		III			
Course Objectives:					
This course aims to provide the student to					
<ul style="list-style-type: none"> To provide knowledge on processing of fruits and vegetables 					
Course Outcomes (CO): Student will be able to					
By the end of this course students, will be able to					
<ul style="list-style-type: none"> To develop proficiency skill in producing different types of processed fruits & vegetables products L6 Discuss Operating & maintenance the modern processing equipments & machineries L3 Explain how to preserve the color, flavor, texture, and nutrition while prolonging the shelf life of perishable fruits and vegetables L2 To make different processed fruit & vegetable based products with quality assurance and safety.L4 To learn Process of packaging, storing & marketing L1 					
LIST OF EXPERIMENTS					
<ol style="list-style-type: none"> Determination of TSS and Acidity in fruit and fruit products Preparation of fruit juices.L2 Preparation of fruit juice concentrates and powder.L2 Preparation of fruit squashes.L2 Preparation of jams, jellies, marmalades, preserves and candied fruits.L2 Preparation of pickles, chutneys, sauces.L2 Measure Dehydration of fruits and vegetables. L3 Preparation of osmotically dehydrated fruits and vegetables.L2 Explain Canning of fruits and vegetables.L2 					
Reference Books:					
<ol style="list-style-type: none"> Ranganna S “Handbook of analysis and quality control for fruits and vegetables”,Mc Grath Hill p(ltd), 2nd edition, 2017. Srivastava R.P. and Sanjeev Kumar.Fruit and Vegetable Preservation Principles and Practices, CBS Publishers and Distributors Pvt ltd, 3rd edition, 2017. 					


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M.Sc in FOOD TECHNOLOGY

Course Code	FOOD QUALITY ANALYSIS LAB	L	T	P	C
21G13308		0	1	2	2
Semester		III			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> To learn about quality management in food production chain and understand the significance of safe processing of foods To train the student to analyze food components and to about physical and chemical contaminants in foods 					
Course Outcomes (CO): Student will be able to					
<p>At the end of this course, students will be able to</p> <ul style="list-style-type: none"> To understand the principles and framework of food safety. L2 To understand food laws and regulations governing the quality of foods.L2 To identify the wide variety of parameters affecting food quality.L2 To learn about the standards and specifications of FSSAI and its limits in all food commodities.L1 To understand harmful effects of adulterants and toxicity of foods.L2 					
LIST OF EXPERIMENTS					
<ol style="list-style-type: none"> Examination of cereals & pulses from one of go-downs and market shops in relation to FSSAI specifications. Detection of adulteration and examination of ghee for various standards of AGMARK & FSSAI standards. Detection of adulteration and examination of spices as per AGMARK and FSSAI standards, Detection of adulteration and examination of milk and milk products as per FSSAI standards, Detection of adulteration and examination of fruit products such as jams, jellys, marmalades as per FSSAI specification Study of registration process and licensing procedure under FSSAI. Study of sampling techniques from food processing establishments. 					
Reference Books:					
<ol style="list-style-type: none"> Early ,R. Text book of Guide to Quality Management Systems for Food Industries .Blackie Academic publications.1995. Krammer A & Twigg BA. Text book of Quality Control in Food Industry. Vol. I, II. AVI Publications,1973. Vasconcellos , J. Andres. “Quality Assurance for the Food Industry: A Practical Approach”,CRC Press.2003. 					



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M.Sc in FOOD TECHNOLOGY

Course Code	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
21DAC101a		2	0	0	0
Semester		III			
Course Objectives: This course will enable students:					
<ul style="list-style-type: none"> • Understand the essentials of writing skills and their level of readability • Learn about what to write in each section • Ensure qualitative presentation with linguistic accuracy 					
Course Outcomes (CO): Student will be able to					
<ul style="list-style-type: none"> • Understand the significance of writing skills and the level of readability • Analyze and write title, abstract, different sections in research paper • Develop the skills needed while writing a research paper 					
UNIT - I		Lecture Hrs:10			
1) Overview of a Research Paper- Planning and Preparation- Word Order- Useful Phrases - Breaking up Long Sentences-Structuring Paragraphs and Sentences-Being Concise and Removing Redundancy -Avoiding Ambiguity					
UNIT - II		Lecture Hrs:10			
Essential Components of a Research Paper- Abstracts- Building Hypothesis-Research Problem - Highlight Findings- Hedging and Criticizing, Paraphrasing and Plagiarism, Cauterization					
UNIT - III		Lecture Hrs:10			
Introducing Review of the Literature – Methodology - Analysis of the Data-Findings - Discussion- Conclusions-Recommendations.					
UNIT - IV		Lecture Hrs:9			
Key skills needed for writing a Title, Abstract, and Introduction					
UNIT - V		Lecture Hrs:9			
Appropriate language to formulate Methodology, incorporate Results, put forth Arguments and draw Conclusions					
Suggested Reading					
<ol style="list-style-type: none"> 1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) Model Curriculum of Engineering & Technology PG Courses [Volume-I] 2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press 3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. 					



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Highman'sbook

4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011



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M.Sc in FOOD TECHNOLOGY

Course Code	FOOD PRODUCT DEVELOPMENT AND COMMERCIALIZATION	L	T	P	C
21G13401a	PROGRAM ELECTIVE	4	0	0	4
Semester		IV			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> • This course is intended to familiarize students with the product food product development including preliminary product description, prototype development, product testing phases. • Students will learn the importance of teamwork, product specification, food formulation, food ingredient technology, ingredient interaction and how to conduct and terminate a project in an orderly manner. 					
Course Outcomes (CO): Student will be able to					
<p>After completion of the course, the student should be able to</p> <ul style="list-style-type: none"> • Critically analyse the role of food product development in food industry management and identify the reasons for its success or failure.L3 • Understand and critically analyze methods of organizing for food product development, including the relationship between different industry specialists (specifically NPD technologists, marketing and production) and how to manage them. L2 • Evaluate the usefulness of new product development models for the food industry and understand the role of accurate product costing.L5 • Computer aided ingredient analysis and designing, labeling and formulation.L6 • Review the process of food product development for both retail and food service food products L6 					
UNIT - I					
New food product requirements					
Market survey and its importance in; designing a questionnaire to find consumer needs for a product or a concept. Developing a Product to Meet the Requirements. Product life cycle. Creating brand value for the Product. The SWOT analysis, standardization of foods					
UNIT - II					
New product design and Development					
New Food Product Development (NPD) process and activities, The Stage-Gate model NPD success factors, new product design, food innovation case studies, market-oriented NPD methodologies,					



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organization for successful NPD; Recipe Development; use of traditional recipe and modification; involvement of consumers, selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness and return on investment, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies.

Statistical designs for new product optimization and standardization- Response surface methodology, and other statistical tools. Process design, equipment needed; establishing process parameters for optimum quality; Sensory Evaluation;

UNIT - III

Specialty food products

Health foods, Medical foods, Therapeutic foods, Herbal foods, Fortified foods. Infant foods, Geriatric foods, Sports drink. Functional foods, Designer foods and Nutraceuticals. Prebiotics, Probiotics and Synbiotics.

UNIT - IV

Quality evaluation and regulatory requirements:

Product Stability; evaluation of shelf life; changes in sensory attributes and effects of environmental conditions; accelerated and ambient shelf life testing; developing packaging systems for maximum stability and cost effectiveness; Regulatory Aspects; whether standard product and conformation to standards; Approval for Proprietary Product.

UNIT - V

Product commercialization:

Outcomes and activities in product commercialization, Pre-launch trial, Steps in product launch, Evaluation of the Launch, product performance testing, developing test market strategies, Case Studies of some successes and failures, food choice models and new product trends, branding and warehousing.

TEXT BOOKS

1. Fuller, G.W. New food product development: from concept to market place .CRC Press, New York, vol (3), 1994.
2. Man, C.M.D. and jomes A.A. Shelf life evaluation of foods. Blackie academic and professional, London, 1994.
3. Howard R. Moskowitz, I. Sam Saguy& Tim Straus, An Integrated Approach to New Food Product Development. Taylor and Francis Group, LLC.USA, 2009.

Reference Books:

1. Shapton, D.A. and shapton, N.F. Principles and practices for the safe processing of foods, Butterworth Heinemann Ltd, oxford.1991.
2. Graf, E. and saguy, I.S. , Food product development: from concept to the market Place, van no strand Reinhold new York.1991.



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3. Oickle, J.G. New product development and value added. Food development division agriculture, Canada. 1990.
4. Maroulis Z.B. and Saravacos G.D. "Food Process Design", CRC Press, 2003


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Course Code 21G13401b	MANAGEMENT OF FOOD PROCESSING INDUSTRIES WORLD PROGRAM ELECTIVE	L 4	T 0	P 0	C 4
Semester		IV			
Course Objectives:					
<p>This course aims to provide the student to</p> <ul style="list-style-type: none"> To Introduce Management Concepts and Functions To Learn about various Functional areas of Management. To understand the selection of plant location. To get familiarize with basics of accountancy To study various methods of optimization applicable in business. 					
Course Outcomes (CO): Student will be able to					
<p>At the end of the course, the students will be able to:</p> <ul style="list-style-type: none"> Understand various types of business, managerial concepts, principles and functions of management.L2 Understand roles and responsibilities of various functional areas of Management L2 Aware Plant Location and Layouts for the Organization.L1 Prepare Financial Statements for a typical business entity.L2 Understand various methods of optimization of resources.L2. 					
UNIT - I					
MANAGEMENT INTRODUCTION					
Types of business - Proprietorship, Partnership, Public Limited, Private Limited. Management – Definition –Principles - Functions – Planning – Organizing – Coordinating – Directing – Controlling. – Organization Structures – types - advantages and disadvantages of each type.					
UNIT - II					
FUNCTIONAL MANAGEMENT SYSTEMS AND DEMAND & SUPPLY					
Brief description of Functional Management systems - Financial Management, Human Resource Management, Production Management and Marketing Management. Labour welfare and safety measures – Forecasting the demand for the product and demand analysis – Supply and demand relationships.					



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UNIT - III		
PLANT LOCATION AND LAYOUT		
Selection of project – Selection of Location – Economics of Site Location – Urban Vs Suburban Location – Plant layout – Types of Lay out – Flow lines – Material handling Equipment – Selection of Handling Equipment for Food Processing Industries – Introduction to production systems.		
UNIT - IV		
BASICS OF ACCOUNTING		
Introduction to Accounting – Stages of Accounting – types of Accounts - Journal & Ledger postings – Discussion on Trial Balance – Trading & Profit and Loss accounts – Balance sheet – Branches of Accounting: Financial Accounting, Management Accounting & Cost accounting – Types of Cost Accounting Methods - Methods of preparing cost sheet for the product manufactured.		
UNIT - V		
OPERATIONS RESEARCH		
Introduction to Operations Research – Model building – Brief description with simple examples of Linear Programming – Resource allocation model – Transportation model – Assignment model – Inventory Management – EOQ model – ABC, JIT, FIFO, FILO, VED and FSN analysis .		
TEXT BOOKS		
<ol style="list-style-type: none"> 1. O.P. Khanna, Industrial Engineering and Management – Dhanpat Rai publications, 2. Lisa Jordan, Food Industry: Food Processing and Management, Callesto Reference, 2015. 		
Reference Books:		
<ol style="list-style-type: none"> 1. V .K .Kapoor, Operations Research, Sultan Chand and sons, 2012 2. Ambrish Gupta Financial Accounting for Management – Pearson Education, 6th edition, 2018. 3. Kishore R.M, Cost & Management Accounting – Taxmann publications pvt ltd, 4th edition, 2006. 4. L.M. Prasad.Principles of Management, Sultan Chand and sons, 8th edition, 2013. 		



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M.Sc in FOOD TECHNOLOGY

Course Code	FOOD DEMAND AND INDIAN SCENARIO	L	T	P	C
21G13401c	PROGRAM ELECTIVE	4	0	0	4
Semester		IV			
Course Objectives:					
This course aims to provide the student to					
<ul style="list-style-type: none"> • Comprehensive review about the current challenges related to food security and hidden hunger. • Issues are presented according to major factors, such as growing population, changing dietary habits, • Water efficiency, climate change and volatile food prices. 					
Course Outcomes (CO): Student will be able to					
After completion of the course student shall be able to					
<ul style="list-style-type: none"> • Explain Population (Growing population) L2 • Discuss Food demand by comparing Indian scenario • Illustrate Crop biology (Amount of crop production and Yield) L2. • Interpret various Resources (Land and water resources, Population vs Cultivating land, Manpower) L4 • Identity Climatic changes, Eating habits L2 • Explain Food supply chain and storage facilities & Purchasing capacity (Food price & Security) L2 					
UNIT - I					
Introduction					
General aspects of food industry, world food demand and Indian scenario, constituents of food, quality and nutritive aspects. Food additives, standards, deteriorative factors and their control, preliminary processing methods, conversion and preservation operation. Food security and nutrition. Food spoilage, processing and preservation statistics.					
UNIT - II					
Food demand and supply					
Qualitative and quantitative requirements. Expected Technological Advances to meet the needs. Future priorities in Food Production needs –Status of Food Industry in India and Abroad. Magnitude and Inter dependence of Food Production and processing Agencies.					
UNIT - III					



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M.Sc in FOOD TECHNOLOGY

Food industry- New trends

Food availability, production Trends – Factors of Production – Types of Foods such as processed, semi processed, ready to eat Foods, Fast Foods and convenient foods. Food Characteristics. Nutritional Significance of major food groups. Present trends of consumption, further requirements. Consumers change of aptitude in Food Products consumption. Industrial food by-products

UNIT - IV

Food industry-Marketing trends

New food products developed Programmes aimed for making more food availability to increasing population and their prospects– Merits and drawbacks, prospects for future growth in India. National and International Trends and Programmes in Food handling, processing and marketing.

UNIT - V

Developments of food industry in world

Potentials and Prospects of developing Food Industry in India. Food Losses –Factors affecting – Programmes and strategies to eliminate the loses and rate the required demand. Global demand for food. World Food Day –Importance and action plans.

TEXT BOOKS

1. Sheikh Mohammad Fakhurul Islam and Zahurul Karim ,World's Demand for Food and Water: The Consequences of Climate Change, Published: August 8th 2019 DOI: 10.5772/intechopen.85919.
2. Sukhpal Singh, Modern Food Value Chains in India: Emerging Potential for the Poor, An Access Publications, 2012.

Reference Books:

1. Heid, J.L. and Joslyn, M.A., Fundamentals of Food Processing Operation, the AVI Publishing Co; Westport, 1967.
2. Leroy L. Blakeslee, World Food Production, Demand, and Trade Paperback, 30 August 1973.
3. Krissoff, Barry, Bohman Mary, Caswell Julie (Eds.), Global Food Trade and Consumer Demand for Quality, Kluwer Academic/Plenum Publishers
4. Prabhu PingaliAnaka, Aiyar Mathew Abraham, Andaleeb Rahman, Transforming Food Systems for a Rising India.



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OPEN ELECTIVES


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Course Code	INDUSTRIAL SAFETY	L	T	P	C
21DOE301b		3	0	0	3
Semester		IV			
Course Objectives:					
<ul style="list-style-type: none"> To know about Industrial safety programs and toxicology, Industrial laws , regulations and source models To understand about fire and explosion, preventive methods, relief and its sizing methods To analyse industrial hazards and its risk assessment. 					
Course Outcomes (CO): Student will be able to					
<ul style="list-style-type: none"> To list out important legislations related to health, Safety and Environment. To list out requirements mentioned in factories act for the prevention of accidents. To understand the health and welfare provisions given in factories act. 					
UNIT - I		Lecture Hrs:			
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.					
UNIT - II		Lecture Hrs:			
Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.					
UNIT - III		Lecture Hrs:			
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants- types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.					
UNIT - IV		Lecture Hrs:			
Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.					



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UNIT - V		Lecture Hrs:
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance		
Textbooks:		
1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services. 2. Maintenance Engineering, H. P. Garg, S. Chand and Company.		
Reference Books:		
1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication. 2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.		


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M.Sc in FOOD TECHNOLOGY

Course Code	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	C
21DOE301a			3	0	0
Semester		IV			
Course Objectives:					
<ul style="list-style-type: none"> To explain cost concepts and objectives of costing system and cost management process To provide knowledge and explain Cost behaviour in relation to Volume and Profit and pricing decisions. To know the concepts of target costing, life cycle costing and activity based cost management in a project or business. To discuss on budget and budgetary control , type of budgets in a business to control costs To provide knowledge on project, types of projects, stages of project execution, types of project contracts and project cost control. 					
Course Outcomes (CO): Student will be able to					
<ul style="list-style-type: none"> Know the cost management process and types of costs Learn and apply different costing methods under different project contracts To understand relationship of Cost-Volume and Profit and pricing decisions. Prepare budgets and measurement of divisional performance. Acquires knowledge on various types of project contracts, stages to execute projects and controlling project cost.. 					
UNIT - I		Lecture Hrs:10			
Introduction and Overview of the Strategic Cost Management Process - Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.					
UNIT - II		Lecture Hrs:12			
Cost Behavior and Profit Planning: Marginal Costing- Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems; Pareto Analysis Just-in-time approach, Theory of constraints.; Divisional performance management: - Measurement of Divisional profitability - pricing decisions - transfer pricing.					
UNIT - III		Lecture Hrs:10			
Target costing- Life Cycle Costing - Activity-Based Cost management:- Activity based costing- Value-Chain Analysis- Bench Marking; Balanced Score Card.					


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UNIT - IV	Lecture Hrs:10
Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	
UNIT - V	Lecture Hrs:12
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.	
Textbooks:	
<ol style="list-style-type: none"> 1. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting 2. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher 	
Reference Books:	
<ol style="list-style-type: none"> 1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi 2. Charles T. Horngren and George Foster, Advanced Management Accounting 3. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd 	
Online Learning Resources:	
https://nptel.ac.in/courses/105/104/105104161/ https://nptel.ac.in/courses/112/102/112102106/	


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M.Sc in FOOD TECHNOLOGY

Course Code	WASTE TO ENERGY	L	T	P	C
21DOE301e			3	0	0
Semester		IV			
Course Objectives:					
<ul style="list-style-type: none"> • Introduce and explain energy from waste, classification and devices to convert waste to energy. • To impart knowledge on biomass pyrolysis, gasification, combustion and conversion process. • To educate on biogas properties ,bio energy system, biomass resources and their classification and biomass energy programme in India. 					
Course Outcomes (CO): Student will be able to					
<ul style="list-style-type: none"> • To know about overview of Energy to waste and classification of waste. • To acquire knowledge on bio mass pyrolysis, gasification, combustion and conversion process in detail. • To gain knowledge on properties of biogas, biomass resources and programmes to convert waste to energy in India. 					
UNIT - I		Lecture Hrs:10			
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors					
UNIT - II		Lecture Hrs:10			
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.					
UNIT - III		Lecture Hrs:12			
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation					
UNIT - IV		Lecture Hrs:12			
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.					
UNIT - V		Lecture Hrs:10			



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Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification- pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Textbooks:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 2018
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., TMH, 2017

Reference Books:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996

Online Learning Resources:

<https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ch13/>
<https://www.youtube.com/watch?v=x2KmjbCvKTK>