

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI



Scheme of Teaching and Examinations and Syllabus
M.Tech. Food Technology (FDT)
(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI											
Scheme of Teaching and Examinations – 2020 - 21											
M.Tech. FOOD TECHNOLOGY (FDT)											
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)											
I SEMESTER											
Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination			Credits	
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks		Total Marks
				L	P	SDA					
1	PCC	20FDT11	Mathematical modelling and analysis in food technology	03	--	02	03	40	60	100	4
2	PCC	20FDT12	Food microbiology	03	--	02	03	40	60	100	4
3	PCC	20FDT13	Food chemistry	03	--	02	03	40	60	100	4
4	PCC	20FDT14	Food process engineering-I	03	--	02	03	40	60	100	4
5	PCC	20FDT15	Food packaging and storage engineering	03	--	02	03	40	60	100	4
6	PCC	20FDTL16	Food processing laboratory	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research methodology and IPR	01	--	02	03	40	60	100	2
TOTAL				16	04	12	21	280	420	700	24
Note: PCC: Professional core.											
Skill development activities:											
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.											
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.											
The students shall											
(1) Gain confidence in modelling of systems and algorithms.											
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.											
(3) Handle advanced instruments to enhance technical talent.											
(4) Involve in case studies and field visits/ field work.											
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.											
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.											
Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.											
Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.											
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.											
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.											

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II SEMESTER											
Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination			Credits	
				Theory	Practical/ Seminar	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks		Total Marks
				L	P	SDA					
1	PCC	20FDT21	Food process engineering-II	03	--	02	03	40	60	100	4
2	PCC	20FDT22	Fruit and vegetable technology	03	--	02	03	40	60	100	4
3	PCC	20FDT23	Dairy technology	03	--	02	03	40	60	100	4
4	PEC	20FDT24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20FDT25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20FDTL26	Food Analysis and Quality Control Laboratory	--	04	--	03	40	60	100	2
7	PCC	20FDT27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				17	06	06	18	340	360	700	24
Note: PCC: Professional core, PEC: Professional Elective.											
Professional Elective 1						Professional Elective 2					
Course Code under 20FDT24X			Course title			Course Code under 20FDT25X			Course title		
20FDT241			Grain Processing and Baking Technology			20FDT251			Functional foods and nutraceuticals		
20FDT242			Sugar, Protein and Oil Technology			20FDT252			Enzyme and Fermentation Technology		
20FDT243			Microbial Biotechnology			20FDT253			Livestock, Fish and Marine Products Processing		
20FDT244			Food Product Development			20FDT254			Food Industry Byproduct and Waste Management		
Note:											
<p>1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the programme shall be mandatory.</p> <p>The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.</p> <p>2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.</p>											

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III SEMESTER											
Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini-Project/ Internship	Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20FDT31	Food laws, regulations and certifications	03	--	02	03	40	60	100	4
2	PEC	20FDT32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20FDT33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20FDT34	Evaluation of project phase -1	--	02	--	--	100	--	100	2
5	PCC	20FDT35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20FDTI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				09	04	02	12	360	240	600	20
Note: PCC: Professional core, PEC: Professional Elective.											
Professional elective 3						Professional elective 4					
Course Code under 20FDT32X			Course title			Course Code under 20FDT33X			Course title		
20FDT321			Plantation Products and Spices Technology			20FDT331			Food Business Management and Entrepreneurship Development		
20FDT322			Water and Beverage Technology			20FDT332			Biosafety and Bioethics		
20FDT323			Process Control and Instrumentation in Food Industry			20FDT333			Biochemistry and Human Nutrition		
20FDT324			Agricultural Biotechnology			20FDT334			Food Separation Engineering		
Note:											
1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.											
CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.											
SEE (University examination) shall be as per the University norms.											

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	20FDT41	Project work phase -2	--	04	03	40	60	100	20
TOTAL				--	04	03	40	60	100	20

Note:

1. Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.



MATHEMATICAL MODELING AND ANALYSIS IN FOOD TECHNOLOGY			
Course Code	20FDT11	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Error definition, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.			
Module-2			
Roots of Equations: False position method, Newton-Raphson method, Horner's Method. Developing mathematical relationship between the independent and dependent variables affecting the food processing operations by using physical and chemical principles governing the process.			
Module-3			
Probability distributions: Binomial, Poisson, Normal Sampling Theory: Testing of hypothesis using t and X^2 test, Goodness of fit.			
Module-4			
F-test, Analysis of Variance: One – way with/without interactions, problems related to ANOVA, Design of experiments, RBD. Statistics: Correlation and Regression analysis			
Module-5			
Application of fuzzy logic to sensory evaluation and ranking of food, predictive model using neural net work, optimization of processing parameters using genetic algorithms			
<p>Course outcomes: At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> 1. Understand different errors and engineering problem solving 2. Learn numerical and statistical methods required for analyzing and interpretation 3. do curve fitting and probability distribution for data analysis 4. Learn analysis of variance of the statistical data through ANOVA 5. evaluate the sensory attributes of food samples by applying fuzzy logic and evaluate processing parameters using genetic algorithms and neural networking 			
<p>Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.</p> <ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			
1. Advanced Engineering Mathematics. C. Ray Wylie and Louis C Barrett, McGraw-Hill, 6 th Edition, 1995			

2. Miller and Miller (2005) Statistics and Chemometrics for Analytical Chemistry (Pearson Education Ltd, Harlow) 5th Edition.
3. Food process operations. H. Das, Asian Books Pvt. Ltd., 1st Edition, 2005
4. Neural network modeling of end-over-end thermal processing of particulates in viscous fluids. Yang Meng and Hosahalli S. Ramaswamy, Journal of food process engineering, ISSN:1745-4530, 33:23-47, 2010
5. Fundamental of Food Process Engineering. Romeo T. Toledo, Springer. 3rd Edition, 2007
6. Numerical Methods for Engineers. Steven C Chapra and Raymond P Canale, McGraw-Hill,6th Edition, 2010

Reference Books

1. Probability and Statistics in Engineering. William W. Hines, Douglas C. Montgomery, David M. Goldsman and Connie M. Borror, 4th Edition, John Wiley and Sons Ltd, 2003
2. Higher Engineering Mathematics. B.S. Grewal, Khanna Publishers, 44th Edition, 1965
3. Numerical methods for scientific and engineering computation. M K Jain, S.R.K Iyengar, R K. Jain, New Age International, 2003
4. Engineering Mathematics. R. R. Singh, M. Bhat, Mcgraw Hill Publication, 1st Edition, 2016
5. Advanced Engineering Mathematics. Erwin Kreyszig, Wiley Publication, 9th Edition, 2011

FOOD MICROBIOLOGY			
Course Code	20FDT12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Microbial growth			
Types of microorganisms, their importance in foods, classification of food borne bacteria, fungi & yeast, their morphology and distinguishing features with examples; Growth of microorganisms in foods; Intrinsic (pH, moisture content, redox potential, nutrient content, antimicrobial constituents and biological structures) and extrinsic factors (temp., RH, presence and concentration of gases) governing growth of microorganisms in food.			
Module-2			
Food spoilage			
Chemical changes caused by microorganisms in foods (breakdown of proteins, carbohydrates, fats and other constituents during spoilage), specific microorganisms causing spoilage of milk and milk products, meat, fish, egg, cereals, fruits, vegetables and their processed products, quality defects in canned foods, sugar and confectionary products.			
Module-3			
Food fermentations			
Different types of fermentations (solid -state, submerged, static, agitated, batch, continuous). Starter cultures, Probiotic cultures, Fermented foods - types, methods of manufacture for vinegar, ethyl alcohol, cheese, yoghurt, baker's yeast and traditional Indian foods.			
Module-4			
Microbial foodborne diseases and detection of microbes			
Types of microbial foodborne diseases (foodborne intoxications and foodborne infections), symptoms and prevention of some commonly occurring foodborne diseases, detecting foodborne pathogens and their toxins- conventional versus rapid and automated methods; genetic and immunologic techniques for detecting foodborne pathogens and toxins.			
Module-5			
Food preservation by controlling microbes			
Principles of preservation, methods of food preservation – high temperature, low temperature, drying, radiation, , antimicrobial agents (types- chemical preservatives, biopreservatives, mode of action and their application), hurdle technology, active packaging, novel processing technologies.			
Course outcomes:			
At the end of the course the student will be able to			
<ol style="list-style-type: none"> 1. understand different factors affecting microbial growth and survival in foods 2. analyze causes for microbial food spoilage and food born diseases & control them 3. understand different microbial fermentations and analyze microbial problems during the processing of fermented food products 4. evaluate food samples by different methods for microbial contamination 5. create appropriate strategies for food preservation and controlling microbial quality of foods 			

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

1. Food Microbiology. Adams MR and Moss MO, RSC Publishing, 3rd Edition, 2008
2. Fundamental Food Microbiology. Bibek Ray, CRC Press, 3rd Edition, 2005
3. Modern Food Microbiology. Jay JM, Aspen Publishers, 6th Edition, 2000
4. Food Microbiology. Doyle MP and Beuchat LR, ASM Press, 3rd Edition, 2007
5. Basic Food Microbiology. Banwart GJ, Chapman & Hall, 2nd Edition, 1989

Reference Books

1. Food Microbiology. W C Frazier & D C Westhoff, McGraw Hill Education; 5th Edition, 2017
2. Modern Food Microbiology, J. M. Jay, CBS Publication, 2005
3. Essentials of Food Microbiology. John Garbutt, Hodder Arnold Publication, CRC Press, 2nd Edition, 1997
4. The Microbiology of Safe Food, S J Forsythe, Blackwell Science Ltd., 2nd Edition, 2010
5. Fundamentals of Food Microbiology. Bibek Ray and Arun Bhunia, CRC Press, 5th Edition, 2013
6. Microbiology of foods. J. C. Ayres, J. O. Mundt, W. E. Sandine, W H Freeman, Wiley Online Library, DOI: 10.1002/jobm.19810210711, 1981

FOOD CHEMISTRY			
Course Code	20FDT13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Proteins			
Nomenclature, classification, structure, chemistry and properties of amino acids, peptides, proteins; Essential and non-essential amino acids, Qualitative and quantitative analysis of amino acids and proteins, Changes during food processing. Browning reactions: Enzymatic and nonenzymatic browning, advantages and disadvantages, factors affecting their reaction and control.			
Module-2			
Carbohydrates			
Nomenclature and classification, structure, physical and chemical properties of polysaccharides and their functions; Qualitative and quantitative analysis of carbohydrates; changes in carbohydrates during food processing			
Module-3			
Lipids			
Structure, classification, physical and chemical properties, utilization of fats and oils, margarine, shortenings, salad and cooking oils, importance of fats and oils in diet, introduction to hydrogenation and its importance.			
Module-4			
Nutrient Supplements			
Vitamins and minerals: Types of vitamins and minerals, chemistry and functions, sources and deficiency diseases; Plant pigments: Importance, structure and properties of plant pigments, chemical changes in pigments during food processing.			
Module-5			
Food ingredients and additives			
Classification and functions, need for food ingredients and additives, Permitted dosages of food additives , food preservatives, antimicrobial agents, thickeners- polysaccharides, bulking agents; antifoaming agents, synergists, antagonists. Antioxidants (synthetic and natural, mechanism of oxidation inhibition), chelating agents-types, uses and mode of action; Coloring agents-color retention agents, applications and levels of use, natural colorants, sources of natural color (plant, microbial, animal and insects), misbranded colors, color stabilization; Flavoring agents- flavors (natural and synthetic flavors), flavor enhancers, flavor stabilization, flavor encapsulation; Flour improvers- leavening agents, humectants and sequesterants, hydrocolloids, acidulants, pH control agents, buffering salts, anticaking agents; Sweeteners- natural and artificial sweeteners, nutritive and non-nutritive sweeteners, properties and uses of various sweeteners in food products; Emulsifiers: Types, selection of emulsifiers, emulsion stability, functions and mechanism of action.			
Course outcomes: At the end of the course the student will be able to:			
<ol style="list-style-type: none"> 1. understand and analyze amino acids, peptides, proteins and enzymes for utilization in food processing 2. understand and analyze carbohydrates during food processing 3. understand classification, structures and properties of lipids 4. understand different kind of nutrient supplements 5. analyze and evaluate levels of food ingredients and additives for the acceptability of food products 			

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) Food Chemistry. H.D. Belitz, W.Grosch, P,Schieberle, Springer, 4th revised edition, 2009

(2) Fennemas's Food Chemistry. S. Damodaran and K. L. Parkin, CRC Press, 5th edition, 2017

(3) Food Chemistry. Meyer LH, CBS publication, 2006

(4) Basic Food Chemistry. Frank Lee, Springer, 1st Edition Reprint, 1983

(5)Principles of Biochemistry. Albert L. Lehninger, David L. Nelson, Michael M. Cox, W. H. Freeman publisher, 2004

Reference Books

(1) Food Antioxidants: Technological, Toxicological and Health Perspective. D.L. Madhavi, S.S. Deshpande, D.K. Salunkhe, CRC Press, 1st Edition,

(2) Food Flavours, Part A, B & C. I.D. Morton, A.J. Macleod, Elsevier Science Publishers, 1990

(3) A Textbook of Organic Chemistry. Arun Bhal and B.S. Bhal, S. Chand & Company, 22nd Edition, 2016

(4)Essential of Physical Chemistry. Arun Bhal, B.S. Bhal and G.D. Tuli, S. Chand Publication, 2010

(5)Organic Chemistry. Paula Y. Bruice, Pearson Education Publication, 7th Edition, 2013

(6) Natural food additives, ingredients and flavourings. D. Baines, Woodhead Publishing Series in Food Science, Technology and Nutrition, 1st Edition, 2012

(7)Fenaroli's Handbook of Flavor Ingredients. Gerorge A. Burdock, CRC Press, 1st Edition, 2009

FOOD PROCESS ENGINEERING-I			
Course Code	20FDT14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Properties of Foods & Food Processing at ambient temperature			
Properties of Foods: Composition, Physical, Rheological and biochemical properties, Sensory characteristics, Nutritional quality			
Food Processing at ambient-temperature:			
Raw Food Processing- Cooling crops and carcasses; Cleaning- wet and dry cleaning; Sorting and grading- shape and size sorting, weight sorting, colour and machine vision sorting and grading; Peeling			
Reduction of Size- Solid foods- Theory, equipment, developments in size reduction technology, effects on foods and microbes; Liquid foods- Theory, emulsifying agents and stabilizers, equipment, effect on foods and microbes. ■			
Module-2			
Food Processing at ambient temperature			
Mixing and Forming- Mixing-Theories of solids and liquids mixing, equipment, effect on foods and microorganisms; Forming- Bread moulders, pie, tart and biscuit formers, confectionery moulders and depositors			
Separation and Concentration of components of Food: Theory and equipment for Centrifugation, Filtration and Expression; Solvent Extraction- Theory, solvents, supercritical CO ₂ , Equipment; Membrane concentration- theory, equipment and applications, types of membrane system, effect on foods and microorganisms ■			
Module-3			
Food processing by heat removal			
Chilling and modified atmospheres- theory-refrigeration, modified atmospheres; equipment- mechanical refrigerators, cryogenic chilling, cold storage, temperature monitoring, modified and controlled atmospheric storage; applications- fresh and processed foods; effects on sensory and nutritional qualities of foods & microbes			
Freezing- theory- ice crystal formation, solute concentration, freezing time calculation, thawing; equipment- mechanical freezers, cryogenic freezers, new developments in freezing, frozen storage, thawing; effect on foods- freezing, frozen storage and thawing; effect on microbes			
Freeze drying- Theory, equipment and effect on foods and microbes			
Freeze concentration- Theory, equipment and effect on foods and microbes. ■			
Module-4			
Food Processing by heat application			
Heat Processing – Theory- Thermal properties of foods, heat transfer; Heat sources and application methods- direct and indirect heating methods, energy use and methods to reduce energy consumption, types of heat exchangers; Effect of heat on microbes, enzymes, nutritional and sensory characteristics of food ■			
Module-5			
Food Processing by heat application			
Processing by heat using steam or water:			
Blanching- Theory, Equipment- steam blanchers, hot water blanchers, new blanching methods, effect on food and microbes			
Pasteurisation- Theory, Equipment- pasteurization of packaged and			

unpackaged foods, effect on foods **Sterilization by heat-** In container sterilization- theory, retorting, equipment; Ultra high temperature (UHT)/aseptic processes- theory, processing, equipment; effect on food-canning, UHT processing
Evaporation- theory, improvement of evaporation economics, equipment, effect on foods and microbes **Distillation-** theory, equipment, effect on foods and microbes
Extrusion- theory of extrusion cooking- ingredient properties, operating characteristics of extruder; equipment- single and twin screw extruders, control of extruders; food applications- confectionery, cereal and protein based products; effects on sensory characteristics and nutritional value of foods & microorganisms ■

Course outcomes: At the end of the course the student will be able to:

1. Understand food properties and food processing at ambient temperature
2. Apply food processing methods at ambient temperature
3. Apply heat removal methods for food processing
4. Understand heat processing for food applications
5. Apply heat application methods for food processing

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

1. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009
2. Introduction to Food Engineering. R Paul Singh & Dennis R Heldman, Amsterdam Elsevier/Academic Press, 4th Edition, 2009
3. Fundamentals of food engineering. D.G. Rao, PHI Learning Private Limited, New Delhi, 2010
4. Food process engineering and technology. Zeki Berk, 1st edition, 2009, CRC Press, New York
5. Trends in Food Engineering. Jorge E. Lozano, Cristina Anon, Gustavo V. Barbosa-Canovas, Efrén Parada-Arias, CRC Press; 1st Edition, 2000
6. Novel Food Processing Technologies (Food Science and Technology Series). Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Publisher: CRC Press, 1st Edition, 2004
7. Minimal Processing Technologies in the Food Industry. Thomas Ohlsson and Nils Woodhead Publishing Limited, 1st Edition, 2002

Reference Books

1. Fundamental Food Microbiology, Bibek Ray, 3rd edition, 2004, CRC Press, New York, Washington DC
2. Hurdle Technologies – Combination treatments for food stability safety and quality. L. Leistner and G.W. Gould, Springer US publication, 1st Edition, 2002
3. Food Process Operations. H. Das, Asian Books Pvt. Ltd., 1st Edition, 2005
4. Pulsed Electric Fields in Food Processing: Fundamental aspects and applications: a volume in the Food Preservation Technology series. G V Barbosa-Cánovas and Q H Zhang, Woodhead Publishing Limited, 1st Edition, 2001
5. Pulsed electric field technology for the food industry: Fundamentals & applications (Food engineering series). Javier Raso and Volker Heinz, Springer US Publication, 1st Edition, 2006
6. Thermal Technologies in Food Processing. P Richardson, Woodhead Publishing Limited, 1st Edition, 2001
7. Food Processing Operations Modeling: Design and Analysis. J.M. Irudavarai. CRC Press, 1st Edition, 2001
8. Food Processing Hand Book. James G. Brennen, Wiley-VCH Verlag GmbH & Co. KGaA, 1st Edition, 2006
9. Emerging Technologies for Food Processing. Da-wen Sun, Academic Press Imprint, 2015

FOOD PACKAGING AND STORAGE ENGINEERING			
Course Code	20FDT15	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction			
Function of packaging, marketing consideration for a package and types of packaging. Barrier properties of packaging material, gas permeation rates-oxygen transmission rate (OTR), water vapour transmission rate (WVTR), bursting strength, tensile strength, tearing strength, drop test, puncture test, etc.			
Module-2			
Selection of packaging materials, packaging machines and labeling			
Packaging materials for foods, Selection criteria of packaging materials for raw and processed food products. Machinery for Packaging: Form fill and seal machines, vacuum packaging machine, shrink wrap packaging machine and multilayer packaging system. Package labeling: functions, nutrition labelling, ingredient characterization handling instruction, and regulations; Shelf life of packaged food: water activity and prediction of shelf life. Packaging logistics.			
Module-3			
Storage engineering-I			
Food Storage: Importance of scientific storage systems, postharvest Physiology of semi-perishables and perishables, climacteric and non-climacteric fruits, respiration, ripening, changes during ripening, ethylene biosynthesis. Product damages during storage. Storage structures: Traditional, improved and modern storage structures; farm silos. Stored grain management and aeration: moisture and temperature changes in stored grains; conditioning of environment inside. Storage, purposes of aeration, aeration theory and aeration system operation.			
Module-4			
Storage Engineering-II			
Storage pests and control: Damage due to storage insects, pests, rodents and its control. Storage of perishables: cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside perishable storage.			
Module-5			
Biodegradable packaging			
Types of packaging, classification, advantages and limitations of each type of packaging, economics of various packaging materials; Specifications for packaging various food products, testing standards, testing agencies and biodegradability; Types of natural polymers used for developing food packaging, properties of natural polymers for food packaging applications, chemical modifications of natural polymers for food applications; Methods of manufacturing biodegradable packaging, testing and evaluation; Synthetic biopolymers used for packaging applications. Properties of the polymers and specifications; Methods of manufacturing synthetic polymer films, testing and evaluation; Practicals- Developing packaging films from starch and evaluating properties; Developing packaging films from synthetic biopolymers; Testing of developed films; Evaluation for the films developed for various food packaging.			

<p>Course outcomes: At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> 1. Understand the primary functions, marketing considerations and terms related to packaging 2. Learn about packaging materials, packaging systems and food storage. 3. Learn to evaluate suitability of appropriate storage system. 4. Apply his understanding to select appropriate packaging for different food products. 5. Evaluate bio- films for various food packaging & learn how to test materials for their suitability for packaging.
<p>Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.</p> <ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■
<p>Textbooks</p> <ol style="list-style-type: none"> 1. Food Packaging: Principles and Practice. Gordon L. Robertson, CRC Press, 3rd Edition, 2013 2. Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. A. Chakraverty, A. S. Mujumdar, G.S.V. Raghavan, H.S. Ramaswamy, CRC Press, 1st Edition, 2003 3. Food Packaging and Preservation, M. Mathlouthi, Aspen Publishers Inc., United States, 1999
<p>Reference Books</p> <ol style="list-style-type: none"> 1. Hermeticity of Electronic Packages. Hal Greenhouse, William Andrew Publishing, LLC, Norwich, New York, U.S.A., 2nd Edition, 2011 2. Storage of Cereal Grains and Their Products. David B. Saucer, Food and Agricultural Organization of the United Nations, 4th Edition, 1992 3. Principles of Agricultural Engineering. A.M. Michael and T.P. Ojha, Jain Brothers-New Delhi, 2nd Edition, 2003 4. Handling and Storage of Food Grains in Tropical and Subtropical Area, David Wylie Hall, FAO, 1970 5. Silos, Theory and Practice: Vertical Silos, Horizontal Silos (retaining Walls), André M. Reimbert, 2nd Edition, 1900 6. Fruit and Vegetables: Harvesting, Handling and Storage. A Keith Thompson 2nd Edition, Wiley-Blackwell, 2003

FOOD PROCESSING LABORATORY			
Course Code	20FDTL16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03
S. No.	Experiments		
	<ol style="list-style-type: none"> 1. Preservation of fruits and vegetables by osmotic dehydration, salting and canning 2. Yield and performance evaluation of juice extraction and processing 3. Studying the effect of chemical preservatives on the shelf life of juices and pastes 4. Determination of physical properties of grains, cereal and spice seeds 5. Determination of coefficient of static friction for grain against different surfaces and angle of repose 6. Size reduction of cereals and evaluation of energy consumption, yield and performance of respective equipments 7. Convective hot air drying of foods and to understand about moisture removal kinetics 8. Studies using freeze dryer to find out the freezing time and drying - rehydration characteristics of given food sample 9. Microwave drying of foods and comparative study of moisture removal rates between hot air drying and microwave drying 10. Determination of thermal process time for sterilization 		
<p>Course outcomes: At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> 1. Learn different food preservation methods. 2. Evaluate the performance of different food processing equipments. 3. Determine physical properties of different food grains. 4. Analyze the energy and material balances of food processes. 			
<p>Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.</p>			
Textbooks/Manuals			
(1). Unit Operations of Agricultural Processing. K.M. Sahay and K.K. Singh, Vikas Publishing House Pvt. Ltd., 2 nd Edition, 2004.			
(2). Experimental Methods in Food Engineering, Rizvi, S.S.H. and Mittal, G.S., Springer US, 1 st Edition, 1992.			
Reference Book			
(1) Introduction to Food Engineering. R Paul Singh & Dennis R Heldman, Amsterdam Elsevier/Academic Press, 4 th Edition, 2009			

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03
Module-1			
<p>Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.</p> <p>Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. ■</p>			
Module-2			
<p>Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.</p> <p>Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ■</p>			
Module-3			
<p>Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.</p> <p>Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.</p> <p>Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. ■</p>			
Module-4			
<p>Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.</p> <p>Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. ■</p>			
Module-5			

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999, The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act 1999, Copyright Act, 1957, The Protection of Plant Varieties and Farmers' Rights Act, 2001, The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO), WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR. ■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks
(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 4 th Edition, 2018.
(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), Ranjit Kumar, SAGE Publications, 3 rd Edition, 2011.
(3) Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.
Reference Books
(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

*** END OF I SEMESTER ***

FOOD PROCESS ENGINEERING-II			
Course Code	20FDT21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
<p>Food Processing at ambient-temperature Irradiation- theory-dose distribution; equipment-radiation dose measurement; applications- radappertisation, radacidation, radurisation, ripening control, disinfection, sprouting inhibition; effect on foods- induced radioactivity, radiolytic products, nutritional and sensory qualities; effect on microbes; effect on packaging; detection of irradiated foods- physical, chemical and biological methods High pressure processing of Foods- theory- effect on food components, mechanism of microbial cell inactivation; equipment- batch operation, semi continuous operation, process developments; effect on parasites and microbes- yeasts, moulds, bacteria, viruses; effect on enzymes; effect on foods; combinations of high pressure and other minimal processing techniques ■</p>			
Module-2			
<p>Food Processing at ambient-temperature Minimal Food processing methods- Processing by Pulsed electric field (PEF)- theory, equipment, effects on microbes, enzymes and food components, combinations of PEF and other treatments; Processing by electric arc discharges and oscillating magnetic fields; Processing with pulsed light, UV light and pulsed X-rays- theory, equipment, effects on microbes, enzymes and food components; Processing by ultrasound- theory, processing, effects on microorganisms and foods; Microwave processing. ■</p>			
Module-3			
<p>Food Processing by heat application Processing by heat using hot air: Dehydration (Drying)- theory- drying with heated air and heated surfaces, intermediate moisture foods; equipment- hot air driers, heated surface (contact) driers, control of dryers, rehydration; effect on sensory and nutritional properties of food and microbes. Smoking- theory- smoke constituents, liquid smoke; processing equipment; effect on foods and microorganisms. Baking and Roasting- theory; equipment- batch and semi continuous ovens, continuous ovens, control of ovens; effects on sensory and nutritional qualities of foods & microorganisms Processing by heat using hot oils: Frying- theory-heat and mass transfer, frying time and temperature; equipment- atmospheric fryers, vacuum and pressure fryers, fryer operation control, oil filtration and heat recovery; oils used for frying and effect of frying on oils; effect of frying on foods- oil absorption, changes to texture, colour and flavour & nutritional changes; effect of frying on microbes. ■</p>			
Module-4			
<p>Food Processing by heat application Heat processing by direct and radiated energy: Dielectric heating- theory, equipment, applications, effect on foods and microbes Ohmic heating- theory, equipment, applications, effect on foods and microbes Infrared heating- theory, equipment, applications, effect on foods and microbes ■</p>			
Module-5			

Extraction & Hurdle Technology

Extraction- Solid-liquid extraction (Leaching)- types of extraction processes; extraction principles- counter current extraction, McCabe-Thiele method, right angled triangle method; equipment- batch extractor, continuous counter current extractor, multi stage continuous counter current extractor; extraction applications in food processing- extraction of oils & fats, oleoresins, food colours, coffee, flavours and pigments

Hurdle technology-

Basics of hurdle technology – Mechanism

Application to foods - Newer Chemical and Biochemical hurdles- organic acids – Plantderived

antimicrobials – Antimicrobial enzymes – bacteriocins – chitin / chitosan (only one

representative example for each group of chemical and biochemical hurdle) ■

Course outcomes: At the end of the course the student will be able to:

1. apply irradiation and high pressure for food processing
2. apply minimal methods for food processing
3. apply heat for food processing applications
4. apply ohmic and infrared heating for food processing
5. apply extraction and hurdle technology for food processing

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

1. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009
2. Introduction to Food Engineering. R Paul Singh & Dennis R Heldman, Amsterdam Elsevier/Academic Press, 4th Edition, 2009
3. Fundamentals of food engineering. D.G. Rao, PHI Learning Private Limited, New Delhi, 2010
4. Food process engineering and technology. Zeki Berk, 1st edition, 2009, CRC Press, New York
5. Trends in Food Engineering. Jorge E. Lozano, Cristina Anon, Gustavo V. Barbosa-Canovas, Efrén Parada-Arias, CRC Press; 1st Edition, 2000
6. Novel Food Processing Technologies (Food Science and Technology Series). Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Publisher: CRC Press, 1st Edition, 2004
7. Minimal Processing Technologies in the Food Industry. Thomas Ohlsson and Nils Woodhead Publishing Limited, 1st Edition, 2002

Reference Books

1. Fundamental Food Microbiology, Bibek Ray, 3rd edition, 2004, CRC Press, New York, Washington DC
2. Hurdle Technologies – Combination treatments for food stability safety and quality. L. Leistner and G.W. Gould, Springer US publication, 1st Edition, 2002
3. Food Process Operations. H. Das, Asian Books Pvt. Ltd., 1st Edition, 2005
4. Pulsed Electric Fields in Food Processing: Fundamental aspects and applications: a volume in the Food Preservation Technology series. G V Barbosa-Cánovas and Q H Zhang, Woodhead Publishing Limited, 1st Edition, 2001
5. Pulsed electric field technology for the food industry: Fundamentals & applications (Food engineering series). Javier Raso and Volker Heinz, Springer US Publication, 1st Edition, 2006
6. Thermal Technologies in Food Processing. P Richardson, Woodhead Publishing Limited, 1st Edition, 2001
7. Food Processing Operations Modeling: Design and Analysis. J.M. Irudavarai. CRC Press, 1st Edition, 2001
8. Food Processing Hand Book. James G. Brennen, Wiley-VCH Verlag GmbH & Co. KGaA, 1st Edition, 2006
9. Emerging Technologies for Food Processing. Da-wen Sun, Academic Press Imprint, 2015

FRUIT AND VEGETABLE TECHNOLOGY			
Course Code	20FDT22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Post Harvest Processing			
Production of Fruits and vegetables in India, Composition of major fruits and vegetables produced in the country, Post harvest handling and storage of fresh fruits and vegetables Causes for heavy post harvest losses; Spoilage factors; Fruit Ripening and Related Parameters, Changes in Fruit Quality Attributes during Handling Cold Storage and Fruit Quality, cold chain effect on fruit shelf life, Effect of Heat, Calcium, Polyamine and 1-Methylcyclopropene Treatments.			
Module-2			
Fruits and Vegetables Processing			
Canning: Preparation of fruits and vegetables for canning – Washing, peeling, grating, slicing dicing, deseeding, blanching; Common machinery for operations Juice and pulp extraction – extractors, Hydraulic Press, Hot and Cold Break process, Clarification, Clarification centrifuges, Decanters and desludgers; Fruit juice concentrates-methods of concentration, types of evaporators; Fruit Powders - Preparation of Fruit material for powder production, Process operations.			
Module-3			
Drying & Applications of enzymes in processing			
Preparation of fruits and vegetables for dehydration, Equipments used for drying, design aspects of dryers, effects of drying, Enzymes in fruits and vegetable processing.			
Module-4			
Aseptic and other processing methods			
Aseptic processing- Aseptic heat exchangers / pasteurizers, Aseptic fillers. Filling systems- Tetra pack for small quantities, Dole system and Scholle system for bulk filling; Hurdle technology with reference to Vegetable and Fruit processing.			
Module-5			
Novel Processing methods			
UV applications, High pressure applications, Ultrasound applications, Membrane applications, High intensity pulsed electric field applications, ozone processing, Irradiation applications in fruit processing, Minimal processing, Storage in Modified Atmosphere, Active Packaging, Freeze concentration applications, Vacuum frying applications, Edible coatings.			
Course outcomes: At the end of the course the student will be able to:			
1. Understand the importance of fruits and vegetable processing in India.			
2. Have clear understanding about different processing and preservation methods for fruits and vegetables.			
3. Gain insights about advanced methods of fruit and vegetable processing.			
4. Apply his understanding to evaluate different processing methods.			
5. Apply his understanding to select appropriate method for processing of fruits and vegetables.			

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

(1) Hand book of fruits and fruit processing. N.K.Sinha, J.S. Sidhu, J. Barta, J.S.B. Wu, M.P. Cano, Wiley-Blackwell, 2nd edition, 2012

(2) Hand book of vegetables and vegetable processing. N.K.Sinha, Y. H. Hui, E. O.Evranuz, M. Siddiq, J. Ahmed, Wiley-Blackwell, 1st edition, 2011

(2) Hand Book of Vegetable Preservation and Processing. Y. H. Hui, E. ÖzgülEvranuz, CRC Press, 2nd Edition, 2015

(3) Fruit and Vegetable Preservation; Principles and Practices. R.P. Srivastava and Sanjeev Kumar, CBS; 3rd Edition, 2014

(4) Technological Interventions In The Processing Of Fruits And Vegetables. RachnaSehrawat, Khursheed A. Khan, Megh R. Goyal, Apple Academic Press Inc. 2018

Reference Books

(1) Handbook of Fruit Science and Technology: Production, Composition and Processing. D.K. Salunkhe and S.S. Kadam, CRC Press, 1st Edition, 1995

(2) Handbook of Vegetable Science and Technology. Production, Composition, Storage and Processing. D.K. Salunkhe and S.S. Kadam, CRC

(3) Handbook of Post-harvest Technology. A. Chakraverty, A.S. Mujumdar, G.S.V Raghavan and H.S. Ramaswamy, Taylor and Francis Inc. publisher, 1st

(4) Advances in Fresh-Cut Fruits and Vegetables Processing. Ed. Olga Martin-Belloso, Robert SolivaFortuny, CRC Press, 1st Edition, 2010

(5) Advances in Fruit Processing Technologies. Sueli Rodrigues, Fabiano Andre NarcisoFernandes, CRC Press, 1st Edition, 2016

(6) Fruit and Vegetable Processing. M.E. Dauthy, FAO Agricultural Services Bulletin No.119, Food and Agriculture Organization of the United Nations, Rome, 1995

DAIRY TECHNOLOGY			
Course Code	20FDT23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction			
Understanding about milk, milk - composition, food and nutritive value, physico-chemical properties; milk reception at dairies, quality and quantity tests at reception Equipments used in liquid milk processing.			
Module-2			
Unit Operations in Milk Processing			
Principles of milk processing: Filtration, milk storage, bulk cooling, stirring and mixing, standardization, pasteurization, sterilization, centrifugation, homogenization, evaporation and condensation.			
Module-3			
Production of Milk Products			
Drying of milk, principle and equipment: spray dryer, cyclone separator. Manufacturing of milk products and principles of processing of cheese, ice-cream, butter, special milk products, casein, whey, curd, butter milk etc. Equipment for indigenous milk products manufacturing. Enzymes and their role in the manufacture of dairy products.			
Module-4			
Non-thermal processing and packaging			
UV, High pressure, Ultrasound, Membrane, High intensity pulsed electric field applications in milk processing			
Packaging			
Filling Operations: Principles and working of different types of bottle filters and capping machine, pouch filling machine, pre-pack and aseptic filling. Filling and Packaging machines for milk and milk products, aseptic packaging.			
Module-5			
Dairy plant maintenance			
Bulk milk handling system, care and maintenance, Hygienic design concepts, sanitary pipes and fittings, CIP system. Preventive maintenance program for Dairy Plant, Maintenance organization, development of optimum organization planned overhaul and PERT planning, Utilities and sanitation in processing plant.			
By-product utilization			
By-product utilization from dairy industries.			
Course outcomes: At the end of the course the student will be able to:			
1. Understand about properties of milk and raw milk reception for processing			
2. Learn about different unit operations in liquid milk processing			
3. Gain knowledge about manufacturing of different dairy products			
4. Understand about different novel non-thermal dairy processing and packaging of dairy products			
5. Know about by-product utilization and dairy plant maintenance			

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

1. Outlines of Dairy Technology. Sukumar De, Oxford University Press, 5th Edition, 2005
2. Dairy Plant System and Layout. Tufail Ahmed, Kitab Mahal, New Delhi, 1996
3. Milk processing and quality management. A.Y.Tamime, 2009, Wiley-Blackwell, West Sussex, UK
4. Dairy Technology: Principles of Milk Properties and Processes. P. Walstra, T.J. Geurts, A. Noomen, A. Jellema, M.A.J.S. van Boekel, 1st Edition, 1999, Marcel Dekker, New York
5. Dairy science and technology hand book- Principles and properties. Y.H. Hui, 1993, Wiley-VCH, New York

Reference Books

1. Dairy Chemistry and Biochemistry. P. F. Fox, T. Uniacke-Lowe, Paul L. H. McSweeney, James A. O'Mahony, 2nd Edition, 2015
2. Cheese and Butter by V. Cheke and A. Sheeprd, Agro-Bios, 1st Edition, 1998
3. Dairy Plant System and Layout. Tufail Ahmed, Kitab Mahal, New Delhi, 1996

GRAIN PROCESSING AND BAKERY TECHNOLOGY			
Course Code	20FDT241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Grain processing and milling Production, Economics, and processing scenario of Food grains. Classification, structure and physicochemical properties and thermal properties of Food grains; Unit operations and equipment for Food Grain Processing, Processing and storage of cereals, pulses and oil seeds. Commercial processing of Paddy, wheat, Corns, Barley, Millets, Pulses and Oil seeds. Dry Milling (Rice and Wheat), Wet Milling (Maize) and parboiling of rice. ■			
Module-2			
Baking Technology Introduction of bakery products-bread, biscuit, cake, pastries, rusk, crackers. PFA specifications of bakery products. Bread types; role of major and minor ingredients; processes of bread making; problems associated with bread making; equipment for bread manufacturing; processing steps for biscuit, cookies, cracker, cakes and their major and minor ingredients. Nutritional aspect of bakery products; quality evaluation of baked products. ■			
Module-3			
Confectionary Historical development; classification of confectionary products; basic technical considerations for confectionary products- TS, TSS, pH, acidity, ERH, RH etc. raw materials and their role in confectionary products; traditional confectionary products. ■			
Module-4			
Chocolate & Vanilla processing historical development in chocolate processing; ingredients and their role in chocolate; Steps of chocolate processing- mixing, refining, conching, tempering, molding, cooling, coating, enrobing, etc. Vanilla- Production, processing and packaging ■			
Module-5			
Candies and Toffee High boiled sweets/candy-composition, production and preparation of high boiled sweets- traditional, batch and continuous methods; toffee composition, types, ingredient and their role, batch and continuous methods of toffee manufacturing ■			
Course outcomes: At the end of the course the student will be able to: 1. understand structure and proximate composition of grains & physical properties 2. Evaluate different technologies for making bakery products 3. learn roles of different components and technical considerations in different confectionary products 4. create strategies for chocolate and vanilla processing 5. create strategies for candy and toffee making			

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) Principles of cereal science and technology. J.A. Delcour, R.C. Hoseney, AACC International, 3rd edition, 2010

(2) Food Technology-II. A. Patel, H.C. Devraja, P.Sharma, R.R.B.Singh, www.agrimoon.com, ICAR

(3) Food Technology-I. A.K.Singh, P.N.Raju, A. Jana, www.agrimoon.com, ICAR

(4) Bakery Products: science and technology. Y. H. Hui, H. Corke, I.D.Leyn, WK Nip, N.Cross, Blackwell Publishing, 2006

(5) Cereal grains for the food and beverage industries.E.K.Arendt, E. Zannini, Woodhead Publishing, 2013.

(6) Cereals Processing Technology. G.Owens, CRC Press, Woodhead Publishing, 2001.

Reference Books

1. Guidance document-food safety management system: bakery and bakery products. By FSSAI

2. Bakery Science & Cereal Technology. Neelam Khetarpaul, Daya Books, 1st Edition, 2005

3. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture. N.L. Kent, Woodhead Publishing Imprint, 4th Edition, 1994

4. Post-Harvest Technology of Cereals, Pulses and Oil Seeds. A. Chakravarty, Oxford & IBH Publishing Co. Pvt. Ltd., 1st Edition, 1989

5. Bakery Products Science and Technology. Weibiao Zhou and Y. H. Hui, Wiley Blackwell, 2nd Edition, 2014

6. The Complete Technology Book on Bakery Products. NIIR Board of Consultants & Engineers, NPCS, Kamla Nagar, New Delhi, 3rd Edition, 2014

SUGAR, PROTEIN AND OIL TECHNOLOGY			
Course Code	20FDT242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction			
Structure, properties and functionality of sugars Structure, properties and functionality of proteins Structure, properties and functionality of lipids.			
Module-2			
Sugar Technology, products and by-products			
Sugarcane and sugarbeet as sugar raw materials; Flow charts for manufacture of Granulated and Liquid sugars; Properties of Granulated sucrose and Liquid Sugars; Invert sugar and their characteristics Extraction of sugar juice from beet and cane; Juice purification; Decolorisation, Evaporating, Crystallization; Centrifugation; Sugar handling after centrifugals Pressed and dried pulp; Bagasse; Molasses; Liquid sugars; Special crystal sugar products			
Module-3			
Protein processing			
Protein extraction- different methods Protein separation- different methods Protein concentration- different methods			
Module-4			
Oil Processing			
Pressing and Extraction of oils; Chemical, Physical and miscellaneous methods Inter-esterification; Hydrogenation; Fat crystallization			
Module-5			
Extended Applications of Lipids			
Food emulsions; Non-aqueous foods; Special food applications- edible coating and film barriers; spray processing of fat containing foodstuffs - spray drying and cooling; low calorie fats; food emulsifiers; lipid emulsions for intravenous nutrition and drug delivery, Fats and oils Formulation; Shortenings; Margarine			
Course outcomes: At the end of the course the student will be able to: 1. understand structure, properties and functionality of sugars, proteins and lipids 2. create strategies for the production of sugar and by-products from different sources 3. analyze and evaluate the different methods of processing of proteins 4. analyze and evaluate the different methods of oil processing 5. apply lipids for extended uses			

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Lipid Technologies and Applications. Frank D. Gunstone and Fred B. Padley, CRC Press, 1st Edition, 1997
2. Practical Guide to Vegetable Oil Processing. Monoj K. Gupta, AOCS Press, 1st Edition, 2004
3. Bleaching and Purifying Fats and Oils, Gary R. List, AOCS Press and Academic Press, 2nd Edition, 2009
4. Sugar Technology-Beet and Cane Sugar Manufacture. P.W. van der Poel, H. Schiweck, T.K. Schwartz, Publisher: Verlag Dr Albert Bartens KG, 1998
5. Principles of Sugar Technology. P. Honig, Elsevier, 1st Edition, 1953
6. Encyclopedia of Protein Technology. Josie Mehta, Dominant Publishers And Distributors, 1993

Reference Books

1. Fats and Oils-Formulating and Processing for Applications. Richard D. O'Brien, CRC Press, 3rd Edition, 2008
2. Beet- Sugar Technology. R.A. McGinnis, Publisher: Beet Sugar Development Foundation, 3rd Edition, 1982
3. A Textbook of Organic Chemistry. Arun Bhal and B.S. Bhal, S. Chand & Company, 22nd Edition, 2016
4. Food Proteins and Their Applications. Ed. Srinivasan Damodaran and Alain Paraf, Markel Dekker Inc. Publication, 1st Edition, 1997
5. Proteins in Food Processing, Ed. Rickey Y. Yada, Woodhead Publishing (Elsevier), 2nd Edition, 2018

MICROBIAL BIOTECHNOLOGY			
Course Code	20FDT243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction			
The era of the discovery of Microbes, Pasteur and fermentation, The discovery of Antibiotics, Production strains, screening techniques, Industrial Fermentations, Screening Methods, Strain Development.			
Module-2			
Production media			
Characteristics of an Ideal Production Media, Raw materials for production, Different production Media, Principles of Sterilization, Sterilization equipment.			
Module-3			
Principal types of fermentor in industries			
Introduction to Fermentors, Factors involved in fermentor Design, Fermentor configurations, Principal operating characteristics of fermentors, Computer control of Fermentation Process.			
Module-4			
Microbiological assays			
Microbiological assay of Vitamins, Amino Acids, Antibiotics and Trace elements. Advantages and Disadvantages of Microbiological Assay, Automation of Microbiological Assay, Detection methods for pathogens.			
Module-5			
Industrial applications of microbes			
Food sector- Fermented foods, Production of food related metabolites like organic acids, vitamins by microbes; Enzyme Industries- Production of microbial enzymes used in food processing; Sewage treatment methods by using microbes.			
Course outcomes:			
At the end of the course the student will be able to:			
1. Understand Industrial Fermentations, Screening Methods and Strain Development			
2. Understand Different production Media, Principles of Sterilization and related equipment			
3. Analyze different fermentor designs and control their operation			
4. Analyze and evaluate different microbiological assays for biomolecules and pathogens			
5. Apply microbes for industrial uses			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbook/ Textbooks			

1. Microbiology. Michael J Pelczar Jr., E.C.S. Chan and Noel R Krieg, McGraw Hill Inc. US, 5th Revised Edition, 2001
2. Microbiology. Prescott, Joanne Willey and Kathleen Sandman and Dorothy Wood, Harley, Klein, McGraw Hill, 8th Edition, 2010
3. Industrial Microbiology. Samuel C Prescott and Cecil G Dunn, Agrobios (India), 2011
4. Palynology and its applications. Shripad N. Agashe, Oxford and IBH publishing Pvt. Ltd. 1st Edition, 2006
5. Biotechnological Applications of Microbes. Ajit Verma, I.K. International Publishing House, 1st Edition, 2005
6. Alcamo's Fundamentals of Microbiology. Jeffery C Pommerville, Jones and Bartlett Publisher, 9th Revised Edition, 2010
7. Microbiology, an Introduction, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Publisher: Pearson, 12th Edition, 2016
8. Principles of Microbiology. Ronald M Atlas, McGraw-Hill Inc., US, 1995
9. Microbiology: Principles and Explorations, Jacquelyn G. Black and Laura J. Black, John Wiley & Sons, 8th Edition, 2012

Reference Books

1. The Air Spora: A Manual for Catching and Identifying Airborne Biological Particles. Maureen E. Lacey and Jonathan S. West, Springer US, 1st Edition, 2006
2. Soil Microbiology. N.S. Subbarao, Oxford and IBH, Science Publishers U.S., 2nd Revised Edition, 1999
3. Palynology and its applications. Shripad N. Agashe, Oxford and IBH publishing Pvt. Ltd.
4. Text Book of Microbiology. R. Anantaharayan and C.K. Jayaram Panicker, Universities Press, 8th Edition, 2009
5. Microbial Biotechnology International Student edition: Fundamentals of Applied Microbiology. Alexander N. Glazer and Hiroshi Nikaido, Student Edition, 2007

FOOD PRODUCT DEVELOPMENT			
Course Code	20FDT244	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction			
Need, importance and objectives of formulation for new product development. Ideas, business philosophy and strategy of new product.			
Module-2			
Formulation and Standardization			
Formulation based on sources availability and cost competitiveness for concept developments of new products. Standardization of various formulation and product design.			
Module-3			
Product Development			
Adaptable technology and sustainable technology for standardized formulation for process development. Process control parameters and scale-up, production trials for new product development at lab and pilot scale.			
Module-4			
Quality and Market			
Quality assessment of newly developed products- nutritional and sensory qualities, shelf-life and safety evaluation as per FSSAI guide lines. Market testing and marketing plan.			
Module-5			
Economical aspect			
Costing and economic evaluation. Economics of food plant construction- estimation of economic plant size (breakeven analysis and optimization) & Estimation of volume of production for each product. Commercialization / product launch.			
Course outcomes: At the end of the course the student will be able to: 1. Create strategy for new food product development 2. Analyze and formulate new products 3. Create process for product development 4. Evaluate the quality of product and market for new product 5. Evaluate the cost and economics of the product and create strategies for the commercialization of the product			
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. <ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

1. Food Product Development: Maximizing Success. R. Earle and A. Anderson, Woodhead Publishing Series in Food Science, Technology and Nutrition, CRC Press; 1st Edition, 2001
2. New Food Product Development: From Concept to Marketplace, Gordon W. Fuller, CRC Press, 3rd Edition, 2011

Reference Books

1. Food Product Development: From Concept to the Marketplace. E. Graf and I. Saguy, Springer US, 1st Edition, 1991
2. Nutraceuticals Food Processing Technology: Innovative Scientific Research. Ed. R.P. Shukla, R.S. Mishra, Abhishek Dutt Tripathi, Ashok Kumar Yadav, Manju Tiwari, Raghendra Raman Mishra, Bharti Publications; 1st Edition, 2017
3. Food Science. B. Shrilakshmi, New Age International (P) Limited Publication, 3rd Edition, 2003
4. Food processing technology - principles and practice. P.J. Fellows, CRC press, 3rd edition, 2009
5. Industrial Economics: An Introductory Textbook. R.R. Barthwal, New Age Publication, 1st Edition, 2010

FUNCTIONAL FOODS AND NUTRACEUTICALS			
Course Code	20FDT251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction			
Functional foods- concept and definition; nutraceutical-concept and definition. Probiotics, prebiotics and dietary fibres – their functional properties Functional foods-the link between nutrition and medicine, sources and bioavailability of nutraceuticals, chemistry and structure of nutraceuticals. ■			
Module-2			
Functional food components and their roles in disease prevention			
Micronutrients, Vitamins, Isoflavones; Flavanoids, Carotenoids and Lycopene; Nutraceuticals – Garlic, Grape, Wine, Tea; Omega 3 Fatty Acids, Antioxidant, Chemoprevention & Functional Food; Single Cell Proteins. Functional foods for treatment of gastrointestinal disorders, Functional Food and Nutraceuticals for the treatment of Coronary Heart Disease, Role of Functional Food and Nutraceuticals in Tumor.			
Module-3			
Nutraceuticals of plant and animal origin			
Plant secondary metabolites, Animal metabolites, Fat rich functional food and their applications - Functional Fats and Spreads, modified fats and oils. Functional Confectionery and other functional Products. ■			
Module-4			
Functional Food Health Claims			
Functional claims; packaging and labeling; nutrient modification and specific nutrient claims; disease-specific claims; Dietary Supplement Health and Education Act (DSHEA).			
Module-5			
Marketing and Regulation of Functional foods			
Market for Functional Food Products: Functional foods and consumers; the role of health in food choice; functional foods market; Regulations and laws for functional food. Regulations in USA, EU and India. ■			
Course outcomes: At the end of the course the student will be able to:			
<ol style="list-style-type: none"> 1. know about various food ingredients and their functional properties. 2. apply his understanding to select appropriate food for particular disease control. 3. learn how to evaluate functional foods with respect to different regulations. 4. analyse the functional claims with respect to packaging and labelling. 5. know about various regulations and laws imposed for functional food. 			

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

1. Functional Foods: Principles and Technology. M. Guo, Woodhead Publishing, 1st Edition
2. Functional foods-Concept to product. Gibson G.R., Williams G.M. Woodhead Publishing Ltd, 2000
3. Handbook of Nutraceuticals and Functional Foods. Wildman R.E.C., Second Edition, CRC Press, 2007
4. Handbook of fermented functional foods. Farnworth E.R., CRC Press, 2003

Reference Books

1. Phytochemical functional foods. Johnson I., Williamson G. Woodhead Publishing Ltd, 2000
2. Phytosterol as functional food components and nutraceuticals. Dutta P.C., Marcel Dekker, 2004
3. Functional food ingredients and nutraceuticals. Shi J., Taylor and Francis, 2007
4. Biotechnology in functional foods and nutraceuticals. Bagchi D., Lau F.C., Ghosh, D.K., Taylor and Francis, 2010
5. Dietary supplements and functional foods. Webb, G.P., Blackwell Publishing, 2006

ENZYME AND FERMENTATION TECHNOLOGY			
Course Code	20FDT252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction and Enzyme kinetics			
Nature, Function, classification & nomenclature of enzymes, Specificity, Michaeli's Menton equation, K_m , Lineweaver Berk Plot, Different inhibitors.			
Module-2			
Food related enzymes and applications			
Amylases, Pectic Enzymes, Proteases, Rennet; Oxidoreductases- Phenolases, Glucose Oxidases, Catalases, Peroxidases, Lipoxygenases, Xanthine Oxidase, Immobilized enzyme, Application of enzymes in food processing; Application of immobilized enzymes and cells.			
Module-3			
Enzyme Purification			
Ammonium sulphate precipitation, Gel exclusion chromatography, Ion exchange chromatography, Affinity chromatography- GST, His tag, Native PAGE, SDS-PAGE, Zymogram, Coomassie blue and Silver staining.			
Module-4			
Fermentation Technology			
Sterilization methods of Fermentors; Scale up and scale down; Biomass Production; Enzyme Production; Downstream processing.			
Module-5			
Fermentors			
Fermentor design and analysis; Aeration and Heat Transfer; Instrumentation and Control; Batch, Fed batch and continuous bioreactors.			
Course outcomes:			
At the end of the course the student will be able to:			
1. understand enzyme kinetics			
2. evaluate the enzymes for food processing applications			
3. analyze and evaluate different methods for enzyme purification			
4. create strategies for the production of enzymes by fermentation technology			
5. analyze and evaluate different fermentor designs			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

1. Biochemical Engineering Fundamentals. J.E. Baily and D.F. Ollis, McGraw Hill Chemical Engineering Series, 1st Edition, 1986
2. Industrial Microbiology. Samuel C Prescott and Cecil G Dunn, Agrobios (India), 2011
3. Principles of Fermentation Technology. P.F. Stanbury and A. Whitaker, Elsevier; 2nd Edition, 2008

Reference Books

1. Microbiology: Principles and Explorations, Jacquelyn G. Black and Laura J. Black, 8th Edition, John Wiley & Sons, 2012
2. Handbook of Fermented Functional Foods. Edward R.(Ted) Farnworth, CRC Press, 2nd Edition, 2008
3. Enzyme Technology. S. Shanmugam, T. Sathishkumar and M. Shanmugaparakash, I K International Publishing House Pvt. Ltd., 2nd Edition, 2012
4. Enzymes in Food Processing: Fundamentals and Potential Applications. Parmjit S. Panesar, Satwinder S. Marwaha and Harish Kumar, I K International Publishing House, 1st Edition, 2009

LIVESTOCK, FISH AND MARINE PRODUCTS PROCESSING			
Course Code	20FDT253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Production, Economics, and processing scenario of meat, fish and poultry. Preservation of meat- dehydration, freezing, pickling, curing, cooking and smoking; preservation of meat using ionizing radiation; preservation of meats using- antibiotics and chemical preservatives.			
Module-2			
Eating quality of meat and discoloration; water-holding capacity and juiciness in cooked and uncooked meat; texture and tenderness- definition and measurement, factors affecting texture and tenderness, artificial tenderizing.			
Module-3			
Abattoir design and layout, meat plant sanitation and safety, by-products utilization. Processing and preservation of eggs, production of egg yolk and egg yellow powder. Poultry processing.			
Module-4			
Unit operations for various poultry products; Fish processing: Unit operations for various fish products.			
Module-5			
Different sea food resources and their postharvest quality changes; bulk handling and chilling; quick freezing; cook-chill processing; modified-atmosphere packaging; retort pouch packaging.			
Course outcomes:			
At the end of the course the student will be able to:			
<ol style="list-style-type: none"> 1. evaluate different methods of meat preservation 2. evaluate quality of meat 3. analyze abattoir design and evaluate poultry processing methods 4. evaluate unit operations for poultry and fish products 5. evaluate different methods of processing of marine products 			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			
<ol style="list-style-type: none"> 1. Lawrie's Meat Science. Fidel Toldra, Woodhead Publishing, 8th Edition, 2007 2. Egg Science and Technology. W.J. Stadelmen and O.J. Cotterill, CRC Press, 4th Edition, 1995 3. Handbook of Meat Processing. Ed. Fidel Toldrá, Blackwell Publishing, 1st Edition, 2010 4. Marine and Freshwater Products Handbook, Roy E. Martin, Emily Paine Carter, George J. Flick, Jr., Lynn M. Davis, CRC Press, 1st Edition, 2000 			

Reference Books

1. Meat Handbook. A. Lavie, AVI, Westport, 4th Edition, 1980
2. Food Science. Norman N. Potter and Joseph H. Hotchkiss, S. Chand Publication, 5th Edition, 2007
3. Meat Products Handbook. G. Feiner, Woodhead Publishing, 1st Edition, 2006
4. Muscle as Food. P.J. Bechtel, Academic Press, 1st Edition, 1986

FOOD INDUSTRY BYPRODUCT AND WASTE MANAGEMENT			
Course Code	20FDT254	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Byproducts I-Various byproducts from Food Processing Industry: By products of cereals, legumes, oil seeds, dairy, fruit and vegetables processing industries and their uses.			
Module-2			
Byproducts II-By products of meat and fish processing units and their uses. Uses of byproducts of agro based industries in various sectors.			
Module-3			
Various laws and regulations for waste management in food processing industries.			
Module-4			
Food industry wastes, Waste treatment methods for Cereals, Fruits, vegetables, Meat, Fish, Dairy processing and Brewery Industries.			
Module-5			
Waste water treatment-Preliminary treatment, primary, secondary, advanced and final treatment; zero-discharge and zero-emission system.			
Course outcomes:			
At the end of the course the student will be able to:			
1. evaluate the uses of by products of dairy, fruit and vegetables related processing industries			
2. evaluate the uses of by products of meat and fish processing units and agro based industries			
3. analyze various laws and regulations of waste management and apply them for food processing industries.			
4. evaluate different waste treatment methods for food processing industries			
5. create strategies for the zero-discharge and zero-emission of waste			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			
1.Handbook of Waste Management and Co-Product Recovery in Food Processing. K. Waldron, Woodhead Publishing Limited, 1 st Edition, 2007			
2.Waste Management for the Food Industries. I.S. Arvanitoyannis, Academic Press, 2008			
Reference Books			

- 1.Utilization of By-Products and Treatment of Waste in the Food Industry. Vasso Oreopoulou and Winfried Russ, Springer US, 1st Edition, 2007
- 2.Food Science. Norman N. Potter and Joseph H. Hotchkiss, S. Chand Publication, 5th Edition, 2007
- 3.Food Processing By-Products and their Utilization, Ed. Anil K Anal, Willey Publication, 1st Edition, 2017

FOOD ANALYSIS AND QUALITY CONTROL LABORATORY			
Course Code	20FDTL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03
S. No.	Experiments		
	<ol style="list-style-type: none"> 1. Sensory evaluation of fruit juice and analysis of data by fuzzy logic and a method based on simple mathematical calculations (SMC) 2. Determination of protein and sugar concentration in food samples 3. Qualitative analysis of oils and fats 4. Determination of microbial counts in milk samples 5. Analysis of milk for quality 6. Analysis of milk for detection of adulterants 7. Determination of BAR (Brix acid ratio) in beverages 8. Evaluation of food labels of products for PFA standards 9. Identification of food additives by using FTIR or GC or HPLC 10. Verification of packaging material by FTIR method 		
<p>Course outcomes: At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> 1. Analyze different food samples for quality. 2. Evaluate food samples for quality. 3. Evaluate food samples for chemical and microbial safety. 4. Analyze the data for the acceptability of food samples. 			
<p>Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.</p>			
Textbooks/Manuals			
<ol style="list-style-type: none"> 1. Food Quality Control. M. Kalia, Agrotech Publishing Academy, 2010 2. Biochemical Methods. S. Sadasivam and A. Manickam, New Age International, 3rd Edition, 1996 3. Pearson's Composition and Analysis of Foods. Ronald S. Kirk and Ronald Sawyer, Addison-Wesley Longman Ltd, 1991 4. Quality Control for Food Industry. A Krammer, Vol. I and II, Avi Pub. Co., 3rd Edition, 1970 			
Reference Books			
<ol style="list-style-type: none"> 1. Handbook of Analysis and Quality Control of fruits & Vegetables Products. S Ranganna, Tata Mc Grow Hill Publications, 2nd Edition, 1986 2. Gruenwedel, D.W.; Whitaker, J.R. (editors) (1984): Food Analysis Principles and techniques, Volumes 1 to 8, Marcel Dekker, Inc., New York 			

TECHNICAL SEMINAR			
Course Code	20FDT27	CIE Marks	100
Number of contact Hours/week	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--
<p>Course objectives: The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas. Each student, under the guidance of a Faculty, is required to</p> <ul style="list-style-type: none"> • Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization. • Carryout literature survey, organize the Course topics in a systematic order. • Prepare the report with own sentences. • Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities. • Present the seminar topic orally and/or through power point slides. • Answer the queries and involve in debate/discussion. • Submit two copies of the typed report with a list of references. <p>The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.</p>			
<p>Marks distribution for CIE of the course 20FDT27 seminar: Seminar Report: 30 marks Presentation skill:50 marks Question and Answer:20 marks</p>			

FOOD LAWS, REGULATIONS AND CERTIFICATIONS			
Course Code	20FDT31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Food Adulteration, Food Safety Management System. Mandatory and voluntary food laws.			
Module-2			
Various laws, regulations and Certifications for food processing, Essential Commodity Act, Prevention of Food Adulteration Act (PFA), Fruit Products Order (FPO).			
Module-3			
Meat Food Products Order (MFPO), Vegetable Oil Control Order (VOCO), Agricultural Marketing and Grading Standards (AGMARK).			
Module-4			
Bureau of Indian Standards (BIS) and their certifications, Food Safety and Standards Authority of India (FSSAI), Food Safety and Standards Act of India.			
Module-5			
Food Codex laws, Food and Drug Administration (FDA), International Organization for Standardization (ISO), Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP), Hazard Analysis and Critical Control Point (HACCP).			
<p>Course outcomes: At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> 1. Understand implications of food adulteration and food safety management system 2. Apply various laws for smooth running of food industries 3. Apply MFPO, VOCO and AGMARK for smooth running of food industries 4. Apply BIS and FSSAI for smooth running of food industries 5. Apply various international laws and practices for smooth running of food industries 			
<p>Question paper pattern:</p> <p>The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.</p> <ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

1. Food Regulation: Law, Science, Policy and Practice, N.D. Fortin, Wiley Publication, 2nd Edition, 2016
2. A Practical Guide to Food Laws and Regulations. Kiron Prabhakar, Bloomsbury Professional India, 1st Edition, 2016

Reference Books

1. Food Safety and Standards Act and Regulations, Food Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India, 2006
2. A Practical Guide to Food Laws and Regulations. Kiron Prabhakar, Bloomsbury India, 2016
3. International Food Law and Policy. Gabriela Steier and Kiran Patel, Springer International Publishing, 1st Edition, 2016

PLANTATION PRODUCTS AND SPICES TECHNOLOGY			
Course Code	20FDT321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Introduction			
Classification, composition, structure and characteristics. Production status of spices in India: major spice producing area in India and worldwide, export potential of processed and raw spice product ■			
Module-2			
Spice and Dry Fruit Processing			
Processing of major and minor spices: Preservation and processing of major and minor spices of India; Processing of whole spice, spice powder, paste and extracts; production and processing of spice mixtures; spice oils and oleoresins, functional role of spices, quality specification for spices Composition, Structure, characteristics & processing of cashew nut and other dry fruits. ■			
Module-3			
Tea Processing			
Composition and production of tea leaves; processing of tea leaves; CTC tea, black tea, green tea and Oolong tea, grading and packaging; processing of instant tea ■			
Module-4			
Coffee Processing			
Production and processing of coffee cherries by wet and dry method; processing technology for coffee; preparation of brew; processing technology for instant coffee and decaffeinated coffee ■			
Module-5			
Cocoa processing			
Cocoa bean-introduction, history and composition; processing of cocoa bean; processed products of cocoa. ■			
Course outcomes: At the end of the course the student will be able to:			
1. Demonstrate a systematic understanding about different spices and their importance.			
2. Understand methods of processing of different spices & dry fruits.			
3. Create strategies for processing tea leaves and obtaining different kinds of tea			
4. Create strategies for processing coffee cherries and obtaining different kinds of coffee			
5. Create strategies for obtaining different products of cocoa			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

1. The complete book on cultivation and manufacture of tea. Panda H, 2nd revised edition, Asia Pacific Business Press Inc., NIIR
2. Coffee-growing, processing, sustainable production. Wintgens J.N., Wiley-VCH, 2004.
3. Cocoa production and processing technology. Afoakwa EO. Taylor and Francis group, 2014
4. Handbook on Spices and Condiments (Cultivation, Processing and Extraction).Panda H. Asia Pacific Business Press Inc., NIIR, 2010
5. Small-scale cashew nut processing. Azam-Ali S.H. and Judge E.C. FAO, 2001
6. Vanilla-post harvest operations. InPho-Post harvest compendium. Javier De La Cruz Medina , Guadalupe C. Rodriguez Jiménez, and Hugo S. García. FAO, 2009

Reference Books

1. Major spices of India: Crop Management and Post-Harvest Technology. J S Pruthi, Indian Council of Agricultural Research, 1993
2. Production Technology of Spices and Plantation Crops. [Swati Barche](#), New India Publishing Agency, 2016
3. Modern Production Technology of Plantation Medicinal Aromatic & Spices Crops. [Gs Saini](#), Aman Publishing House, 2011
4. Chemistry and Applications of Green Tea. Takehiko Yamamoto, Lekh Raj Juneja, Djong-Chi Chu, Mujo Kim, CRC Press, 1997
5. Handbook on Manufacture of Indian Kitchen Spices (Masala Powder) with Formulations, Processes and Machinery, NIIR Project Consultancy Services; 3rd Edition, 2019

WATER AND BEVERAGE TECHNOLOGY			
Course Code	20FDT322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Introduction			
Types of beverages and their importance; status of beverage industry in India; Manufacturing technology for juice-based beverages; synthetic beverages.			
Module-2			
Non-alcoholic beverages			
Ingredients for beverage preparations, role of various ingredients of soft drinks, carbonation of soft drinks. Technology of still, carbonated, low-calorie and dry beverages; isotonic and sports drinks. Specialty beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and limitation of dairy-based beverages.			
Module-3			
Alcoholic beverages			
Brewing technology; Alcoholic beverages- types- fermented beverages (beer and wines) & distilled beverages (Cane sugar, sugar beet, honey, fruit, grain based, herbal, plant, seed, tree, vegetable distillations & complex/multiple distillations), manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer, equipment used for brewing and distillation.			
Module-4			
Water			
Water chemistry, water activity, water purification and treatment, Impurities in water and its analysis.			
Module-5			
Water – Packaging and quality			
Packaged drinking water- definition, types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.			
Course outcomes:			
At the end of the course the student will be able to:			
<ol style="list-style-type: none"> 1. understand manufacturing technology for juice-based beverages and synthetic beverages. 2. evaluate the manufacturing and quality of non-alcoholic beverages 3. evaluate the manufacturing and quality of alcoholic beverages 4. analyze impurities in water for its purification and treatment 5. evaluate the manufacturing and quality of packaged drinking water 			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

1. Handbook of Brewing. William A. Hardwick, Marcel Dekker, Inc., 1995
2. Handbook of Food and Beverage Fermentation Technology. Y. H. Hui, Lisbeth Meunier-Goddik, Jytte Josephsen, Wai-Kit Nip, Peggy S. Stanfield, CRC Press, 2004
3. Handbook of Brewing. Graham G. Stewart, Fergus G. Priest, CRC Press, 2006
4. Beverages: Carbonated and Non-Carbonated. Jasper Guy Woodroof and G. Frank Phillips, AGRIS, 1981

Reference Books

1. Commercial Wine Making - Processing and Controls. Vine, Richard, Springer, 1981
 2. Beverages: Technology, Chemistry and Microbiology. A.Varnam and J.M. Sutherland, Springer, 1994
 3. Water Technology: An Introduction for Environmental Scientists and Engineers. N.F. Gray, Butterworth-Heinemann Publication, 3rd Edition, 2010
 4. Water Treatment Plant Design. The American Water Works Association (AWWA), The American Society of Civil Engineers (ASCE), 5th Edition, 2012
 5. Innovative Technologies in Beverage Processing. Ed: Ingrid Aguiló-Aguayo Lucía Plaza, Willey Publication, 1st Edition, 2017
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PROCESS CONTROL AND INSTRUMENTATION IN FOOD INDUSTRY			
Course Code	20FDT323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Instruments for temperature, pressure, humidity measurements - types, calibration. Pressure gauge, basic concept of pneumatic pressure transmitter, pressure current and pressure resistance transducers.			
Module-2			
Positive displacement meter, Weight measurement- mechanical scale, electronic tank scale, conveyor scale, measurement of specific gravity, measurement of humidity, measurement of viscosity, measurement of density, automatic valves. Definition of process control, simple system analysis, dynamic behavior of simple process, Laplace transform.			
Module-3			
Ionization techniques, scanning technique, application of GC/MS, LC/MS and Linked scan techniques. Basic principles of chromatography. Paper chromatography, thin layer chromatography, HPLC (High performance liquid chromatography), Gas chromatography, Application in food analysis.			
Module-4			
Introduction and principles of Spectrophotometry and Atomic absorption spectroscopy. Electromagnetic spectrum – The NMR Phenomenon – Types of information provided by NMR spectra, application of NMR to Food analysis.			
Module-5			
Operating procedures and analysis of foods: FTIR, XRF, Differential Scanning Calorimeter, XRD, SEM, TEM, water activity, textural analyzer, e–sensors, biosensors, Nitrogen analyzers.			
Course outcomes: At the end of the course the student will be able to: 1. apply pressure and humidity related equipments for food related measurements 2. apply and analyze gravimetric methods for food related measurements 3. apply chromatographic and MS methods for food analysis 4. evaluate different spectroscopic methods for food analysis 5. evaluate different analytical, electron microscopic methods and sensors for food analysis			
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. <ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

1. Introduction to Analytical Chemistry: Instrumental methods of chemical analysis. B.K Sharma, Goel Publishing House, 23rd Edition, 2004
2. Process System Analysis and Control. Donald R Coughanowr and Steven E. LeBlanc, Mc-Graw Hill's, 3rd Edition, 2009
3. Principles of Industrial Instrumentation. D. Patranabis, Tata Mc-Graw Hill, 1976
4. Transducers and Instrumentation. D.V.S. Murty, Prentice Hall India, 2nd Edition, 2008
5. Process Control Instrumentation Technology. Curtis D.Johnson , Prentice Hall India, 8th Edition, 2006
6. The Chemical Analysis of Foods. David Pearson, Chemical Publishing Co.,7th Edition, 1976

Reference Books

1. Food Processing Handbook. James G. Brennan and Alistair S. Grandison, Wiley-VCH Verlag GmbH & Co. KGaA, 2011
2. Introduction to Process Control. Jose A. Romagnoli, Ahmet Palazoglu, CRC Press, 2nd Edition, 2012
3. Principles of Process Control. D Patranabis, McGraw Hill Publication, 3rd Edition, 2017
4. Outlines of Chemical Instrumentation and Process Control. Alapati Suryanarayana, Khanna Publishers, 3rd Edition, 2008
5. Manual for Plant Operators. Anon, Milk Industry Foundation, 1957

AGRICULTURAL BIOTECHNOLOGY			
Course Code	20FDT324	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Introduction			
Staple food, fiber, fuel and fruit crops of India and abroad, Agro-climatic zones and cropping pattern of India. Conventional crop improvement programs- Introduction, Selection and Hybridization, Mutation, Haploidy and Polyploidy Breeding. Modern agriculture biotechnology for food security and national economy. Green-revolution.			
Module-2			
Applications of biotechnology in agriculture			
Productivity and performance, disease resistance, genes and gene constructs used for viral resistance by coat protein mediated production, bacterial resistance by lysozyme gene and fungal resistance by chitinase and beta glucanase genes. Agrobacterium mediated transformation. Crop improvement to resist adverse soil conditions. Salinity tolerance, drought resistance. Herbicide resistance in commercially important plants. Insecticide resistance through BT-gene. Integrated pest management. current status of BT crops in the world. Effect of transgenic crops on environment.			
Module-3			
plant tissue culture			
Explant selection, sterilization and inoculation; Various media preparations; MS, B5, SH PC L-2; Callus and cell suspension culture; plant regeneration-organogenesis, somatic embryogenesis; somaclonal variation, its genetic basis and application in crop improvement. Role of tissue culture in rapid clonal propagation, production of pathogen free plants and "synthetic seeds"; haploid production: advantages and methods. Protoplast technology.			
Module-4			
Antisense rna technology and biotechnological applications in agriculture			
Antisense rna technology (ACC synthase gene and polygalacturonase): Delay of softening and ripening of fleshy fruits by antisense RNA for ACC synthase gene in tomato and banana. Use of antisense RNA technology for extending shelf life of fruits and flowers. Protection of cereals, millets and pulses following harvest using biotechnology. Biotechnology for fortification of agricultural products-Golden rice, transgenic sweet potatoes. Importance of biofertilizers in agriculture:(Rhizobium azatobacter, Mycorrhiza, Frankia and Blue green algae) current practices and production of biofertilizers.			
Module-5			
An overview of legal and socioeconomic impact of biotechnology			
Biotechnology & hunger. Ethical issues associated with labeling and consumption of GM foods. Public perception of GM technology. Biosafety management. Cartagena protocol on biosafety. Ethical implication of BT products, public education, Biosafety regulations, experimental protocol approvals, guidelines for research, environmental aspects of BT applications.			

Course outcomes:

At the end of the course the student will be able to:

1. understand conventional crop improvement programs and the role agricultural biotechnology in food security and national economy
2. apply biotechnological approaches for crop improvement
3. apply plant tissue cultural methods for crop improvement
4. evaluate uses of antisense rna technology and biotechnology in agriculture
5. evaluate legal and socioeconomic impacts of biotechnology

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

1. Biotechnology- Expanding Horizons. B.D. Singh, Kalyani Publishers, 4th Edition, 2012
2. Crop Biotechnology. K. Rajashekar, T.J. Jacks and J.W. Finley, American Chemical Society, 1st Edition, 2002
3. Textbook of Agricultural Biotechnology. Ahindra Nag, PHI learning publication, 1st Edition, 2008
4. Plant Tissue Culture: Theory and Practice. S.S. Bhojwani and M.K. Razdan, Elsevier Science, 1996

Reference Books

1. Plant biotechnology in Agriculture. K. Lindsey and M.G.K. Jones, Prentice Hall, 1990
2. Plant Biotechnology and Agriculture- Prospects for the 21st Century. Arie Altman and Paul Hasegawa, Academic Press, 1st Edition, 2011
3. Agricultural Biotechnology in Developing Countries: Towards Optimizing the Benefits for the Poor. Ed: Matin Qaim, Anatole F. Krattiger, Joachim von Braun, Springer, 1st Edition, 2000

FOOD BUSINESS MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT			
Course Code	20FDT331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction and definitions related with project management and entrepreneurship; Fundamentals of project management and entrepreneurship development. ■			
Module-2			
Project formulation: market survey techniques, project identification, project selection, project proposal, work breakdown structure. ■			
Module-3			
Network scheduling: activity, networks, use of CPM, PERT in project scheduling. Resource planning, resource allocation, project scheduling with limited resources. ■			
Module-4			
Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis. Identification of business opportunity in food processing sector. Government policies for promotion of entrepreneurship in food processing. ■			
Module-5			
Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis, resource mobilization. Financial institution in promoting entrepreneurship; Supply chain management ■			
<p>Course outcomes: At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> 1. Understand fundamentals of project management and entrepreneurship development 2. Understand project formulation and market survey techniques 3. Create network and project schedules 4. Evaluate project costs 5. Learn launching and organizing of an enterprise 			
<p>Question paper pattern:</p> <p>The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.</p> <ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

1. An Introduction to Business (v.1). Collins K. creativecommons.org, 2012
2. Economics and Management of the Food Industry. Jeffrey H. Dorfman, Routledge, 1st Edition, 2013
3. Food and Beverage Management. Partho Pratim Seal, Oxford University Press; 1st Edition, 2017
4. Food Industry: Food Processing and Management. Lisa Jordan, Callisto Reference, 2015
5. Fundamentals of Entrepreneurship. Nandan H., Prentice Hall India Learning Private Limited; 3rd Edition, 2013

Reference Books

1. Management in Engineering: Principles and Practice. Gail Freeman-Bell and James Balkwill, Prentice Hall, 1993
2. Operations Research: An Introduction. Hamdy A. Taha, Pearson Publication, 9th Edition, 2010
3. Project Management. K. Nagarajan, New Age International Pvt Ltd; 8th Edition, 2017

BIOSAFETY AND BIOETHICS			
Course Code	20FDT332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Biotechnology and society			
Introduction to science, technology and society, issues of access-Case studies/experiences from developing and developed countries. Ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology, Biotechnology and hunger, Challenges for the Indian Biotechnological research and industries.			
Module-2			
Legal issues & bioethics			
Legal, institutional and socioeconomic impacts of biotechnology; biotechnology and social responsibility, Public education to increase the awareness of bioethics with regard to generating new forms of life for informed decision making – with case studies. Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.			
Module-3			
Biosafety concepts			
Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Rational vs. subjective perceptions of risks and benefits, relationship among risk, hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management. Ethical implications of biotechnological products and techniques. Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution. Experimental protocol approvals, levels of containment.			
Module-4			
Regulations			
Biosafety assessment procedures in India and abroad. International dimensions in biosafety, bioterrorism and convention on biological weapons. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). National and international regulations for food and pharma products.			
Module-5			
Biotechnolgy impact on the environment			
The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Key to the environmentally responsible use of biotechnology. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. Discussions on recombinant organisms and transgenic crops, with case studies of relevance. Plant breeder's rights. Legal implications, Biodiversity and farmers' rights. Biosafety assessment of			

pharmaceutical products such as drugs/vaccines etc. Biosafety issues in clinical trials.
<p>Course outcomes: At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> 1. understand public issues, benefits and challenges with respect to biotechnology 2. evaluate legal, institutional, bioethical and socioeconomic impacts of biotechnology 3. evaluate and manage biosafety concerns at the level of individuals, institutions, society, region, country and the world 4. evaluate biosafety regulations and national and international guidelines with respect to biotechnology products 5. evaluate the impact of biotechnology products and practices on the environment
<p>Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.</p> <ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■
<p>Textbooks</p> <ol style="list-style-type: none"> 1. Biotechnology and Safety Assessment. John A. Thomas and Roy L. Fuchs, Academic Press, 3rd Edition, 2002 2. Biological safety Principles and practices. D.O. Fleming and D.L. Hunt, ASM Press, 3rd Edition, 2000 3. Biotechnology: A Multi-Volume Comprehensive Treatise Legal Economic and Ethical Dimensions. H.J.Rehm and G. Reed, Vch Verlagsgesellschaft Mbh, 1995 4. Bioethics: An Introduction for the Biosciences. Ben Mephram, Oxford University Press, 2nd Edition, 2008 5. Bioethics & Biosafety. R. Rallapalli & Geetha Bali, APH Publication, 2007
<p>Reference Books</p>

1. Bioethics & Biosafety. M.K. Sateesh, I. K. International, 2008
2. Biotechnologies and Development. Albert Sasson, UNESCO Publications, 1988
3. Biotechnologies in Developing Countries: Present and Future Regional and Sub-regional Co-operation and Joint Ventures. Albert Sasson, UNESCO Publishing, 1993
4. Biotechnology and Intellectual Property Rights: Legal and Social Implications. Kshitij Kumar Singh, Springer, 2015
5. WTO and International Trade. M.B. Rao and Manjula Guru, Vikas Publishing House Pvt. Ltd., 2nd Edition, 2003
6. Intellectual Property Rights in Agricultural Biotechnology. F.H. Erbisch and K.M. Maredia, CAB International, 2nd Edition, 2004
7. Biological Warfare in the 21st Century: Biotechnology and the Proliferation of Biological Weapons. Malcolm Dando, Potomac Books Inc, 1st Edition, 1994
8. A Framework for Biosafety Implementation: Report of a Meeting. M.A Mclean, R.J. Frederick, P.L. Traynor, J.I. Cohen, and J. Komen, International Service for National Agricultural Research, 2003

BIOCHEMISTRY AND HUMAN NUTRITION			
Course Code	20FDT333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Introduction to nutrition			
Nutrition, malnutrition, functions of food, basic food groups, nutritional needs, requirements and recommended allowances of foods.			
Module-2			
Enzymology			
Mechanism of enzyme action, coenzymes, enzyme kinetics, Derivation of Michaelis-Menten Equation.			
Module-3			
Metabolism			
Sources, functions, digestion, absorption, assimilation and transport of carbohydrates, proteins and fats in human beings. Metabolism of carbohydrates: Respiration, Metabolism of lipids, Metabolism of proteins.			
Module-4			
Minerals, Vitamins and hormones			
Functions, sources, factors affecting absorption of minerals, absorption promoters and inhibitors, effect of deficiency of Calcium, phosphorus, iron, zinc, iodine, fluorine and copper. Vitamins and hormones.			
Module-5			
Nutritional deficiency and food processing			
Classification, functions, sources, effects of deficiency. Changes during food processing operations, restoration, enrichment, fortification and supplementation of foods.			
Course outcomes:			
At the end of the course the student will be able to:			
1. evaluate nutritional requirements of individuals			
2. understand enzyme kinetics			
3. understand metabolism of carbohydrates, lipids and proteins			
4. evaluate and correlate the ill-effects of deficiency of different micro nutrients			
5. Analyze and learn how to restore deficient nutrients by fortification and supplementation			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

<ol style="list-style-type: none">1. Textbook of Nutrition and Dietetics. Kumud Khanna, Sharda Gupta, Santosh Jain Passi, Rama Seth, Ranjana Mahna and Seema Puri, Elite Publishing House Pvt. Ltd., 2nd Edition, 20162. Principles of Biochemistry, A.L. Lehninger, D.L. Nelson and M.M. Cox, W. H. Freeman, 4th Edition, 19933. Textbook of Biochemistry. E. S. West, W. R. Todd, H. S. Mason, and J. T. Van Bruggen, MacMillan, 4th Edition, 19664. Nutrition and Dietetics. Shubhangini A. Joshi, Tata Mc Grow-Hill publishing Company Ltd, 19925. Biochemistry of Foods. N.A.M Eskin, Academic Press, 1st Edition, 19716. Food Chemistry. O.R. Fennema, Marcel Dekkar Inc, 3rd Edition, 1996
Reference Books
<ol style="list-style-type: none">1. Essentials of Food and Nutrition. M. S. Swaminathan, Ganesh and Co, 1st Edition, 19742. Outlines of Biochemistry. Eric E. Conn and P.K. Stumpf, John Wiley and Sons, 3rd Edition, 19723. Fundamentals of Biochemistry. J L Jain, Sunjay Jain and Nitin Jain, S. Chand Publication; 7th Edition, 20164. Biochemistry. U Satyanarayana and U. Chakrapani, Elsevier; 5th Edition, 20175. General Biochemistry. J.H. Weil, New Age International, 6th Edition, 2005

FOOD SEPARATION ENGINEERING			
Course Code	20FDT334	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Introduction			
Introduction to various separation processes; Gas-Liquid, Gas-Solid, Liquid-Liquid, Liquid-Solid separation.			
Module-2			
Phase Equilibrium			
Concept of phase equilibrium; Impingement separator; Electrostatic precipitation; Distillation-Application of distillation in food processing.			
Module-3			
Membrane separation technology			
Introduction to microfiltration, ultra-filtration, nano-filtration, reverse osmosis, electro dialysis; Physical characteristics of membrane separation; Factor affecting reverse osmosis process; Concentration of polarization; Design of reverse osmosis and ultra-filtration system; Operation layout of the modules; Electrodialysis; Pervaporization; Fabrication of membrane; Application of membrane technology in food industry.			
Module-4			
Powder Technology			
Classification of powder; Separation of powder; Sieving; Air classification; Factor affecting air classification; Cyclone application; Air separation; Particle size distribution.			
Module-5			
Super critical fluid (SCF) extraction			
Introduction; Properties of SCF; Food application of SCF; Application of SCFE during analysis and pharmaceutical applications.			
Course outcomes:			
At the end of the course the student will be able to:			
<ol style="list-style-type: none"> 1. understand various separation processes 2. apply concepts of phase equilibrium in food processing 3. evaluate applications of membrane technology in food industry 4. evaluate applications of powder technology in food industry 5. evaluate applications of super critical fluid extraction in food and pharmaceutical sectors 			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■ 			
Textbooks			

1. Mechanical Operations for Chemical Engineers (Incorporating Computer Aided Analysis). C.M. Narayanan and B.C. Bhattacharya, Khanna Publishers, 3rd Edition, 1990
2. Membrane Technology and Applications. Richard W. Baker, John Wiley & Sons, 2nd Edition, 2004
3. Membranes and Membrane Separation Processes, 1. Principles. Heinrich Strathmann, Wiley VCH Verlag GmbH & Co. KGaA., 2011
4. Powder Technology Handbook. Hiroaki Masuda, Ko Higashitani and Hideto Yoshida, CRC Press Taylor and Francis, 3rd Edition, 2006
5. Supercritical Fluid Extraction. J Reedijk, Elsevier Reference Module in Chemistry, Molecular Sciences and Chemical Engineering. Waltham, MA: Elsevier, doi: 10.1016/B978-0-12-409547-2.10753-X, 2014

Reference Books

1. Mass Transfer Theory and Practice. N. Anantharaman, K.M. Meera Sheriffa Begum, PHI Learning, 2011
2. Membrane Operations. Innovative Separations and Transformations. Enrico Drioli and Lidieta Giorno, WILEY-VCH Verlag GmbH & Co. KGaA, 2009
3. Handbook of Powder Technology: Volume 12, Particle Breakage. Agba Salman, Mojtaba Ghadiri and Michael Hounslow, Elsevier Science, 1st Edition, 2007
4. Transport Processes and Separation Process. Chistie John Geankoplis, Pearson Education India; 4th Edition, 2015
5. Principles of Mass Transfer and Separation Processes. B.K. Dutta, Prentice Hall India Learning Private Limited, 2006

PROJECT WORK PHASE – 1			
Course Code	20FDT34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--
<p>Course objectives:</p> <ul style="list-style-type: none"> • Support independent learning. • Guide to select and utilize adequate information from varied resources maintaining ethics. • Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly. • Develop interactive, communication, organisation, time management, and presentation skills. • Impart flexibility and adaptability. • Inspire independent and team working. • Expand intellectual capacity, credibility, judgement, intuition. • Adhere to punctuality, setting and meeting deadlines. • Instil responsibilities to oneself and others. • Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. 			
<p>Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.</p> <p>Seminar: Each student, under the guidance of a Faculty, is required to</p> <ul style="list-style-type: none"> • Present the seminar on the selected project orally and/or through power point slides. • Answer the queries and involve in debate/discussion. • Submit two copies of the typed report with a list of references. <p>The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.</p>			
<p>Course outcomes:</p> <p>At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Demonstrate a sound technical knowledge of their selected project topic. • Undertake problem identification, formulation, and solution. • Design engineering solutions to complex problems utilising a systems approach. • Communicate with engineers and the community at large in written an oral forms. • Demonstrate the knowledge, skills and attitudes of a professional engineer. 			
<p>Continuous Internal Evaluation</p> <p>CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.</p>			

MINI PROJECT			
Course Code	20FDT35	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours/Batch	--
<p>Course objectives:</p> <ul style="list-style-type: none"> • To support independent learning and innovative attitude. • To guide to select and utilize adequate information from varied resources upholding ethics. • To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly. • To develop interactive, communication, organisation, time management, and presentation skills. • To impart flexibility and adaptability. • To inspire independent and team working. • To expand intellectual capacity, credibility, judgement, intuition. • To adhere to punctuality, setting and meeting deadlines. • To instil responsibilities to oneself and others. • To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. 			
<p>Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.</p>			
<p>Course outcomes:</p> <p>At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Present the mini-project and be able to defend it. • Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task. • Habituated to critical thinking and use problem solving skills. • Communicate effectively and to present ideas clearly and coherently in both the written and oral forms. • Work in a team to achieve common goal. • Learn on their own, reflect on their learning and take appropriate actions to improve it. 			
<p>CIE procedure for Mini - Project:</p> <p>The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25. The marks awarded for Mini - Project report shall be the same for all the batch mates.</p> <p>Semester End Examination</p> <p>SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.</p>			

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20FDTI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03
<p>Course objectives: Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further, To put theory into practice. To expand thinking and broaden the knowledge and skills acquired through course work in the field. To relate to, interact with, and learn from current professionals in the field. To gain a greater understanding of the duties and responsibilities of a professional. To understand and adhere to professional standards in the field. To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality. To identify personal strengths and weaknesses. To develop the initiative and motivation to be a self-starter and work independently. ■</p>			
<p>Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship. Seminar: Each student, is required to</p> <ul style="list-style-type: none"> • Present the seminar on the internship orally and/or through power point slides. • Answer the queries and involve in debate/discussion. • Submit the report duly certified by the external guide. • The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■ 			
<p>Course outcomes: At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Gain practical experience within industry in which the internship is done. • Acquire knowledge of the industry in which the internship is done. • Apply knowledge and skills learned to classroom work. • Develop a greater understanding about career options while more clearly defining personal career goals. • Experience the activities and functions of professionals. • Develop and refine oral and written communication skills. • Identify areas for future knowledge and skill development. • Expand intellectual capacity, credibility, judgment, intuition. • Acquire the knowledge of administration, marketing, finance and economics. ■ 			

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson. ■

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -2			
Course Code	20FDT41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03
<p>Course objectives:</p> <ul style="list-style-type: none"> • To support independent learning. • To guide to select and utilize adequate information from varied resources maintaining ethics. • To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly. • To develop interactive, communication, organisation, time management, and presentation skills. • To impart flexibility and adaptability. • To inspire independent and team working. • To expand intellectual capacity, credibility, judgement, intuition. • To adhere to punctuality, setting and meeting deadlines. • To instil responsibilities to oneself and others. • To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■ 			
<p>Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■</p>			
<p>Course outcomes:</p> <p>At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Present the project and be able to defend it. • Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task. • Habituated to critical thinking and use problem solving skills • Communicate effectively and to present ideas clearly and coherently in both the written and oral forms. • Work in a team to achieve common goal. • Learn on their own, reflect on their learning and take appropriate actions to improve it. ■ 			
<p>Continuous Internal Evaluation:</p> <p>Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.</p> <p>Project Presentation: 10 marks.</p> <p>The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.</p> <p>Question and Answer: 10 marks.</p> <p>The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.</p> <p>Semester End Examination</p> <p>SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■</p>			

