GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(GITAM)

DEEMED TO BE UNIVERSITY

VISAKHAPATNAM, HYDERABAD, BENGALURU

ACCREDITED BY NAAC WITH A^{+} GRADE

REGULATIONS AND SYLLABUS

OF

MASTER OF TECHNOLOGY

IN

FOOD PROCESSING TECHNOLOGY

(W.e.f. 2021-22 Admitted Batch)

A University Committed to Excellence

VISION

To Become a Global Leader in Higher Education

MISSION

To impart futuristic and comprehensive education of global standards with a high sense of discipline and social relevance in a serene and invigorating environment

REGULATIONS

(w.e.f. 2019-20 admitted batch)

M.Tech. in Food Processing Technology

1. ADMISSION

Admission into M.Tech. in Food Processing Technology program of GITAM deemed to be University is governed by GITAM admission regulations.

2. ELIGIBILITYCRITERIA

2.1 A pass in B.E./B.Tech./AMIE in Civil Engineering or its equivalent.

2.2 Admissions into M.Tech. will be based on the following:

(i) Score obtained in GAT (PG), if conducted.
(ii) Performance in Qualifying Examination / Interview.
(iii) Candidates with valid GATE score shall be exempted from appearing for GAT (PG).

2.3 The actual weightage to be given to the above items will be decided by the authorities at the time of admissions.

3. CHOICE BASED CREDIT SYSTEM

3.1 Choice Based Credit System (CBCS) was introduced with effect from 2015-16 admitted batch and revised with effect from academic year 2019-20 in order to promote:

- Student centered Learning
- Activity based learning
- Students to learn courses of their choice
- Cafeteria approach

3.2 Learning objectives and outcomes are outlined for each course to enable a student to know what he/she will be able to do at the end of the program.

4. STRUCTURE OF THE PROGRAM

4.1 The Program Consists of

i) Core Courses (compulsory) which give exposure to a student in core subjects related area.

ii) Program Electives.

iii) Open Electives

iv) Mandatory and Audit Courses

4.2 Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

4.3 In general, credits are assigned to the courses based on the following contact hours per week per semester.

- One credit for each Lecture / Tutorial hour per week.
- One credit for two hours of Practicals per week.

4.4 The curriculum of the four semesters M.Tech. (Food Processing Technology) program is designed to have a total of 68 credits for the award of M.Tech. (Food Processing Technology) degree.

5. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6. REGISTRATION

Every student has to register for the courses in each semester at the time specified in the academic calendar.

7. ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the semester-end examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his / her juniors.

7.2 However, the Vice-Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance to the students whose attendance is between 65% and 74% on genuine grounds and on payment of prescribed fee.

8. EVALUATION

8.1 The assessment of the student's performance in a theory course shall be based on two components: Continuous Evaluation (40 marks) and semester-end examination (60 marks).

8.2 A student has to secure a minimum of 40% in any theory course in the two components (ref. 8.1) put together to be declared to have passed the course, subject to the condition that the student must have secured a minimum of 24 marks out of 60 marks (i.e. 40%) in the theory component at the semester-end examination.

8.3 Practical/ Project Work/ Viva voce/ Seminar etc. course are completely assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure Pass Grade. Details of Assessment Procedure are furnished below in Table 1.

8.4 Audit courses are assessed through continuous evaluation for satisfactory or not satisfactory only. No credits will be assigned.

Table 1: Assessment Procedure

S.No.	Component of Assessment	Marks Allotted	Type of Assessment	Scheme of Evaluation

1	Theory Courses	40 60	Continuous Evaluation Semester-end Examination	i) Thirty (30) marks for mid Semester examinations. Three mid examinations shall be conducted for 15 marks each; performance in best two shall be taken into consideration. ii) Ten (10) marks for Quizzes, Assignments and Presentations. Sixty (60) marks for Semester-end examinations
	Total	100		
2	Practical Courses	100	Continuous Evaluation	i) Fifty (50) marks for regularity and performance, records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the semester. ii) Ten (10) marks for case studies. iii) Forty (40) marks for two tests of 20 marks each (one at the mid-term and the other towards the end of the semester) conducted by the concerned lab teacher.
3	Technical Seminar (II Semester)	100	Continuous Evaluation	Through five periodic seminars of 20 marks each
4	Project Work (III Semester)	100	Continuous Evaluation	i) Forty (40) marks for periodic assessment on originality, innovation, sincerity and progress of the work, assessed by the project supervisor. ii) Thirty (30) marks for mid-term evaluation for defending the project, before a panel of examiners. iii) Thirty (30) marks for final report presentation and viva-voce, by a panel of examiners*.

5	Project Work (IV Semester)	50	Continuous Evaluation	i) Twenty (20) marks for periodic assessment on originality innovation, sincerity and progress of the work, assessed by the project supervisor. ii) Fifteen (15) marks for mid-term evaluation for defending the project, before a panel of examiners*. iii) Fifteen (15) marks for interim report presentation and viva-voce.
		50	Semester-end Examination	Fifty (50) marks for final project report and viva-voce examination assessed by external examiners.
	Total	100		
6	Audit Courses	100	Continuous Evaluation	Audit courses are assessed for PASS or FAIL only. No credits will be assigned to these courses. If a student secures a minimum of 40 out of 100 marks during continuous evaluation, he / she will be declared PASS, else FAIL. PASS grade is necessary to be eligible to get the degree

**Panel of Examiners shall be appointed by the concerned Head of the Department*

9. PROVISION FOR ANSWER BOOK VERIFICATION AND CHALLENGE EVALUATION

9.1 If a student is not satisfied with his/her grade, the student can apply for answer book verification on payment of prescribed fee for each course within one week after announcement of results.

9.2 After verification, if a student is not satisfied with revaluation marks/grade, he/she can apply for challenge valuation within one week after announcement of answer book verification result or two weeks after the announcement of results, which will be valued by two examiners i.e., one Internal and one External examiner in the presence of the student on payment of prescribed fee. The challenge valuation fee will be returned, if the student is successful in the appeal by securing a better grade.

10. SUPPLEMENTARY EXAMINATIONS AND SPECIAL EXAMINATIONS.

10.1 The odd semester supplementary examinations will be conducted after conducting regular even semester examinations during April/May.

10.2 The even semester supplementary examinations will be conducted after conducting

regular odd semester examinations during October/November.

10.3 A student who has secured 'F' Grade in Project work shall have to improve his/her work and reappear for viva-voce after satisfactory completion of work approved by panel of examiners.

10.4 A student who has completed period of study and has "F" grade in final semester courses is eligible to appear for special examination.

11. MASSIVE OPEN ONLINE COURSES

Greater flexibility to choose variety of courses is provided through Massive Open Online Courses (**MOOCs**) during the period of study. Students without any backlog courses up to first semester are permitted to register for MOOCs in second semester up to a maximum of 6 credits from program elective / open elective/audit courses. However the Departmental Committee (DC) of the respective campuses has to approve the courses under MOOCs. The grade equivalency will be decided by the respective Board of Studies (BoS).

12. GRADING SYSTEM

12.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

Table 2: Grades and Grade Points

Sl.No.	Grade	Grade Points	Absolute Marks
1	O (outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab (Absent)	0	-

12.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course, subject to securing a GPA of 5.0 for a Pass in the semester.

13. GRADE POINT AVERAGE

13.1 A Grade Point Average (GPA) for the semester will be calculated according to the formula:

$$GPA = \frac{\Sigma [C \times G]}{\Sigma C}$$

where, C = number of credits for the course,

G = grade points obtained by the student in the course.

13.2 The Cumulative Grade Point Average (CGPA), is calculated using the above formula considering the grades obtained in all the courses, in all the semesters up to that particular semester.

13.3 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

Table 3: CGPA required for Award of Class

Class	CGPA Required
First Class with Distinction	$\geq$ 8.0*
First Class	$\geq$ 6.5
Second Class	$\geq$ 5.5
Pass Class	$\geq$ 5.0

* In addition to the required CGPA of 8.0 or more, the student must have necessarily passed all the courses of every semester in the first attempt.

14. ELIGIBILITY FOR AWARD OF THE M.Tech. DEGREE

14.1 Duration of the program: A student is ordinarily expected to complete the M.Tech. Program in four semesters of two years. However a student may complete the program in not more than four years including study period.

14.2 However the above regulation may be relaxed by the Vice-Chancellor in individual cases for cogent and sufficient reasons.

14.3 A student shall be eligible for award of the M.Tech. Degree if he / she fulfills all the following conditions.

a) Registered and successfully completed all the courses and project works.

b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated period.

c) Has no dues to the Institute, Hostels, Libraries, NCC / NSS etc, and

d) No disciplinary action is pending against him / her.

15. DISCRETIONARY POWER

Notwithstanding anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and

Program Objectives

PO1	**ENGINEERING KNOWLEDGE: Apply the knowledge of Mathematics, Science, Engineering Fundamentals, and an Engineering specialization to the solution of Complex Engineering problems.**
PO2	**PROBLEM ANALYSIS: Identify, formulate, research literature, and analyze Complex Engineering problems reaching substantiated conclusions using first principles of Mathematics, Natural Sciences, and Engineering Sciences.**
PO3	**DESIGN/DEVELOPMENT OF SOLUTIONS: Design solutions for Complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.**
PO4	**CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.**
PO5	**MODERN TOOL USAGE: Create, select, and apply appropriate techniques, resources, and Modern Engineering and IT tools including prediction and modeling to Complex Engineering activities with an understanding of the limitations.**
PO6	**THE ENGINEER AND SOCIETY: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Professional Engineering practice.**
PO7	**ENVIRONMENT AND SUSTAINABILITY: Understand the impact of the Professional Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.**
PO8	**ETHICS: Apply ethical principles and commit to Professional Ethics and responsibilities and norms of the engineering practice.**
PO9	**INDIVIDUAL AND TEAM WORK: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.**
PO10	**COMMUNICATION: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.**
PO11	**PROJECT MANAGEMENT AND FINANCE: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.**
PO12	**LIFE LONG LEARNING: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.**

PROGRAM EDUCATIONAL OBJECTIVES

PEO 1 To develop the ability to utilize the concepts and knowledge of mathematics, science and engineering to design and deliver solutions to problems in food processing

PEO 2 To develop creativity, self-learning and problem solving abilities in students

PEO 3 To train individuals equipped with analytical skills for decision making and planning

PEO 4 To develop self-reliant individuals who can conceive novel solutions and create institutions or corporations to implement their ideas, for their own profit as well as for the benefit of society and environment

PEO 5 To instill team work, leadership, communication skills as well as professional, ethical and human values to become responsible citizens of the society

PROGRAM OUTCOMES

The students of M. Tech. (Food Processing Technology), after completion of the program will be able to:

PO 1	**Apply the principles of Food Processing Technology**
PO 2	**Integrate the concepts of Food Processing Technology**
PO 3	**Implement the concepts of Food Processing Technology**
PO 4	**Introduce the concepts of Food Processing Technology in industry and environment**
PO 5	**Design a pilot plant for implementing a commercial bioprocess**
PO 6	**Adapt to changing professional and societal needs by practicing the art of lifelong learning**
PO 7	**Formulate and design end-to-end solutions for Food Processing Technology industries**
PO 8	**Implement ethical principles in Food Processing Technology practices**
PO 9	**Manage a team of professionals in different fields of Food Processing Technology**
PO 10	**Take up higher studies in core and interdisciplinary fields.**
PO 11	**Carry out research in the field of Food Processing Technology and related multidisciplinary specializations.**
PO 12	**Become an entrepreneur and contribute to industrialization in solving problems of societal relevance**

Program Specific Outcomes

1 Acquire knowledge of the principles and concepts of Biotechnology and Biochemical engineering that are relevant for Food Processing Technology
2 Acquire knowledge of the tools and techniques of Food Processing Technology that are currently deployed in Food Processing Industry
3 Acquire knowledge of advanced and emerging technologies and experience with the applications of Food Processing Technology relevant for industry and research
4 Acquire ability to apply Food Processing Technology to develop products with improved characteristics thereby increasing farmers' income, improving human health and decreasing environmental pollution.

M.Tech. in Food Processing Technology

(Effective from the academic year 2021-22 admitted batch)

SEMESTER I

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EBT705	Engineering properties of food materials	PC	3	0	0	3
2	19EBT707	Food Chemistry & Microbiology	PC	3	0	0	3
3	19EBT7XX	Program Elective I	PE	3	0	0	3
4	19EBT7XX	Program Elective II	PE	3	0	0	3
5	19EMC741	Research Methodology and IPR	MC	2	0	0	2
6	19EBT725	Engineering properties of food materials Laboratory	CE	0	0	4	2
7	19EBT727	Food Chemistry & Microbiology Laboratory	CE	0	0	4	2
8	19EAC7XX	Audit Course I	AC	2	0	0	0
Total				**18**			

SEMESTER II

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EBT706	Food Process Engineering	PC	3	0	0	3
2	19EBT708	Plant and Animal Food Technology	PC	3	0	0	3
3	19EBT7XX	Program Elective III	PE	3	0	0	3
4	19EBT7XX	Program Elective IV	PE	3	0	0	3
5	19EBT7XX	Program Elective V	PE	3	0	0	3
6	19EOE7XX	Open Elective I	OE	3	0	0	3
7	19EBT726	Food Process Engineering Laboratory	CE	0	0	4	2
8	19EBT728	Food Technology Laboratory	PC	0	0	4	2
9	19EACXX	Audit Course II	AC	2	0	0	0
10	19EBT792	Technical Seminar	PC	0	0	4	2
11	19EAC761/**HSMCH102**	Universal Human Values 2: Understanding Harmony	AC	2	1	0	3
Total				**27**			

SEMESTER III

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EBT893	Project Work I	CE	0	0	26	13
Total				**13**			

SEMESTER IV

S.No	Course Code	Course Name	Category	L	T	P	C
1	19EBT894	Project Work II	CE	0	0	26	13
Total				**13**			

Total Number of Credits:

Year	Semester	Proposed Credits
I	I	18
	II	27
II	III	13
	IV	13
Total		71

PROGRAM ELECTIVES

Program Elective- I

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EBT751	Food quality evaluation	PE	3	0	0	3
2	19EBT757	Process Instrumentation and Control	PE	3	0	0	3

Program Elective-II

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EBT755	Fruit and Vegetable Processing	PE	3	0	0	3
2	19EBT759	Computer Simulation and Modelling in Food Processing	PE	3	0	0	3

Program Elective- III

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EBT754	Nutraceuticals and Functional Foods	PE	3	0	0	3
2	19EBT756	Enzymes in Food Processing	PE	3	0	0	3

Program Elective- IV

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EBT760	Process Equipment Design	PE	3	0	0	3
2	19EBT766	Food Packaging	PE	3	0	0	3

Program Elective- V

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EBT762	Advances in Food Engineering	PE	3	0	0	3
2	19EBT768	Bakery and Confectionery Technology	PE	3	0	0	3

Open Electives

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EOE742	Business Analytics	OE	3	0	0	3
2	19EOE744	Industrial Safety	OE	3	0	0	3
3	19EOE746	Operations Research	OE	3	0	0	3
4	19COE750	3D printing	OE	3	0	0	3
5	19EOE752	Waste to Energy	OE	3	0	0	3

Audit Courses I and II

S. No.	Course Code	Course Title	Category	L	T	P	C
1	19EAC741	English for Research Paper Writing	AC	2	0	0	0
2	19EAC748	Personality Development through Life Enlightenment Skills	AC	2	0	0	0
3	19EAC751	Cost Management of Engineering Projects	AC	2	0	0	0
4	19EAC747	Stress Management by Yoga	AC	2	0	0	0
5	19EAC750	Developing Soft Skills and Personality	AC	2	0	0	0

19EBT705 ENGINEERING PROPERTIES OF FOOD MATERIALS

L	T	P	C
3	0	0	3

Course Objectives:

- Introduce the methods of determining the quality and properties of different foods
- Describe engineering properties of food and related measurement methods
- Describe electrical properties of food and its applications in food engineering
- Explain electromagnetic field effects on food materials

MODULE I: **8L**

Dimensional properties of Food products: Size, shape, size distribution, volume, density, porosity surface area. Water-related properties: Moisture content, colligative properties, water activity, moisture isotherms, psychrometrics.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- summarize dimensional and water related properties of food materials. (L2)
- understand the water activity, food stability sorption and desorption isotherm of food materials.(L3)
- evaluate the physical properties of food materials.(L5)

MODULE II: **9L**

Rheological / deformation properties : Introduction, to Rheology, Rheology of solid foods, Rheology of liquid foods, Newtons law of viscosity, viscous fluids-Newtonian and nonnewtonian fluids, plastic fluids,, time dependent properties, viscosity measurement, Deformation of material, visco-elastic behavior, stress relaxation test, creep test, dynamic test, mechanical models.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- appraise the rheology of solid and liquid foods. (L5)
- summarize viscous and plastic properties of food materials. (L2)
- develop the mechanical models . (L5)
- evaluate the visco-elastic properties of food materials. (L5)

MODULE III: **8L**

Thermal properties: specific heat - thermal conductivity- thermal diffusivity - methods of determination - steady state and transient heat flow.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- summarize the thermal properties of food materials. (L2)
- explain procedures to determine the thermal properties of food materials. (L2)

- evaluate steady and transient heat flow in food processing. (L5)

MODULE IV: **8L**

Electromagnetic properties: dielectric properties, principle, factors effecting dielectric properties, measurement methods, , Color properties, basic principle, refraction, colorimetry, Physiology of color perception, color as a vector quantity, measurement methods.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- explain the electromagnetic properties of food materials. (L2)
- identify the color and dielectric properties of food materials. (L3)
- develop measurement methods of color properties. (L5)

MODULE V: **9L**

Electrical properties: Electrical conductivity ,Liquid foods, Factors effecting Electrical conductivity of Liquid Foods **,**Solid foods**,** Factors effecting Electrical conductivity of Solid Foods Effect of temperature on electric field strength, applications of electrical properties

Learning Outcomes:

After successful completion of this unit, the student will be able to

- summarize electrical properties of foods. (L2)
- appraise the factors effecting electrical conductivity of liquid foods. (L5)
- explain the applications of electrical properties. (L2)

Textbooks

1. Rao, M. A., Rizvi, S. S. H. and Datta. A. K. Engineering Properties of Foods, (CRC Press, 2005)
2. Sahin S. and Sumnu, S. G. Physical Properties of Foods, (CRC Press, 2006)

Reference Books

1. Peleg, M. and Bagelay, E. B. Physical Properties of Foods, (AVI publishing Co., 1983)
2. Jowitt, R., Escher, F., Hallstrom, B., Meffert, H. F., Walter, T., Spices, E. C. and Vox, G. Physical Properties of Foods, (Applied Science Publishers, 1983)
3. Mohesenin, N. N. Thermal Properties of Foods and Agricultural Materials, (Gordon and Breach Science Publishers, 1980)
4. Mohesenin, N. N. Physical Properties of Plant and Animal Materials, (Gordon and Breach Science Publishers, 1980)

Course Outcomes:

After successful completion of this course, the student will be able to

- explain the dimensional, rheological, thermal and electromagnetic properties of foods (L2)
- summarize techniques used to determine the engineering properties of food materials(L2)
- appreciate the importance of effects of electrical and electromagnetic fields on food material (L5)

19EBT725 ENGINEERING PROPERTIES OF FOOD MATERIALS LAB

L	T	P	C
0	0	4	2

Course Objectives

- physical and thermal properties of foods
- Storage stability of foods
- effect of heat and humidity on foods

1. Determination of physical properties such as bulk density, porosity, sphericity, angle of repose
2. Determination of water activities of foods.
3. Concentration dependency of water activity.
4. Sorption isotherms and storage stability of foods.
5. Studies on Humidification/ Dehumidification columns.
6. Drying of fruits and vegetables.
7. Psychrometric chart and psychrometers.
8. Heat Exchangers and effectiveness.
9. Estimation of heat transfer coefficients.
10. Measurements and estimation of thermal properties of foods

Text books

Laboratory Manual, Engineering Properties of Foods, By Tadesse Fikre, College of Agriculture School of nutrition, Food Science and Technology.

Laboratory Outcomes:

After successful completion of this laboratory, the student will be able to

- determine physical and thermal properties of foods. (L1)
- stabilize foods under different environmental conditions. (L3)
- understand effect of heat and humidity on foods. (L2)

19EBT707 FOOD CHEMISTRY & MICROBIOLOGY

L	T	P	C
3	0	0	3

Course Objectives

- Introduce the water quality and use in foods.
- Provide the knowledge on functional properties of polysaccharides, proteins and lipids during food processing

MODULE I: **9L**

Water and Carbohydrates: Free, bound & entrapped water, Drinking mineral water, water quality for food processing. Water activity concepts – their relation to physical, chemical, and microbiological stability of foods. Sugars: solubility & Hygroscopicity, mutarotation; sensory properties-sweetness index, caramelization, Maillard reaction; Dextrose Equivalent, Degree of polymerisation; uses of Oligosaccharides in foods. Polysaccharides: thickening & gelatinization, modified starches, resistant starch, Dextrins and dextrans, Pectins, gums & seaweeds. Fiber - Cellulose & hemicelluloses.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- understand the importance of water quality in food processing. (L2)
- explain the physical and sensory properties of sugars. (L2)
- explain the use of oligo and polysaccharides in food processing. (L2)
- apply polymers and fibres in food processing. (L3)

MODULE II: **9L**

Proteins and Lipids: Nutritional classification of proteins, Properties of proteins, Functional properties of proteins in foods, Denaturation, gel formation, Milk proteins, Wheat proteins – dough formation, Applications of enzymes in Food industry, nutritional classification of fatty acids, Properties of fats & oils: melting points, smoke point, isomerisation, cis and trans isomers, emulsification, hydrogenation, rancidity, tests to check the purity of fats and oils, auto oxidation, Prevention of auto oxidation, interesterification, polymorphism, winterization plasticity, Shortening of fats

Learning Outcomes:

After successful completion of this unit, the student will be able to

- explain protein denaturation during processing. (L2)
- understand the functional properties of proteins in foods. (L2)
- apply food enzymes in industry. (L3)
- describe the role of lipids and changes occurring during storage of lipids. (L2)

MODULE III: **8L**

Colour, Flavour & Aroma Components: Naturally occurring colours, Synthetic Colours, flavour & aroma components in herbs: spices, coffee, tea, cocoa, Natural and artificial flavours, organic acids-

Citric acid and vnegar, Threshold values. Naturally occurring toxic substances, protease inhibitors, phytates, polyphenols, saponins, phytoestrogens.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- explain natural and synthetic colors. (L2)
- summarise different flavour and aroma components in herbs. (L2)
- outline the threshold values for artificial colors and flavours. (L3)
- describe naturally occurring toxic substances in foods. (L2)

MODULE IV: **8L**

Microbial spoilage and prevention: Factors affecting spoilage of foods, Microbial spoilage of foods, Intoxicating and infective organisms, Toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa. Microbial flora associated with various food groups, their spoilage potential. Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, Benzoates, Sorbates / Propionates naturally occurring antimicrobials; Tolerance of microbes to chemical and physical methods of sterilization.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- explain about various microorganisms that causes the spoilage of food. (L2)
- summarise infective bacteria and fungi which cause intoxication in foods. (L2)
- outline the microflora associated with different food materials. (L3)
- compare natural and chemical preservatives used for food preservation. (L2)
- summarise the tolerance of microbes to physical and chemical methods of sterilization. (L2)

MODULE V: **8L**

Microbes and Food fermentations: Microbes of importance in food fermentations, – Homo & hetero-fermentative bacteria, yeasts & fungi; Lactic acid bacteria fermentation and starter cultures, Alcoholic fermentations -Yeast fermentations - characteristics and strain selection, Fungal fermentations with typical food fermentations- yoghurt, cheese, fermented milks. Fermented vegetables and meats.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- compare homo and heterolactic fermentations. (L2)
- extend the knowledge to yeast fermentations and strain selections. (L2)
- apply this knowledge for the production of fermentative foods. (L3)

Text Books

1. Chopra, H.K. and P.S. Panesar. “Food Chemistry”. Narosa, 2010.
2. W.C. Frazier, Food Microbiology, 4 Edition TataMc GrawHill, 2008

Reference Books

1. Belitz H.-D, Grosch W and Schieberle P. Food Chemistry, 3rd Revised Edition, Springer-Verlag, 2004.
2. Vaclavik, V. A. and Christian E. W. “Essentials of Food Fat replacements; Food sources, functional role and uses in food

3. “Fennema’s Food Chemistry” 4th Edi/on, by S. Damodaran, K.L. Parkin, and O. Fennema (Eds.), Marcel Dekker, NY, 2007.
4. Vijaya Ramesh “Food Microbiology”. MJP Publishers, 2019
5. Jay, J.M. “Modern Food Microbiology”. 4th Edition. CBS Publishers, 2003
6. Pawsey, R.K. “Case Studies in Food Microbiology for Food Safety and Quality”. The Royal Society of Chemistry, 2002.

Course Outcomes

After successful completion of this course, the student will be able to

- explain the properties and use of water and carbohydrates in foods. (L2)
- summarize the properties of proteins and fats, applications of enzymes. (L2)
- describe the color, flavour and aroma components in foods. (L2)
- understand the role of microbes in food spoilage and methods of food preservation (L2)
- extend the knowledge to microbial fermentations in food industry. (L2)

19EBT727 FOOD CHEMISTRY & MICROBIOLOGY LAB

L	T	P	C
0	0	4	2

Course Objectives

- Introduce the isolation techniques of microorganisms from various foods.
- microbial examination of canned foods.
- quantitave estimation of biomolecules in various foods.

1. Isolation and characterization of Bacteria from different foods
2. Isolation and Identification of Fungi from Fruits and Vegetables
3. Microbial Examination of Canned Foods
4. Detection and Determination of Coliforms, fecal coliforms and *E. coli* in foods and beverages
5. Antimicrobial activity by measuring minimum inhibitory concentrations
6. Isolation and characterization of lactic acid bacteria from milk
7. Isolation of gels from seaweeds
8. Isolation of food colors from green leafy vegetables
9. Determination of AW Value of foods
10. Estimation of Amino acids in foods
11. Estimation of Carbohydrates in foods
12. Estimation of Acid Value of Fats and Oils
13. Estimation of Iodine Value of Fats and Oils

Text books

1. Aneja K.R. Laboratory Manual of Microbiology and Biotechnology, 2/e Paperback – 2018

2. Miller D.D Food Chemistry: A Laboratory Manual, John Wiley, 2014

Reference Books

1. Connie M. Weaver James R. Daniel, The Food Chemistry Laboratory: A Manual for Experimental Foods, Dietetics, and Food Scientists, 2nd Edition, CRC PRESS
2. FSSAI Manual of methods of analysis of foods: Microbiological testing, 2012

Laboratory Outcomes:

After successful completion of this course, the student will be able to

- demonstrate different microbial isolation techniques (L4)
- detect pathogens in various foods (L1)
- apply various isolation techniques for assessing the food quality. (L3)
- analyse different food materials using biochemical methods.(L3)

19EBT766 FOOD PACKAGING

L	T	P	C
3	0	0	3

Course Objectives:
The objective of the course is to

1. explore history of packaging system in the food industry.
2. apply the properties of food packaging materials and techniques in the food industry.
3. innovation of new techniques in food packaging system.
4. explore packaging design using modern technology.
5. enforcement of law and regulation from various national and international authorities.

MODULE I: **9L**

Principles and History of Packaging and its Components, Permeability, Mechanisms of Spoilage, Corrosion and Prevention of Corrosion, Package Evaluation, Ecological Aspects, Bar-coding Applications in Packaging. Paper & Paper Board Cellulosic Materials, Processes in Cellulose Industries, Paper and Board Manufacture, Testing of Cellulose and Paper Materials, Specialty Papers, Folding Cartons, Multiwall Paper Sacks, Composite Containers. Glass Containers: Manufacture, Properties, Applications and Testing.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- acquire knowledge about packaging history of food products. (L1)
- understand the primary properties of food packaging materials. (L2)
- process various food packaging materials. (L2)
- select food packaging materials. (L2)
- evaluate various food packaging materials. (L5)

MODULE II: **9L**

Introduction to Plastics & Polymers Polymeric Material, Properties, Applications, Polymer Composites, Polymer Blends, Additives for Plastics, Testing & Evaluation. Introduction to Plastic Processing Injection molding, Extrusion & Blow molding, calendaring, Thermoforming, Rotational molding, Foam Plastics, FRP Process, Coatings, Wax and lamination Processing Technics Rigid Packaging Material Non-Plastic - CFB, Composites, Metal, Wood etc. Fiberboard Containers, Drums, Tin, Aluminum Cans Containers, Aluminum Foils, Steel Drums, Wooden Containers Crates Ancillary and other Packaging Material Cushioning, Textile Bags, Techniques of sealing Process, Adhesive, Reinforcement, Twines and cards, Clips, Hooks, Stitching Methods, Seals & Closures.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- understand use of plastic materials in food packaging system. (L2)

- apply different types of plastic materials for packaging. (L3)
- apply non plastics materials in food packaging. (L3)
- understand various techniques for food packaging. (L2)

MODULE III: **8L**

Package Printing Technology Process of Communication, Printing Processes and Methods, Layout & Paste-up, Composition for Printing, Theory of Full Color Graphic Arts, Photography, Printing Image, Carriers, Printing Presses, Paper and other Printing Stocks, Printing Inks. Product Packaging Food Packaging Machinery Tooling and Design of Molds for Packaging Injection Molds, Blow Molds, Extrusion Dies, Product Design, Designing for Packaging Application. Modified atmospheric packaging, controlled atmospheric packaging, and meat packaging.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- understand printing technology and labelling. (L2)
- use material for printing and labelling system. (L2)
- use instrumentation and machinery for printing and labelling. (L2)
- design the printing technology. (L6)

MODULE IV: **8L**

Introduction to Packaging Design Concepts: Introduction to design, 2D & 3D dimensional Design, Study of Visual Elements, Principles of Typography, Introduction to visual ergonomics, understanding the relationship between consumer & communication Design Creating 3D objects etc. Standards and Standardization, Quality Standard, Eco Regulations, FSSAI Rules and Regulations etc. Application of Computers in Packaging Design.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- apply modern technology in designing package and printing process. (L4)
- understand the importance of printing and labelling. (L2)
- understand the regulations of various authorities. (L2)
- discuss the application of computers in designing and printing processes. (L1)

MODULE V: **8L**

Packaging Laws & Regulations: Introduction to Food Preservation Packaging Technology, Method of Storage, Packaging of Food, standards and Standardization, Quality Standard, Eco Regulations, The Standards of Weights & Measures Act (SWMA) the Prevention of Food Adulteration Rules (PFA). The Fruit Products Order, 1955 (FPO) The Meat Food Products Order, 1973 (MFPO) The Edible Oil Packaging Order, 1998 The Agmark Rules FSSAI Rules and Regulations etc.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- understand various regulatory standards at national and international level. (L2)
- understand the quality assurance of a food product. (L2)

- discuss various rules and regulations for using food packaging material. (L2)
- understand the prevention of adulteration of food materials. (L2)

Text Books

Gordon L. Robertson, Food Packaging: Principles and Practice, 3rd Edition, CRC Press 2012

Reference Books

Dong Sun Lee, Kit L. Yam, Luciano Piergiovanni, Food Packaging Science and Technology 1st Edition, CRC Press, 2008

Course outcome

After successful completion of this course, the student will be able to

- apply the fundamentals of engineering, basic sciences to solve packaging problems related to processed and un processed food materials. (L3)
- identify packaging systems of various food products. (L1)
- design packaging systems of various food products. (L 5)
- analyze packaging systems of various food products. (L 4)
- design engineering solutions for problems of food packaging methods. (L5)
- utilize rules and regulations of regulatory authorities from national and international for packaging of food products. (L4)

19EBT751 FOOD QUALITY EVALUATION

L	T	P	C
3	0	0	3

Course objectives:

- To acquire knowledge of importance of hygienic conditions for food products
- To utilize the functional or nutraceutical foods for good health
- To implement guidelines for food safety
- To study the effect of food borne disease and toxins
- To optimize conditions for food processing
- To produce food products free from biological or chemical hazards

MODULE I: **9L**

Functional Foods and Nutraceuticals, Food fortification and sports nutrition, Characterization of food safety: Food Safety definition and principles, characterization of food hazards, risk analysis frameworks for chemical and microbial hazards, dose-response modeling for microbial risk, exposure assessment of microbial food hazards, chemical risk food assessment economic consequences of food-borne hazards.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- understand the value of food components or whole food. (L2)
- describe food hazards for food safety. (L2)
- understand risk analysis framework for food safety. (L2)
- discuss good manufacturing practices for food safety. (L4)
- understand the importance of nutrition in good health. (L2)

MODULE II: **8L**

Food Hazards from biological agents, prevalence of food-borne pathogens, physiology and survival of food-borne pathogens in various food systems, characteristics of biological hazards in foods, contemporary monitoring methods.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- understand the mechanism of biological agents causing food hazards. (L2)
- discuss different factors inducing food hazards. (L4)
- characterize methods of biological risk assessment. (L3)
- analyze biological food hazards. (L4)

MODULE III: **9L**

Chemical and physical nature of food hazards, hazards from natural origin, chemical and physical hazards produced during food processing, storage, and preparation, hazards associated with nutrient fortification, monitoring chemical hazards: regulatory information, hazards resulting from environmental, industrial, and agricultural contaminants.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- understand the nature of physical or chemical hazards. (L2)
- analyze the hazards during processing, storage and preparation. (L4)
- identify hazards of nutrient fortification of foods. (L4)
- understand the hazards due to contamination. (L2)

MODULE IV: **8L**

Implementation of FSLS regulatory programs for pathogen reduction, advances in food sanitation, use of intervention strategies, use of surveillance networks, hazard analysis critical control point (HACCP), United States import / export regulation and certification.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- implement food safety guideline at national or international level. (L4)
- use surveillance networks for hazard control. (L2)
- apply risk assessment procedures (HACCP) for food safety. (L2)
- understand regulations for import and export of foods. (L2)

MODULE V: **8L**

Food plant sanitation, food safety control systems in food processing, food safety and innovative food packaging, safe handling of fresh-cut produce and salads, good manufacturing practices: prerequisites for food safety, commercial food service establishments: the principles of modern food hygiene, Codex Alimentarius as FAO/WHO food standards program.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- apply food standards for improving the quality of food products. (L3)
- maintain quality in food service establishments. (L2)
- develop food safety assessment procedures. (L4)
- discuss the principles of food hygiene. (L4)

Text Books

Ronald H. Schmidt and Gary E. Rodrick, 2003, Food Safety Handbook. A John Wiley & Sons Publication

Reference Books

A. K. Singh P. N. Raju & A. Jana. Food Technology-I, www.agrimoon.com
R. Paul Singh and Dennis R. Heldman. 2009. Introduction to Food Engineering Fourth Edition, Academic Press is an imprint of Elsevier

Course Outcomes

After successful completion of this course, the student will be able to

- discuss the importance of biological agents in causing hazards. (L2)
- identify and analyse food safety hazards. (L3)
- implement food safety guidelines and surveillance mechanisms. (L2)
- apply food standards for maintaining quality in food establishments. (L2)

- discuss food safety assessment procedures and food hygiene principles. (L2)

19EBT768: BAKERY AND CONFECTIONERY TECHNOLOGY

L	T	P	C
3	0	0	3

This course designed for students of Food Processing Technology to impart knowledge of ingredients used in Baking and Confectionery. It also educated about the selection, composition and the entire process of Baking and Confectionery services. Also candidates are taught about overview of bakery machinery, developments in high protein, high fibre and sugar-free biscuits, technology of muffins and pizza base manufacture and Confectionery foods

Course Objectives:

- To explain the concepts of Bakery industry and know various kinds of ingredients used in baking.
- To explain the concepts of bakery machinery, technology of bread making.
- To explain the concepts of technology and manufacture of Biscuits
- To explain the concepts of technology and manufacture of muffins & pizza
- To explain the concepts of technology and manufacture of Confectionery foods.

MODULE I **9L**

Bakery industry: current status and future prospects; Role of ingredients in baked products manufacture-1: wheat flour, flour improvers and water; Role of ingredients in baked products manufacture-2: shortening and sugar; Role of ingredients in baked products manufacture-3: leavening agents; Role of ingredients in baked products manufacture-4: salt and other minor ingredients.

Learning outcomes:

After completion of this unit, the student will be able to

- outline the current status and future prospects of Bakery industry (L2)
- know various kinds of ingredients used in baking (L3)
- explain the role of ingredients in baked products manufacture 1, 2, 3 & 4 (L2)

MODULE II

9L

Overview of bakery machinery: mixers, forming machines and ovens; Technology of bread making-1: straight dough and sponge and dough methods; Technology of bread making-2: rapid dough development methods; Developments in formulation of bread: multigrain, gluten-free and reduced salt; Bread staling: Theories and methods of prevention.

Learning outcomes:

After completion of this unit, the student will be able to

- outline the overview of bakery machinery (L2)
- understanding the technology of bread making 1 & 2 (L2)
- developments in formulation of bread (L3)
- explain the bread staling (L2)

MODULE III **8L**

Biscuits: Classification and general aspects of manufacture; Technological aspects of short, hard and fermented dough biscuits; Developments in high protein, high fibre and sugar-free biscuits; Technology of wafer biscuits; Technology of cake manufacture.

Learning outcomes:

After completion of this unit, the student will be able to

- classification and outline of manufacture of biscuits (L2)
- explain the technological aspects of short, hard and fermented dough biscuits (L2)
- developments in high protein, high fibre and sugar-free biscuits (L3)
- explain the technology of wafer biscuits (L2)
- explain the technological of cake manufacture (L2)

MODULE IV **8L**

Technology of muffins and pizza base manufacture; Technology of water vapour leavened baked products: puff pastry; Technology of unleavened baked products: pie crust, tortillas, chapati and parotta; Technological aspects of other baked products: doughnuts and pretzels; Shelf life extension of bakery products.

Learning outcomes:

After completion of this unit, the student will be able to

- explain the technology of muffins and pizza base manufacture (L2)
- explain the technology of water vapour leavened baked products - puff pastry (L2)
- explain the technology of unleavened baked products - pie crust, tortillas, chapati and parotta (L2)
- explain the technology of baked products - doughnuts and pretzels (L2)
- explain shelf life extension of bakery products (L2)

MODULE V

8L

Confectionery foods: Classification and current status of the market; Role of ingredients used in confectionery industry; General aspects of sugar confectionery manufacture; Technology of high boiled sweets; Technology of gums, jellies and chewing gums.

Learning outcomes:

After completion of this unit, the student will be able to

- classification and outline of Confectionery foods (L2)
- know role and various kinds of ingredients used in confectionery industry (L3)
- explain the technology of high boiled sweets (L2)
- explain the technology of gums, jellies and chewing gums (L2)

Text Books

1. Stanley P. Cauvain, Linda S. Young, Baked Products: Science, Technology and Practice, John Wiley and Sons, 2008.
2. Emmanuel Ohene Afoakwa, Chocolate Science and Technology, John Wiley & Sons, 2011.

Reference Books

1. Servet Gulum Sumnu, Serpil Sahin, Food Engineering Aspects of Baking Sweet Goods, CRC Press, 2008.

Course Outcomes:

After completion of this course, the student will be able to:

- demonstrate the knowledge of bakery and confectionery foods (L2)
- analyze the role of ingredients in baked products manufacture 1, 2, 3 & 4 (L4)
- demonstrate the concepts of technology and manufacture of Biscuits (L2)
- demonstrate the concepts of technology and manufacture of muffins & pizza and confectionery foods (L2)

L	T	P	C
3	0	0	3

19EBT755 FRUIT AND VEGETABLE PROCESSING

Course Objectives

- Introduce the current scenario in production and processing of fruits and vegetables
- Provide the knowledge on handling and storage of fruits & vegetables
- Summarize the FSSAI specifications for different fruit and vegetable products
- Provide knowledge on preservation and processing technology
- Outline food laws and quality control standards

MODULE I: **9L**

Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India. Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables. Storage and handling of fresh fruits and vegetables;

Learning Outcomes:

After successful completion of this unit, the student will be able to

- understand the current scenario of world fruit and vegetable production. (L2)
- explain the principles of preservation methods. (L2)
- analyse the scope of fruit and vegetable processing industry. (L4)
- discuss the storage and handling of fresh fruits and vegetables. (L4)

MODULE II: **9L**

Minimal processing of fruits and vegetables. Primary processing and pack house handling of fruits and vegetables Blanching- operations and equipment. Peeling, slicing, cubing, cutting and size reduction operations for fruits and vegetables.

Learning Outcomes:

After successful completion of this unit, the student will be able to

- describe the primary processing of fruits and vegetables. (L2)
- explain the pack house handling of fruits and vegetables. (L2)
- understand the applications of blanching techniques and related equipment. (L1)
- discuss the size reduction operations for fruits and vegetables. (L4)

MODULE III: **8L**

FSSAI specifications of preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials. Preservation of fruits and vegetable by heat treatment. Preservation of fruit juice by hurdle technology. Processing and equipment for squashes and syrups.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- understand FSSAI specifications. (L2)
- explain the preparation and preservation of juices squashes. (L2)
- explain the hurdle technology for fruit juice preservation. (L2)
- discuss the process equipment for squashes and syrups. (L4)

MODULE IV:
8L

FSSAI specifications of cold storage of fruits. Preparation of Jam, Jelly and marmalade. Production of pectin and vinegar. Fruit waste management and vegetable waste recycling.

Learning Outcomes:
After successful completion of this unit, the student will be able to

- apply the FSSAI specifications for crystallization of fruits and vegetables. (L2)
- explain the preparatory methods of Jam, jelly and marmalade. (L2)
- utilise the equipment for the preparation of pectin and vinegar. (L2)
- outline the procedure for fruit and vegetable waste recycling. (L2)

MODULE V:
8L

Preparation, preservation and machinery for manufacture of pickles, sauce, puree, paste, ketchup; dehydrated soup powders. Commercial processing technology of mango and potato products. Food Laws, food rules and standards, Quality Control.

Learning Outcomes:
After successful completion of this course, the student will be able to

- compare the procedures and process machinery for the preparation of pickles, sauce, puree, paste, ketchup; dehydrated soup powders. (L4)
- outline the commercial processing technology of mango and potato products. (L2)
- discuss laws, rules and quality control of fruits and vegetables. (L4)

COURSE OUTCOMES:
After successful completion of the course, the student will be able to

- understand the principles of handling, preservation and storage of fresh fruits & vegetables. (L2)
- identify the processing operations of fruits & vegetables. (L1)
- explain preparation, processing and preservation of fruit juices. (L2)
- describe the equipment for the production of fruits & vegetable products. (L2)
- explain the industrial processing for value added products. (L2)
- comprehend legislation, standards and quality assurance of fruits and vegetables. (L4)

Text Books

1 U.D. Chavan and J.V. Patil. 2013. Industrial Processing of Fruits and Vegetables. Astral International Pvt. Ltd., New Delhi.
2. S. Rajarathnam and R.S. Ramteke. 2011. Advances in Preservation and Processing Technologies of Fruits and Vegetables. New India Publishing Agency, New Delhi.

3. R.P. Srivastava and Sanjeev Kumar. 2002. Fruit & Vegetable Preservation: Principles and Practices, 3 rd Ed. International Book Distribution Co., Delhi.

Reference Books

1. Y.H. Hui. 2006. Handbook of Fruits and Fruit Processing. Blackwell Publishing Ltd., Oxford

2. Girdhari Lal, G.S. Siddappa and G.L. Tandon. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi. EIRI Board of Consultants and Engineers.

3. A.K. Thompson. 2003. Fruit and Vegetables: Harvest, Handling and Storage, 2nd Ed. Blackwell Publishing Ltd., Oxford, UK

19EMC741: RESEARCH METHODOLOGY AND IPR

L	T	P	C
2	0	0	2

This course introduces the student, to the fundamentals of research, research process, technical writing and intellectual property rights. Students will be able to use this knowledge to gain interest in their subject area and pursue their career in research.

Course Objectives

1. To familiarize the meaning, objectives and sources of research
2. To acquaint the student with the importance and methods of literature review/research ethics
3. To impart the knowledge of technical writing for preparing reports, presentations, research proposals, conference/journal publications
4. To introduce the terminology and process of obtaining intellectual property rights
5. To expose the intricacies in the process of obtaining patent rights

MODULE I

5L

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Learning Outcomes

After the completion of this unit, the student will be able to

- define the meaning of a research problem
- list the different sources of research problem
- enumerate the different criteria of good research and list the different errors in selecting research problem
- contrast the different approaches of research
- compare the different methods for data collection and analysis

MODULE II

5L

Effective literature studies approaches, analysis Plagiarism, Research ethics

Learning Outcomes

After the completion of this unit, the student will be able to

- list and elaborate the different steps of the research process
- explain the importance of carrying out an effective literature review
- identify the research gaps from literature review

- describe the ethical principles to be following during research process and authorship
- define the terminology and list the methods to avoid being accused of plagiarism
- list the different types of research misconduct

MODULE III **5L**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Learning Outcomes

After the completion of this unit, the student will be able to

- list the attributes, reasons and guidelines for effective technical writing
- contrast between conference paper, technical presentation and journal paper
- choose a particular research contribution for patenting or journal publication
- define the terminology related to citation, citation index, h-index etc

MODULE IV

5L

Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. **International Scenario**: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the codes and standards in building intellectual property rights
- list the subject, importance and requirements for of patentability
- explain the process of patenting and commercialization in academia
- enumerate the procedure for application preparation, filing and grant of Patents
- define the terminology related to citation, citation index, h-index etc

MODULE V

8L

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. **New Developments in IPR**: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the scope of patent rights
- describe the process for licensing and transfer of technology
- identify the sources of patent information and databases
- elaborate the administration of patent system
- describe the new developments in IPR in computer software, biological systems etc

Text Book(s):

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for Science and engineering students”, Tata Mcgraw Hill India, 2013.
2. Ranjit Kumar, “Research Methodology: A Step by Step Guide for beginners”, 2/e, Prentice Hall of India, 2013.

References:

1. Halbert, “Resisting Intellectual Property”, Taylor and Francis Limited, 2007.
2. Mayall, “Industrial Design”, McGraw Hill, 1992.
3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov, “Introduction to Design”, Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand Publishers, 2008

Course Outcomes

After successful completion of the course, the student will be able to

- define the meaning, sources, approaches for research problems. (L1)
- explain the guidelines for carrying out effective literature review and identify research gaps. (L2)
- describe effective guidelines for preparing technical reports, research publications, presentations and research proposals. (L3)
- describe the codes, standards and process of obtaining intellectual property rights. (L2)
- enumerate the new developments of IPR in engineering systems. (L2)

L	T	P	C
3	0	0	3

19EBT706 FOOD PROCESS ENGINEERING

Course objectives:

- Introduce different engineering approaches for processing of food products
- To understand the food property required in optimal food processing
- Minimal loss of food quality of developing new food or food products.
- Engineering processing approaches for good food quality or food safety
- To develop the optimal processing condition for transformed of foods
- To apply standard processing conditions for good food products

MODULE I: **9L**

Foods Properties: mechanical, electrical and thermal properties, Rheology of food products Food processing principles and concepts, Nutritional and sensory characteristics of processed foods, processing techniques: size reduction theory, momentum transfer, material transfer and heat transfer, scope and importance of food processing, principles and equipment of membrane technology.

Learning outcomes:

After the completion of this unit, the student will be able to

- discuss mechanical, electrical or thermal properties of foods. (L2)
- conceptualise principles of food processing. (L3)
- understand nutritional and sensory quality in processed foods. (L2)
- describe the equipment for membrane technology. (L1)

MODULE II: **8L**

Principles and concept of refrigeration, chilling and freezing, crystallization, dehydration, evaporation processes and their application, Dryers application in the food processing, Cleaning kinetics and mechanisms, Kinetics of disinfection, Cleaning of raw materials, Cleaning out of place (COP), Cleaning in place (CIP), Cleaning of packages.

Learning outcomes:

After the completion of this unit, the student will be able to

- apply the principles of unit operations in food processing. (L3)
- evaluate mechanisms and kinetics of disinfection. (L5)
- understand the need for cleaning in food processing and storage. (L2)

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MODULE III:

8L

Thermal food processing: Sources of heat application, thermal death rate: concept of decimal reduction time, thermal death time constant, reduction degree and methods of heat application to foods: sterilization, blanching and pasteurization techniques, microwave and radio frequency heating and Infra- Red (IR), heat effect on nutritional and sensory characteristics, mechanism of microbial inactivation by thermal processing.

Learning outcome

After the completion of this unit, the student will be able to

- understand thermal processing principles for food quality. (L2)
- apply different thermal processing approaches for minimal food quality loss. (L3)
- apply different electromagnetic radiation heating for good food quality. (L3)
- apply engineering approaches for thermal process. (L3)
- understand the design of equipment for thermal processes. (L2)

MODULE IV: **8L**

Non-thermal food processing: Concept and principles: Hurdle technology, Processing Theory, equipment and application of High pressure processing (HPP), ultrasonic processing, Irradiation theory and equipment: radiation sources, Interaction with matter, radiation dose, Pulsed intense light and pulsed electric field, Chemical and biological effects of ionizing irradiation, Industrial applications of Irradiation.

Learning outcome

After the completion of this unit, the student will be able to

- understand the principle of non-thermal modes of food processing. (L2)
- use thermal processing for minimal nutrition losses. (L2)
- obtain higher nutrienal quantity during food processing. (L2)
- understand the application and limitations of non-thermal food processing. (L2)

MODULE V:

9L

Food safety, good manufacturing practice and quality assurance**,** Contaminants and Food Safety**,** Quality controls and its detection: Export Quality Control and Inspection Systems, concept and application of Codex Almentarious and ISO 9000; Package function and principles, materials for packaging foods; transport properties of packaging materials, Optical properties, mechanical properties and chemical reactivity, Controlled, modified-atmosphere storage and active packaging Deteriorative changes in foodstuff, Packaging methods for protection of food deterioration Shelf life of packaged foodstuff.

Learning outcomes

After the completion of this unit, the student will be able to

- understand the importance of food quality standards. (L2)
- use recommended food quality guidelines or standards for food safety. (L2)
- assess foods for checking quality. (L3)
- understand the mechanisms from prevention to control of food hazards. (L2)

Text Books

1. Albert Ibarz and Gustavo V. Barbosa-Cánovas. Unit Operations in Food Engineering, 2003 by CRC Press LLC
2. P. Fellows, 2000, Food Processing Technology: Principles and Practice, Woodhead Publishing Limited, Cambridge CB1 6AH, England
3. Carl J Schaschke, 2011, Food Processing, Carl J. Schaschke & Ventus Publishing ApS

Reference Books

1. Fellows, P. & Ellis H.1990 Food Processing Technology. Principles and practice; Newyork
2. Macrae R, Roloson R & Sadlu MJ. 1994. Encyclopedia of Food Science & Technology & Nutrition. VolXVI. Academic Press.
3. Barbosa-Canovas, G.V.,Maria Tapia and M. Pilar Cano, eds. 2005. Novel Food processing Technologies. Boca Raton, FL: CRC Press.
4. Zeki Berk, Food Process Engineering and Technology, International Series. Series Editor: Steve L. Taylor, First edition, 2009

Course Outcomes

After successful completion of this unit, the student will be able to

- explain the nutritional significance during food processing.(L1)
- summarize techniques and equipment used in food processing. (L2)
- appreciate the importance of processed foods for world. (L5)
- apply recommendation and standards of different foods at industrial production. (L3)

19EBT708 PLANT AND ANIMAL FOOD TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives

- Introduce the different processing technologies and equipment required for plant foods
- Explain milk processing techniques and milk products.
- Describe the meat resources-poultry, animal and aquaculture products-nutritive value, processing**.**
- Introduce the different aspects of industrial production, quality control, laws and standards for different food products**.**

MODULE I: 9L

Processing characteristics & Technologies of Cereals as Paddy, Wheat, Equipments used. Parboiling of Paddy. Turbogrinding, Milling of Durum Wheat, Rice and Wheat Products. Legumes & Oilseeds. Pretreatments, Processing characteristics, Equipment and Machinery involved, Quality Grading, Refining of oils and utilization of byproducts. Processing characteristics of Corn and its milling, Wet milling and Dry milling of Corn. Processed Cereal Foods, Breakfast Cereals: Processing Technologies involved. Bakery products from Cereals, Bread, Biscuits, Cookies and Cakes.

Learning Outcomes:

After the completion of this unit, the student will be able to

- demonstrate different processing technologies for plant foods.(L2)
- identify different processing equipment for plant foods. (L4)
- classify categories of plant foods. (L2)

MODULE II: 8L

Physico-chemical properties of milk and milk constituents. Fluid milk processing, packaging and distribution. Common dairy processes: cream separation (standardization), pasteurization and homogenisation. UHT processing of milk. Process technology for manufacture of evaporated milk, condensed milk, dried milk, malted milk, baby foods, ice cream, cheese, butter, fermented milk and indigenous dairy products.

Learning Outcomes:

After the completion of this unit, the student will be able to

- appraise milk composition. (L4)
- identify different processing steps of milk. (L3)
- categorize dairy products. (L4)

MODULE III:
9L
Sources of meat and meat products in India. Slaughtering of animals, inspection, grading and evaluation of meat quality. Factors affecting post-mortem changes. Mechanical deboning. Meat tenderization. Shelf life of meat. Meat plant sanitation and safety. Poultry: Nutritive Methods of preservation. Measurement of egg quality.

Learning Outcomes:
After the completion of this unit, the student will be able to
- evaluate nutritional value of animal foods. (L5)
- explain the methods of processing and preservation of different animal foods. (L2)
- Perceive the safety and sanitation of processing plants. (L5)

MODULE IV:
8L
Processing of fish and shrimp, Fishery byproducts Methods of preservation. Physical changes due to chilling and freezing. Typical frozen products. Typical dry products.

Learning Outcomes:
After the completion of this unit, the student will be able to

- appraise the potential of processing methods for fish and shrimp. (L3)
- evaluate methods of preservation. (L4)
- explain the importance of ready–to-cook foods.(L2)

MODULE V:
8L
Industrial production and Quality parameters. Cell culture based production of meat substitutes. Quality control in dairy, meat and fish processing. Laws and standards for meat products, milk and milk products. Methods and procedures for sampling and testing of milk and milk products.

Learning Outcomes:
After the completion of this unit, the student will be able to
- develop industrial production of animal foods for economic development.(L5)
- outline the laws & standards of food production.(L2)
- evaluate milk and milk products. (L1)

Text Books
1. P. Sinha, Fish processing and preservation, APH Publishing Corporation, 2011.
2. EIRI Board of Consultants & Engineers, Hand Book of milk processing, dairy products and packaging technology, Engineers India Research Institute, 2008.

Reference Book
1. V. Khader, A textbook of food science and technology, ICAR, New Delhi,2001.
2. H. Hui (Ed.), Handbook of meat and meat processing, 2/e, CRC Press, 2012.
3. S. Barbut, Poultry Products Processing: An Industry Guide, CRC Press, 2001.

Course Outcomes
After the completion of this course, the student will be able to

- explain the sources and significance of plant and animal foods. (L5)
- summarize techniques and equipment used for plant and animal food processing. (L2)
- appreciate the importance of plant and animal processed foods. (L5)
- apply laws and standards in industrial production of plant and animal foods. (L3)
- explain the importance of byproducts from plant and animal food processing. (L2)

19EBT726: FOOD PROCESS ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

1. Size reduction of Chickpeas using Ball mill.
2. Determination of Hardness of Chocolate using Texture analyser.
3. Estimation of Gluten content in Flour.
4. Measurement of Viscosity of fruit juice by using falling ball method.
5. Estimation of fiber content in fruits and vegetables.
6. Estimation of pectin content in fruits.
7. Production of Clear juice from fruit pulp using bioseparation techniques
8. Estimation and analysis of anti-nutritional factors in raw materials.
9. Production of cheese and yoghurt and microbiological evaluation
10. Determination of Rehydration characteristics of dried foods
11. Study of Shelf life of packaged foodstuff.
12. Pickling of vegetables.

Text Book(s)

1. S. Ranganna, Handbook of analysis and quality control for fruit and vegetable products, 2/e, Tata McGraw Hill, 1986.
2. S. S. Nielsen, Introduction to the chemical analysis of foods. CBS Publishers and Distributors, 2002.

References

B. M. Jacobs, The chemical analysis of foods and food products, 3/e, CBS

19EBT728: FOOD TECHNOLOGY LABORATORY

L	T	P	C
0	0	3	2

List of Experiments

1. **Dehydration of corn**
2. **Preparation of millet based products**
3. **Sensory and texture analysis of milk based products**
4. **Homogenization of milk**
5. **Clarification and cream separation from milk**
6. **Meat tenderization**
7. **Grading of eggs**
8. **Preservation of fruits**
9. **Fish processing**
10. **Good Manufacturing practices**

19EBT754: NUTRACEUTICALS AND FUNCTIONAL FOODS

L T P C
3 0 0 3

The increased awareness about disease prevention and improved health can be accomplished by means of dietary change. It is now realized that food does not only have a nutritional function but that it also plays a disease prevention role. This course has designed to lead to the introduction of nutraceutical and functional foods, role of food additives, prebiotics and probiotics, development of nutraceuticals and functional foods and dosage for effective control of diseases and quality assurance.

Course Objectives

- Introduce the history, classification and health benefits of nutraceuticals and functional foods
- Provide the knowledge on food additives
- Introduce the role of probiotics and prebiotics
- Provide the knowledge on formulation, development and safety and quality assurance of nutraceuticals

MODULE I **8 hours**

Introduction to nutraceuticals and functional foods. Definition, history, classification, health benefits of some of nutraceuticals and functional foods: Spirulina, Soyabean, Ginseng, Garlic, Broccoli, Flaxseeds, Microbes as nutraceuticals.

Learning Outcomes:

After completing this unit, the student will be able to
- understand classification of nutraceuticals and functional foods. (L1)
- discuss health benefits of nutraceuticals and functional foods. (L2)
- discuss some examples with their applications. (L2)
- understand concepts of microbes as nutraceuticals. (L1)

MODULE II **8 hours**

Food additives: definition, need and classification of food additives, preservatives, antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavors and flavor enhancers, leavening agents, nutritional supplements, non-nutritive sweeteners, pH control agents, stabilizer and thickeners, anti-caking agents, acidulants, buffering salt. Food uses; indirect food additives, additives and food safety.

Learning Outcomes:

After completing this unit, the student will be able to
- understand the role of food additives in food processing. (L1)
- explain food preservatives, antioxidants and leaving agents. (L2)
- interpret the applications of food additives in various food industries. (L4) • discuss the concepts in food safety. (L1)

Unit III **8 hours**

Probiotics-important features of probiotic micro- organisms. Probiotics in various foods:

fermented milk products, non-milk products. Prebiotics- Definition, chemistry, sources, metabolism and bioavailability.

Learning Outcomes:

After completing this unit, the student will be able to

- understand the important features of probiotics. (L1)
- explain the various probiotics foods. (L2)
- conceptualise the principles of prebiotics. (L1)
- discuss the sources, metabolism and bioavailabiity of prebiotics. (L1)

Unit IV **8 hours**

Formulation and Development of Nutraceuticals: Probiotics, prebiotics, antioxidants and vitamins. Safety and toxicity evaluation in animal models.

Learning Outcomes:

After completing this unit, the student will be able to

- understand the formulation and development of nutraceuticals.(L1)
- explain different formulations owith vitamins, antioxidants. (L2)
- evaluate safety and toxicity with animal model concepts. (L2)

Unit V **8 hours**

Quality Assurance of Nutraceutical formulations and safety, Dosage for effective control of disease, Regulations and Claims – Current Products: Label Claims, Nutrient Content Claims, Health Claims, Dietary Supplements Claims.

Learning Outcomes:

After completing this unit, the student will be able to

- Explain the quality assurance of nutraceutical formulations. (L1)
- Understand the dosage effective for control of diseases. (L1)
- explain regulations and claims. (L2)

Text Book(s)

1. Robert E C Wildman, Hand book of nutraceuticals and functional foods. 2 nd edition, CRC publishers, 2006

References

1. Aluko, Rotimi,Functional Foods and Nutraceuticals, Springer-Verlag New York Inc.,2012.
   Satinder Kaur Brar, Surinder Kaur and Gurpreet Singh Dhillon,Nutraceuticals Functional Foods,2014.
2. Robert E.C. Wildman, Robert,Wildman, Taylor C, Handbook of Nutraceuticals and Functional Foods, Third Edition,Wallace,2002.3. I. D. Morton and A. J. Macleod, Food Flavours, Part C, Elsevier, 1990.

19EBT756 ENZYMES IN FOOD PROCESSING

L	T	P	C
3	0	0	3

Enzymes are biocatalyst produced by living cells for a specific chemical reaction. Enzymes have played an important role in food processing and technology. The course provides information about enzymes characterization, kinetics, commercial production and processing of some foods such as vegetables, fruits, dairy products, meat and some beverages.

Course Objectives

- Introduce the enzyme classification, mechanism of action and enzyme kinetics
- Provide the knowledge on preparation immobilization of enzymes and their applications
- Understand the role of enzymes in dairy, laundry, bakery and beverage industries
- Provide the knowledge on meat and leather processing with enzymes
- Understand the application of enzymes in food quality control

MODULE I **8 hours**

Enzymes: Introduction, **c**lassification, characterization, mechanisms of enzyme action, factors affecting rate of enzyme catalyzed reactions, Enzyme kinetics, Enzyme inhibition and their types.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- classify and characterize enzymes. (L1)
- understand the mechanism of enzyme catalysed reactions. (L2)
- explain the enzyme kinetics. (L2)
- discuss different types of enzyme inhibitions. (L4)

UNIT II **8 hours**

Enzyme immobilization- Immobilization of enzymes, methods of immobilization, Applications of immobilized enzymes in food processing, enzyme reactors, commercialization and safety implications.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- prepare immobilized enzymes. (L2)
- understand the applications of immobilized enzymes. (L2)
- use the enzyme reactors. (L2)
- discuss the commercialization and safety implications. (L2)

MODULE III **8 hours**

Enzymes in dairy and laundry industry - Application of enzymes in milk processing and preservation, quality assessment. Endogenous and exogenous microbial enzymes, role of enzymes in making dairy products. Enzymes in processing of fats and glycerol, application of enzymes in degreasing. Production fruit juices (guava, apple), enzymatic clarification of fruit juices and factors affecting the clarity of fruit juices.

Learning Outcomes:
After successful completion of the unit, the student will be able to

- apply enzymes in milk processing. (L3)
- explain endogenous and exogenous enzymes. (L2)
- describe the role of enzymes in dairy and laundry industries. (L1)
- use enzymes for clarification of fruit juices. (L2)

MODULE IV **8 hours**

Application of enzymes in Bakery and Beverage industry: Introduction, role of enzymes in baking industry, Application of proteases, lipases, Application of starch degrading enzymes, hemicellulase: source and applications. Application of enzyme in industrial production of beverages, production of alcoholic beverages wine, beer, ciders.

Learning Outcomes:
After successful completion of the unit, the student will be able to

- apply enzymes in bakery industry. (L3)
- understand the application of proteases and lipases. (L2)
- use enzymes in production of beverages. (L2)

UNIT V **8 hours**

Applications in meat and leather industry: Application of enzymes in tenderization of meat, Application of enzymes in development of by products, leather processing, pre tanning, soaking, dehairing, bating. Application of enzymes in quality control.

Learning Outcomes:
After successful completion of the unit, the student will be able to

- apply enzymes for meat tenderization. (L2)
- understand the application of enzymes in development of byproducts. (L2)
- outline the processing technology for leather. (L2)
- apply enzymes in quality control of foods. (L3)

Text Book(s)

1. . G. A. Tucker and L. F. J. Woods, Enzymes in Food Processing, Kluwer Academic Publishers 1991.
2. P. S Panesar, S, S Marwaha and H. K Chopra (Eds.), Enzymes in food processing fundamentals and potential applications I.K. International, 2010.
3. T. W. Nagodawithana, G. Reed and S. Taylor (Eds.), Enzymes in Food Processing, Academic Press Inc. 1993.
3. Alaa El-Din A. Bekhit (1 Eds), Advances in meat processing technology, CRC press 2017.

COURSE OUTCOMES:
After successful completion of the course, the student will be able to

- understand enzyme catalyzed reactions and their kinetics. (L2)
- explain preparation and application of immobilized enzymes. (L2)
- describe the role of enzymes in bakery, dairy, laundry and beverage industries. (L2)
- apply the knowledge on enzymes in meat leather processing. (L3)
- comprehend use of enzymes in food quality control. (L3)

19EBT757 PROCESS INSTRUMENTATION AND CONTROL

L	T	P	C
3	0	0	3

The main thrust of this course is to make the student to understand the theory and applications of process instrumentation and control

Course objectives:
1. Explain various methods of pressure and temperature measurement.
2. Explain various methods of flow and level measurement
3. Understand principles involved in various microwave and infrared sensors.
4. Predict the behavior of first and second order systems
5. Apply different tuning methods for controlling processes.

MODULE I: **9L**

Pressure Measurement: Manometer, Bourdon tubes, McLeod gage, Knudsen gauge, thermal conductivity gage, Pirani gage, ionization gage. Temperature Measurement: Bimetallic thermometers, pressure thermometers, thermocouples, resistance thermometers, thermistors, radiation thermometers.

After successful completion of the unit, the student will be able to
1. explain various types of pressure measurement devices. (L2)
2. use suitable pressure measuring device for various applications. (L2)
3. explain various types of temperature measuring devices. (L2)
4. use suitable temperature measuring devices for various applications. (L2)

MODULE II: **8L**

Flow Measurement: Pilot static tube, hot wire anemometer, orifice meter, rotameter, turbine flow meter. Liquid Level Measurement.

At the end the unit student will be able to
1. understand the working of various types of flow measurement devices. (L2)
2. use suitable flow measuring device for various flow rates. (L2)
3. understand various types of liquid level measuring devices. (L2)
4. use suitable level measuring device for various levels. (L2)

MODULE III: **8L**

Moisture measurement of granular materials; Humidity Measurement; Microwave and infrared sensors for protein and fat content; Applications of biosensors in food industry.

After successful completion of the unit, the student will be able to

1. understand the types of moisture and humidity measurement devices. (L2)
2. use suitable moisture and humidity measuring device for given objects. (L2)
3. apply various types of microwave and infrared sensors. (L3)
4. apply biosensors for monitoring parameters in food industry. (L3)

MODULE IV: **9L**

Laplace Transforms; first and second order responses of instruments (only Thermometer, liquid level, mixing tank, U-tube manometer); Proportional, integral and derivative control modes; on-off control system, feedback control system.

After successful completion of the unit, the student will be able to

1. derive models for control of first and second order systems. (L4)
2. select the appropriate controller for given process. (L3)
3. use optimum values of controller settings. (L2)
4. use appropriate controller mechanism for a given process. (L2)

MODULE V: **8L**

Stability criterion, Roth test, root loci, Frequency response, Bode plots, controller tuning; Process control application in Food Industry.

After successful completion of the unit, the student will be able to

1. determine the stability of a given system. (L2)
2. use optimum settings to stabilize a system. (L2)
3. determine the response of controlled systems. (L2)
4. apply process control in food industry. (L3)

Text Books

1. D. P. Eckman, Industrial Instrumentation, Wiley Eastern Ltd. 2004 .
2. D. R. Coughnowr and S. E. LeBlanc, Process Systems Analysis and Control, 3/e, McGraw-Hill, 2009.

Reference Books

1. G. Stephanopoulos, Chemical process control: an introduction to theory and practice, Pearson Education Inc., 2005.
2. McFarlane, Automatic control of food manufacturing processes, 2/e, Springer/ Chapman and Hall, 1995.

Course outcomes

After successful completion of the course, the student will be able to

1. apply the fundamental concepts in controlling processes. (L3)
2. derive equations for predicting response of first and second order systems. (L4)
3. determine optimum controller settings of a given process. (L4)

19EBT760 PROCESS EQUIPMENT DESIGN

L	T	P	C
3	0	0	3

Course Objectives

- Introduce the different processing technologies and equipment design aspects required for food processing
- Explain thermal processing equipment designing techniques.
- Describe designing of cold storages and refrigerated vans
- Introduce the different aspects of plant layout, quality control and cost estimation for food processing**.**

MODULE I: **8L**

Introduction: General design information; Important aspects of product and process development. Basic flow sheet development for food processing.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- demonstrate basic principles of product development in food processing. (L2)
- demonstrate basic principles of process development in food processing. (L2)
- develop process flow sheet for food processing. (L5)

MODULE II: **9L**

Thermal processing. Canning and retort processing – process design and equipment. Equipment design aspects of pasteurizer, homogenizer, sterilizers, evaporators and concentrators, dryers and their design parameters – tray dryer, spray dryer, fluidized bed dryer and solar dryer.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- appraise thermal process canning in food processing. (L4)
- develop designing aspects for canning and retort processing equipment. (L5)
- explain design parameters of dryers for food processing. (L5)

MODULE III: **9L**

Construction of cold storages and refrigerated vans; Types of freezers and their design parameters – plate contact freezer, air blast freezer, cryogenic freezer.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- evaluate principles for cold storage of foods. (L5)
- categorize types of freezers for food processing. (L 4)
- explain design aspects of freezers.(L5)

MODULE IV: **8L**

Other food processing such as Bakery machines and equipment; Sheeting, mixing and blending, Extrusion and other non thermal processing – process design and equipment

Learning Outcomes:

After successful completion of the unit, the student will be able to

- explain designing of Bakery equipment. (L2)
- categorize types of non thermal processing equipment. (L4)
- develop process and equipment design for non thermal processing. (L5)

MODULE V: **8L**

Food processing Plant layout, CGMP, material of construction, corrosion, waste utilization. Process control, optimization and preliminary project costing.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- develop plant lay out for economic development of food processing (L5)
- outline the current good manufacturing processes for food materials (L2)
- Identify different food grade material for food processing equipment design. (L3)

Text Books

1. Plant Layout and Material Handling, Apple JM, 1977, John Wiley & Sons.
2. Manufacturing Facilities, Design and Material Handling, Meyers FE and Stephens MP, 2000, Prentice Hall.

Reference books

1. Elements of Food Engineering, Watson EL and Harper JC, 1989, The Avi Publishing Co.
2. Food Process Engineering, Heldman DR and Singh RP, 1984, Chapman and Hall.
3. Engineering Economics, Dwivedi DN and Dwivedi A, 2005; Vikas Publishing House Pvt. Ltd.
4. Fundamentals of Food Process Engineering, Toledo RT, 2000, Chapman and Hall.
5. Food Plant Design, 1st Edition, By **Antonio Lopez-Gomez**, **Gustavo V. Barbosa-Canovas**, CRC Press, 2005

Course Outcomes:

After successful completion of the course, the student will be able to

- explain the basic flow sheet development for food processing. (L5)
- summarize techniques and equipment used for food processing. (L2)
- explain optimization and preliminary project costing procedures. (L5)
- explain waste utilization and process control techniques. (L5)

19EBT762 ADVANCES IN FOOD ENGINEERING

L T P C

3 0 0 3

Course objectives:

- Introduce the concept and principles for advanced processing food
- Understand the property of food (mechanical, chemical or biological) for best processing condition
- Understand the transport phenomena of food or food products
- Study the heating and flow behaviour of transformed or new foods
- Optimize the advanced processing for rich quality food products
- Application of engineering processing approaches for food

MODULE I: **8L**

Application of Transport Phenomena for food systems. Flow behaviour of non Newtonian fluids. Rheology of dough with special reference to wheat. Unsteady state Heat Transfer with phase change. Heat transfer during freezing and thawing.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- understand the concept of transport phenomena in food. (L2)
- discuss flow behaviour of different types of foods required in processing. (L2)
- apply rheological properties of wheat dough. (L2)
- understand the rate of heat transfer in unsteady and steady condition. (L2)
- understand the concepts of food thawing or freezing. (L2)

MODULE II: **8L**

Equipment design aspect of evaporators, dryers, freezers. FFS, Vacuum and other packaging machines. RTE frozen foods with reference to packaging Materials used for food processing equipment and corrosion control.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- design food dryer equipment used in processing. (L4)
- apply vacuum packaging during food processing or handling. (L3)
- characterize the biological risk in RTE or frozen foods. (L3)
- understand the impact of packaging materials in food processing. (L2)

MODULE III: **9L**

Advances in food processing techniques both thermal and non thermal.Newer techniques in thermal processing - Retort processing, UHT, Extrusion - hot and cold Ohmic heating, pulsed electric field, high-intensity light pulses, radio-frequency heating, microwave, thermo-sonication, modified atmosphere, enzymic processing and hurdle technology.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- understand the concept of thermal or non-thermal processing. (L2)
- utilize the concept of thermal processing for minimal food quality loss. (L2)
- understand the impact of electromagnetic radiation heating in food processing. (L2)
- understand the principles and application of advanced processing. (L2)

MODULE IV: **8L**

Advanced Membrane Technology for water and liquid foods and effluent treatment. Application of Microwave for food cooking, dehydration. Recent developments in Food Processing with focus on Indian Industry.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- discuss the principle of advanced membrane technology for processing. (L2)
- understand the concept of MW heating for good food quality. (L2)
- apply dehydration process for increasing shelf life of foods. (L3)
- optimise food processing techniques for improving food quality. (L3)

MODULE V: **9L**

High hydrostatic processing of foods. Effect on enzymes, microorganisms in various food systems Equipment for batch and continuous processing. Other applications of HPP including thawing. RTE frozen foods with reference to packaging Materials used for food processing equipment and corrosion control.

Learning Outcomes:

After successful completion of the unit, the student will be able to

- understand the concept of hydrostatic processing of food. (L2)
- use enzymes or microbe during processing. (L2)
- apply high pressure in batch or continuous processing of foods. (L3)
- understand the mechanisms to control the food hazards during food processing. (L2)

Text Books

1. Food Engineering: Process And Technology by S. N. Mukhopadhyay, Viva, 2017
2. Processing And Food Engineering PB Paperback – 2012, Garg M K
3. Food Process Engineering and Technology, Zeki Berk, Academic Press 2018

Reference books

1. Unit Operations in Food Engineering, 1st EditionAlbert Ibarz, Gustavo V. Barbosa-Canovas, CRC Press
2. Advanced Drying Technologies, 2nd Edition, By Tadeusz Kudra, Arun S. Mujumdar, CRC Press, 2009

Course outcomes:

After successful completion of the course, the student will be able to

- understand the advanced processing techniques for safe food products. (L2)
- understand the principles of advanced food processing technologies. (L2)
- use thermal and nonthermal processing technologies for improving shelf life of foods. (L2)
- discuss the principles of membrane technologies. (L2)
- apply high pressure in batch or continuous processing of foods. (L3)

19EBT759 COMPUTER SIMULATION AND MODELLING IN FOOD PROCESSING

L T P C

3 0 0 3

This course designed for students of Food Processing Technology to impart knowledge on different modelling and simulation approaches for food processing operations. It also educated about the thermal processing & kinetic modeling of inactivation, modeling of drying processes for food materials, modeling of multiphase unit operations and extrusion processes. Also candidates are taught about using logistic models to optimize the food supply chain and future trends in modelling food processing operations.

Course Objectives:

- To explain the concepts of modelling and simulation in food processing operations and different modelling and simulation approaches for food processing.
- To explain the concepts of thermal processing and kinetic modeling of inactivation.
- To explain the concepts of modelling of drying processes for food materials.
- To explain the concepts of modeling of multiphase unit operations and extrusion processes.
- To explain the concepts of using logistic models to optimize the food supply chain.

MODULE I: 9L

Introduction to computational modeling in food processing operations, Modeling principles, significance of modeling and simulation, model development from first principles. Different modelling and simulation approaches for food processing, Basic considerations of food processing, Modelling and simulation approaches, Types of Process Modeling, Analytical Models, Numerical or Computational Models, Observational (Empirical) Models and Other Models Used in Food Plant Design and operation.

Learning outcomes:

After completion of this unit, the student will be able to

- outline the modelling and simulation in food processing operations. (L2)
- classify different modelling and simulation approaches for food processing. (L2)
- list the different types of process modeling. (L1)
- develop simple models from first principles. (L3)

MODULE II:

8L

Modeling of food processes involving heating and cooling, Quality and microbial modeling during thermal processes, Dynamic temperature parameter estimation for microbial inactivation, Model selection for dynamic parameter estimation, Software programs dealing with dynamic forward and inverse modeling problems in food science, Modeling thermal processing and reactions: sterilization and pasteurization.

Learning outcomes:

After completion of this unit, the student will be able to

- apply modeling principles to the thermal processing.

- develop kinetic models for microbial inactivation (L2)
- select models for parameter estimation
- match software programs in food science (L2)
- model destruction of microorganisms in sterilizers and pasteurizers (L2)

MODULE III:
8L
Modelling of drying processes for food materials, Modelling of baking processes, Modelling an oven with a simple food product description, Modelling coupled heat, mass and momentum transfers in a simple geometry, Modeling of food-frying processes, Modelling cold food chain processing and display environments. Process Simulation of Food Manufacturing.

Learning outcomes:
After completion of this unit, the student will be able to
- develop models for drying of food materials (L2)
- model baking processes (L2)
- select a model for food-frying processes (L2)
- make use of models for cold food chain processing. (L2)
- simulate food manufacturing processes

MODULE IV:
8L
Modeling of multiphase unit operations: Introduction, Hydrodynamic interactions in concentrated suspensions, Experimental evaluation of shear-induced migration (SIM), Particle migration in microfiltration (MF) and flow field-flow fractionation (F1FFF), Options for fractionation technology, Modeling extrusion processes, Overview of modeling approaches, 3D computational fluid dynamics simulation of biopolymeric melt flow in a twin-screw extruder.

Learning outcomes:
After completion of this unit, the student will be able to
- identify hydrodynamic interactions in concentrated suspensions (L2)
- discover options for fractionation technology
- evaluate migration of particles in microfiltration and field-flow fractionation
- build models for extrusion processes (L2)
- simulate flows in twin screw extruders

MODULE V:
9L
Using logistic models to optimize the food supply chain: Introduction, Features and current trends in food supply chain logistics, Overview of fruit and vegetable logistics, Overview of grains logistics, Overview of beef and meat logistics, Overview of logistics in fisheries, Urban distribution of food products, Dairy logistics.

Learning outcomes:

After completion of this unit, the student will be able to

- use logistic models to optimize the food supply chain (L2)
- appraise current trends in food supply chain logistics
- show the logistics of fruit and vegetables, food grains and meat industry
- organise the logistics of fisheries, Dairy and food distribution
- analyse future trends in logistics of food processing operations (L2)

Text Books

Serafim Bakalis, Kai Knoerzer and Peter J. Fryer, Modeling Food Processing Operations, Woodhead Publishing Series in Food Science, 2015.

Course Outcomes:

After completion of this course, the student will be able to:

- summarize the concepts of modelling and simulation in food processing operations (L2)
- analyze the thermal processing and kinetic modeling of inactivation (L4)
- justify the concepts of modelling of drying processes for food materials (L2)
- relate the concepts of modeling of multiphase unit operations (L2)
- construct the logistic models to optimize the food supply chain (L3)

19EOE742: BUSINESS ANALYTICS

L	T	P	C
3	0	0	3

This course introduces students to the science of business analytics. The goal is to provide students with the foundation needed to apply data analytics to real-world challenges they confront daily in their professional lives. Students will learn to identify the ideal analytic tool for their specific needs; understand valid and reliable ways to collect, analyze, and visualize data; and utilize data in decision making for managing agencies, organizations or clients in their workspace

Course Objectives

- To familiarize the scope, process and advantages of business analytics
- To acquaint the student with the modeling and problem solving skills in business analytics
- To impart the organization and management of business analytics
- To introduce the forecasting models and techniques used in analytics
- To expose the formulation and decision strategies used in business analytics

MODULE I **8L**

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

Learning Outcomes

After the completion of this unit, the student will be able to

- define the scope and process of business analytics (L1)
- choose an organizational structure to implement a business analytics process (L3)
- describe the statistical tools and methods used for data modeling and analysis (L2)
- identify the sampling and estimation requirements for data analysis (L1)

MODULE II **8L**

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Learning Outcomes

After the completion of this unit, the student will be able to

- identify the relationships and trends in data (L1)
- utilize linear regression methods for identifying data relationships (L4)
- list the types of data and their models used for business analytics (L1)

- describe the methods for visualization and exploration of data (L2)

MODULE III **8L**

Organization Structures of Business analytics: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the management issues in the organization structures (L2)
- define the designing information policy and its usage (L1)
- list the methods for ensuring data quality measuring contribution (L1)
- explain the use of data mining methodologies for predictive analytics analysis (L3)
- describe the use of prescriptive analytics methods in business analytics process (L2)

MODULE IV **10L**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Learning Outcomes

After the completion of this unit, the student will be able to

- classify and describe the use of forecasting models (L3)
- model the use of regression forecasting with casual variables (L5)
- identify the appropriate forecasting model for a given data (L5)
- explain the use of monte carlo simulation for forecasting and identify the involved risk (L2)

MODULE V **8L**

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Learning Outcomes

After the completion of this unit, the student will be able to

- formulate decision problems (L2)
- list the decision strategies with and without probabilities (L1)
- use the decision trees for analysis (L4)
- describe the value of information, utility and its use in decision making (L4)

Textbook(s):

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications Pearson FT Press, 2014.
2. James Evans, Business Analytics, Pearson Education, 2013.

Course Outcomes

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

- define the scope, process and advantages of business analytics (L1)
- explain the modeling and problem solving skills in business analytics (L2)
- describe the organization and management of business analytics (L3)
- utilize the forecasting models and techniques used in analytics (L4)
- enumerate and utilize the formulation and decision strategies (L2)

19EOE744: INDUSTRIAL SAFETY

L	T	P	C
3	0	0	3

Safety by design or prevention through design is in the core for maintaining engineering systems safe. The students will be equipped with concepts of engineering systems safety, dimensions of engineering systems safety, safety design and analysis mathematics, design for engineering systems safety and control for safety, and integrating safety with other operational goals such as quality and reliability

Course Objectives

- to impart knowledge on different facets and aspects of industrial systems safety
- to familiarize the student with tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings
- to impart the knowledge of definition, function and types of maintenance activities
- to familiarize the different wear and corrosion mechanisms and their prevention methods
- to expose the students to different faults and their tracing mechanisms
- to impart the art of planning periodic and preventive maintenance mechanisms

MODULE I **8L**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Learning Outcomes

After the completion of this unit, the student will be able to

- list the different types of mechanical and electrical hazards in industrial systems(L1)
- enumerate the salient points of factories act 1948(L2)
- describe the health and safety measures to be enforced for industrial safety(L3)
- elaborate the different fire prevention and firefighting arrangements to be made(L2)

MODULE II **8L**

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Learning Outcomes

After the completion of this unit, the student will be able to

- define the meaning and aim of maintenance engineering(L1)
- elaborate the primary and secondary functions of maintenance department(L2)

- classify the different types and applications of maintenance(L3)
- relate the replacement economy with maintenance cost(L5)
- estimate the service life of equipment from the specifications of individual components(L4)

MODULE III **8L**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the different types, causes and effects of Wear(L2)
- elaborate the different methods for reducing wear(L2)
- list the different types of lubricants and mention their applications(L1)
- define the principle and factors affecting corrosion(L1)
- classify the different types of corrosion and identify their prevention methods(L3)

MODULE IV **8L**

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,vi. Electrical motors, Types of faults in machine tools and their general causes.

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the different types, causes and effects of Wear(L2)
- use the concept of decision tree for fault tracing in machine tools(L4)
- build decision trees for different machine tools including pump, air compressor etc(L4)
- classify the different types of faults in machine tools and their causes(L3)

MODULE V **10L**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Learning Outcomes

After the completion of this unit, the student will be able to

- explain the concept of periodic inspection and its need(L2)
- list the common troubles and remedies of electric motor(L1)
- define the need for preventive maintenance and list its steps(L3)
- elaborate the steps/procedure of periodic and preventive maintenance of diesel generating sets, pumps etc(L2)

Text Book(s):

1. Lindley R. Higgins, Lester Coridon Morrow, Maintenance Engineering Handbook, Da Information Services, 1977.
2. H. P. Garg, Maintenance Engineering, S. Chand and Company, 1987.
3. Audels, Pump-hydraulic Compressors, Mc Graw Hill Publication, 1992.
4. Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London, 1975

Course Outcomes

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

- describe the different facets and aspects of industrial systems safety(L2)
- demonstrate the use of tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings(L4)
- define the function and list the types of maintenance activities(L1)
- describe the concept of wear and corrosion mechanisms and their prevention methods(L2)
- enumerate the different faults and their tracing mechanisms (L3)
- elaborate the planning periodic and preventive maintenance mechanisms needed for industrial safety(L4)

19EOE746: OPERATIONS RESEARCH

L T P C

3 0 0 3

Optimization problems arise in all walks of human activity- particularly in engineering, business, finance and economics. The simplest optimization problems are linear in nature which may be subject to a set of linear constraints. This course will equip the student with the expertise to mathematically model real life optimization problems as Linear Programming (Optimization) Problems and subsequently educate the student to solve these models with the help of the available methods.

Course Objectives

- to impart knowledge on developing mathematical formulation for linear programming and transportation problem
- to familiarize the student in the construction of the required activities in an efficient manner to complete it on or before a specified time limit and at the minimum cost.
- to expose the development of mathematical model for interactive decision-making situations, where two or more competitors are involved under conditions of conflict and competition.
- to illustrate PERT and CPM techniques for planning and implementing projects.
- To impart the knowledge of formulating and analysis of real life problems using advanced tools and techniques for resource optimization
- to provide frameworks for analyzing waiting lines using advanced queuing theory concepts

MODULE I **8L**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Learning Outcomes

After completing this unit, the student will be able to

- identify and develop operational research models from the verbal description of the real system. **[L4]**
- understand the classification systems of effective Inventory control models**[L2]**

MODULE II **8L**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Learning Outcomes

After completing this unit, the student will be able to

- translate a real-world problem, given in words, into a mathematical formulation. **[L2]**
- utilize the mathematical tools that are needed to solve optimization problems. **[L2]**

MODULE III **8L**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Learning Outcomes
After completing this unit, the student will be able to

- describe the need and origin of the optimization methods.[L2]
- classify optimization problems to suitably choose the method needed to solve the particular type of problem.[L3]

MODULE IV **8L**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Learning Outcomes
After completing this unit, the student will be able to

- choose linear programming problems to suitably choose the method needed to solve the particular type of problem**[L1]**
- identify industrial problems involved in inventory, MRP and scheduling**[L2]**

MODULE V **8L**
Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Learning Outcomes
After completing this unit, the student will be able to

- identify the values, objectives, attributes, decisions, uncertainties, consequences, and trade-offs in a real decision problem.[L2]
- Apply the models to incorporate rational decision-making process in real life situations.[L3]
- Analyze various modeling alternatives & select appropriate modeling techniques for a given situation. [L3]

Text Book(s):

1. H.A. Taha, Operations Research, An Introduction, Prentice Hall of India, 2008
2. H.M. Wagner, Principles of Operations Research, Prentice Hall of India, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, 2008
4. Hitler Libermann Operations Research: McGraw Hill Publishers, 2009
5. Pannerselvam, Operations Research: Prentice Hall of India, 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India, 2010

Course Outcomes
After the successful completion of the course, the students will be able to:

- Understand the basic concepts of different advanced models of operations research and their applications. (L2)
- Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action. (L4)

- Apply the models to incorporate rational decision-making process in real life situations. (L4)
- Analyze various modeling alternatives & select appropriate modeling techniques for a given situation. (L3)
- Validate output from model to check feasibility of implementations. (L5)
- Create innovative modeling frameworks for a given situation. (L6)
- Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship. (L3)

19EAC741: ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C
2	0	0	0

COURSE OBJECTIVES:

- To write clearly, concisely and carefully by keeping the structure of the paper in mind.
- To use standard phrases in English and further improve his command over it.
- To write with no redundancy, no ambiguity and increase the readability of the paper.
- To plan and organize his paper by following a logical buildup towards a proper conclusion.
- To decide what to include in various parts of the paper.
- To write a suitable title and an abstract in order to attract the attention of the reader.
- To identify the correct style and correct tense.
- To retain the scientific value of the paper by using minimum number of words.

MODULE I **5L**

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Learning Outcomes:

- To know the expectations of various journals and referees
- To know the typical structure of a paper
- Learn to put words in a sentence in the correct order
- To write short and clear sentences from the very beginning of the paper
- To increase the readability of the paper by making it easy to read and 100% clear
- Learn to be concise without losing any important content
- To avoid some typical grammar mistakes made in research papers

MODULE II **5L**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

Learning Outcomes:

- Learn to make useful contribution worth recommending for publication
- Learn good use of language to make readers notice the key findings
- Learn to anticipate or predict possible objections to the claims made in the paper
- To understand what is plagiarism, and how to paraphrase other people's work
- Learn to attract the right kind of readers with a suitable title
- Learn to sell the abstract to potential readers by attracting their curiosity

MODULE III **6L**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key

skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Learning Outcomes:

- To have a deep knowledge about everything that has been previously written on the topic and decide what is important to know in Introduction.
- Learn to provide the right amount of literature regarding the sequence of events leading up to the current situation in the Literature review

MODULE IV **6L**

Writing Skills: skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

Learning Outcomes:

- Learn to describe the materials used in experiments and/or the methods used to carry out the research
- The key skill is in reporting the results simply and clearly
- Learn to structure the Discussion and satisfy the typical requirements of the referees
- Learn to provide a clear and high-impact take-home message in the conclusion

MODULE V **6L**

Good Paper Writing: Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Learning Outcomes:

- Learn various lists of frequently used phrases that have a general acceptance in all disciplines and use in specific sections of the paper
- Learn various kinds of things one should look for when doing the final check

Text Book (s):

1. Goldbort R, Writing for Science, Yale University Press, 2006
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006
3. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM, Highman, 1998.

References:

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

Course Outcomes:

By the end of the course the learners will be able to:

- Frame the structure of the paper precisely. (L2).
- Improve his command over English by using standard phrases. (L3).
- Avoid repetition and mistakes in the paper and increase its readability. (L3).
- Organize the paper logically towards a proper conclusion. (L4).
- Decide on the content to be included in various parts of the paper. (L5).
- Identify whether to use personal or impersonal style in the paper. (L5).
- Express the content in a clear and concise way. (L6).
- Attract the attention of the reader by providing a suitable title and an appropriate abstract. (L6).

19EAC748: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

L	T	P	C
2	0	0	0

This course is aimed to familiarize the student with life enlightenment skills for personality development. This course helps the student in building his holistic personality through human values, ethics and spiritual attributes.

Course Objectives

- to familiarize the student to good personality traits through moral stories
- to make the student understand the goal of human life and importance of good personality in reaching the goal
- to expose the student to the study of Shrimad-Bhagwad-Geeta for developing his/her personality and achieve the highest goal in life
- to familiarize the student to leadership skills for driving nation and mankind to peace and prosperity
- to expose the role of Neetishatakam for developing versatile personality of students.

MODULE I **9L**

Neetisatakam-Holistic development of personality
Verses- 19,20,21,22 (wisdom)
Verses- 29,31,32 (pride & heroism)
Verses- 26,28,63,65 (virtue)
Verses- 52,53,59 (dont's)
Verses- 71,73,75,78 (do's).

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the moral stories illustrating the traits of good personality
- define the meaning and importance of wisdom, pride, heroism, virtue etc
- identify do and donts in life from the foundations of human morals/ethics

MODULE II **9L**

Approach to day to day work and duties.
Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48,
Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
Chapter 18-Verses 45, 46, 48.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the characteristics and principles of bhakti yogam, jnana yogam and karma yogam
- identify the use of different yogic characteristics in different activities of daily life/duties

- apply the use of yogic principles for leading a stress-free, happy and fruitful life with good developed personality

MODULE III **9L**

Statements of basic knowledge.
Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68
Chapter 12 -Verses 13, 14, 15, 16,17, 18
Personality of Role model. Shrimad BhagwadGeeta:
Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
Chapter 4-Verses 18, 38,39
Chapter18 – Verses 37,38,63

Learning Outcomes

After the completion of this unit, the student will be able to

- list the characteristics of role model proposed by verses of bhagavad gita
- explain the methods for obtaining life enlightenment through the practice of four yoga appropriately
- describe the characteristics of karma yogi/jnana yogi for developing leadership personality

Text Book(s):

1. Swami Swarupananda, "Srimad Bhagavad Gita", Advaita Ashram (Publication Department), Kolkata
2. P. Gopinath, Bhartrihari's Three Satakam (Niti-Sringar-vairagya), Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

After successful completion of the course, the student will be able to

- List the different parables of neethisathakam and identify their morals
- enumerate the different traits of human personality for life enlightenment
- describe the leadership attributes for driving nation and mankind to peace and prosperity
- explain the applicability of different types of yoga to day-to-day work and duties resulting in responsible personality

19EAC751: COST MANAGEMENT OF ENGINEERING PROJECTS

L	T	P	C
3	0	0	3

This course will equip the student with the expertise to mathematically model engineering projects and use effective methods and techniques to plan and execute engineering activities.

Course Objectives

- to introduce the basic principles of strategic cost management and the related terminology
- to familiarize the project planning and execution process involving technical/nontechnical activities
- to acquaint the student with detailed engineering activities and their cost management analysis
- to impart the knowledge of cost analysis and profit planning of engineering projects
- to familiarize the quantitative techniques for optimization of budget allocation

MODULE I **8L**

Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the cost concepts in decision making(L2)
- define the various costs involved in the cost management process(L2)
- list the objectives of cost control(L2)
- identify the different fields of a database for operational control(L2)

MODULE II **8L**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities.

Learning Outcomes

After the completion of this unit, the student will be able to

- define the meaning of a project and list the different types. (L2)
- identify the measures to manage cost overruns. (L2)
- describe the various stages of project execution from conception to commissioning. (L2)

- plan the proper order of technical/nontechnical activities as part of project execution. (L2)

MODULE III **8L**

Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

Learning Outcomes

After the completion of this unit, the student will be able to

- identify the different clearance norms required in the pre-project execution phase(L2)
- describe the hierarchy of project team and identify the role of each member(L2)
- list the different contents of project contracts(L2)
- present the project cost control and planning through bar charts, network diagrams etc(L2)

MODULE IV **8L**

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the cost behavior and profit planning.(L2)
- distinguish between marginal costing and absorption costing.(L2)
- analyze the variance of standard costing.(L2)
- analyze the pricing strategies in project costing.(L2)
- identify the quality measures satisfying the appropriate constraints.(L2)

MODULE V **10L**

Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory

Learning Outcomes

After the completion of this unit, the student will be able to

- define and compare the different budgeting strategies(L2)
- model the cost management as a linear programming problem(L2)
- measure the divisional profitability and decide the appropriate pricing(L2)

Textbook(s):

1. Charles T. Horngren, Srikant M. Datar, George Foster, Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2006.

References:

1. Charles T. Horngren, George Foster, Advanced Management Accounting, Greenwood Publishing, 2001.
2. Robert S Kaplan, Anthony A. Alkinson, Management & Cost Accounting, 1998.
3. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, Wheeler Publisher, 2004.
4. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book, 2006.

Course Outcomes

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

- list the basic principles of strategic cost management and define the related terminology. (L1)
- plan the project execution process involving technical/nontechnical activities. (L4)
- describe the detailed engineering activities and their cost management analysis. (L2)
- carry out the cost analysis and profit planning of engineering projects. (L5)
- utilize quantitative techniques for optimization of budget allocation. (L6)

19EAC747: STRESS MANAGEMENT BY YOGA

L	T	P	C
2	0	0	0

This course is aimed to familiarize the student with basic principles of yoga and different physical/mental practices for managing mind and body. This course helps the student in managing stress during education, home and workplace. Further, principles learnt in this course help in building overall personality for a stress-free, happy and independent life.

Course Objectives

- to familiarize the student about eight parts of yoga and their significance
- to expose the student to the importance and meaning of Yam and Niyam
- to make the student understand the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc
- to introduce the different yogic poses with a knowledge of their benefits for mind and body
- to familiarize the effect of different types of breathing techniques in concept and in activity

MODULE I
9L

Definitions of Eight parts of yoga (Ashtanga).

Learning Outcomes

After the completion of this unit, the student will be able to

- list the eight parts of yoga
- describe the effects of different parts of yoga on mind and body
- elaborate the importance of yoga in stress management and personality development

MODULE II **9L**

Yam and Niyam.
Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

Learning Outcomes

After the completion of this unit, the student will be able to

- elaborate the importance of Yam and Niyam
- describe the meaning and significance of Ahinsa, satya, astheya etc
- explain the need for shaucha, santosh, tapa, swadhyay in leading a healthy and fruitful life

MODULE III **9L**

Asan and Pranayam

i) Various yog poses and their benefits for mind & body

ii) Regularization of breathing techniques and its Effects-Types of pranayam.

Learning Outcomes
After the completion of this unit, the student will be able to

- demonstrate the different physical asanas and explain their physical and phychological effects
- demonstrate the different breathing techniques and describe their physical and mental effects
- distinguish between different types of pranayamam

Text Books
1. Janardan, Yogic Asanas for Group Tarining-Part-I, Swami Yogabhyasi Mandal, Nagpur
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature", Advaita Ashrama, Kolkata

Course Outcomes
After successful completion of the course, the student will be able to

- describe the eight parts of yoga and their significance. (L1)
- explain the the importance and meaning of Yam and Niyam. (L1)
- define the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc. (L1)
- demonstrate the different yogic poses and explain their benefits for mind and body. (L4)
- demonstrate the different types of breathing techniques and explain their physical and mental benefits. (L4)

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19EAC750: DEVELOPING SOFT SKILLS AND PERSONALITY

L	T	P	C
3	0	0	0

Soft skills comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility, friendliness and effective communication skills. The course aims to cause a basic awareness within the students about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality.

Course Objectives

- to familiarize the student to the criteria for self assessment and significance of self-discipline
- to expose the student to attitudes, mindsets, values and beliefs
- to acquaint the student to plan career and goals through constructive thinking
- to enable the student to overcome barriers for active listening and persuasive speaking
- to familiarize the skill of conducting meetings, writing minutes and involving in active group discussions

MODULE I **(8L)**

Self-Assessment; Identifying Strength & Limitations; Habits, Will-Power and Drives; Developing Self-Esteem and Building Self-Confidence, Significance of Self-Discipline

Learning Outcomes

After the completion of this unit, the student will be able to

- identify strengths & limitations through self-assessment(L3)
- list the attributes of personalities will good will-power and self-drives(L1)
- describe the reasons for building self-esteem and self-confidence(L2)
- explain the significance of self discipline(L2)

MODULE II **(8L)**

Understanding Perceptions, Attitudes, and Personality Types: Mind-Set: Growth and Fixed; Values and Beliefs

Learning Outcomes

After the completion of this unit, the student will be able to

- define the characteristics of different perceptions, attitudes and personality types(L1)
- distinguish between fixed and growing mindsets(L3)
- define the importance and meaning of values and beliefs(L2)

MODULE III **(8L)**

Motivation and Achieving Excellence; Self-Actualisation Need; Goal Setting, Life and Career Planning; Constructive Thinking

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the need for having high motivation and achieving excellence(L2)
- define the need for self-actualization(L1)
- plan the life and career goals based on self assessment(L4)
- explain the attributes of constructive thinking(L2)

MODULE IV **(8L)**

Communicating Clearly: Understanding and Overcoming barriers; Active Listening; Persuasive Speaking and Presentation Skills.

Learning Outcomes

After the completion of this unit, the student will be able to

- self-assess the barriers for communicating clearly (L4)
- list the attributes of active listening(L1)
- describe the minimal aspects of effective presentation(L2)
- organize ideas resulting a persuasive talk(L3)

MODULE V **(8L)**

Conducting Meetings, Writing Minutes, Sending Memos and Notices; Netiquette: Effective E-mail Communication; Telephone Etiquette; Body Language in Group Discussion and Interview.

Learning Outcomes

After the completion of this unit, the student will be able to

- describe the format and structure of writing meeting minutes. (L2)
- identify the essential components of memos and notices. (L3)
- explain the principles of effective email communication. (L2)
- list the basic etiquette of telephone conversation. (L1)
- describe the effective body traits during group discussion and interviews. (L2)

Text Books

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman& Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
4. Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5. Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.

Course Outcomes

After successful completion of the course, the student will be able to

- carry out self assessment and describe the significance of self-discipline. (L4)
- define, classify and compare attitudes, mindsets, values and beliefs. (L3)
- plan career and goals through constructive thinking and personal assessment. (L4)
- overcome barriers for active listening and persuasive speaking. (L5)
- conduct meetings, write minutes and involve in active group discussions. (L3)

19COE750: 3D PRINTING

LTPC
3003

3D printing is defined by the ASTM F42 committee as the fabrication of objects through the deposition of a material using a print head, nozzle, or other printer technology. In particular, it is associated with machines that are lower in relative price and overall functional capability. 3D Printing is used to build physical models, prototypes, patterns, tooling components and production parts with materials like plastics, metal, ceramic, glass, and composite materials. 3D Printing systems use thin, horizontal cross sections from computer-aided design (CAD) models, 3D-scanning systems, medical scanners, and video games to produce parts in about every shape imaginable. Design and manufacturing organizations use 3D Printed parts for products in the consumer, industrial, medical implants, and military markets, to name just a few which are benefited by the 3D Printing technology.

Course Objectives

- Understand the fundamentals of various Additive Manufacturing Technologies for application to various industrial needs.
- Able to convert part file into STL format.
- Able to understand the method of manufacturing of liquid based, powder based and solid based techniques.
- Understand the manufacturing procedure of a prototype using FDM technique.

Unit I **10L**

Introduction: Introduction of 3D Printing, Evolution of 3D Printing, General procedure of 3D Printing, Prototyping fundamentals, Historical development, Advantages of AMT, commonly used terms, process chain, 3D modeling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, Classification of AMT process, Applications to various fields.

Learning outcomes

At the end of this unit, the student will be able to

- understand history, concepts and terminology of additive manufacturing[**L1**]
- differentiate between additive and subtractive manufacturing techniques[**L4**].

Unit II **10L**

Liquid based systems: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo

polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies.

Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.

Learning outcomes

At the end of this Unit, the student will be able to

- able to prepare CAD model, understand the various software tools, processes and techniques that enable manufacturing and personal fabrication[**L3**]
- articulate the various tradeoffs that must be made in selecting additive manufacturing processes, devices and materials to suit particular product requirements[**L4**]

Unit III **10L**

Solid based systems: Laminated object manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and disadvantages, Case studies.

Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration.

Learning outcomes

At the end of this Unit, the student will be able to

- identify the need for liquid and solid based additive manufacturing systems[**L3**]
- demonstrate the application of different AM techniques[**L2**].

Unit IV **10L**

Powder Based Systems: Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Three-dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies.

Learning outcomes

At the end of this Unit, the student will be able to

- design and develop newer tooling models[**L3**].
- analyze the best powder-based AM method for present day market requirements[**L4**].

Unit V **8L**

Medical And Bio-Additive Manufacturing: Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE)– Case studies. **Learning outcomes**

At the end of this Unit, the student will be able to

- evaluate the Additive Manufacturing systems, scope for new product development for medical and bio implants[**L5**]
- Analyze the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools[**L4**].

Text Book(s):

1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, 3/e, World Scientific Publishers,2010.
2. Gebhardt A., Rapid prototyping, Hanser Gardener Publications, 2003.

References:

1. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2/e, 2014.
2. Liou L.W., Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press,2007.
3. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer,2006.
4. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press,2000.

Course Outcomes

After completing the course, the student will be able to

- understand the fundamentals of Additive Manufacturing Technologies for engineering applications[**L3**].
- understand the methodology to manufacture the products using SLA and SGC technologies and study their applications, advantages, and case studies[**L1**].
- understand the methodology to manufacture the products using LOM and FDM technologies and study their applications, advantages, and case studies[**L2**]
- understand the methodology to manufacture the products using SLS and 3D Printing technologies and study their applications, advantages, and case studies[**L3**].

19EOE752: WASTE TO ENERGY

L	T	P	C
3	0	0	3

This course introduces the basic principles and different technologies of converting waste to energy. Student will be able to appropriately identify the methods and build biomass gasification systems of different capacities depending on application requirements

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Course Objectives

to introduce the classification of waste for its usefulness in preparing different fuels
to familiarize the biomass pyrolysis process and its yield issues
to acquaint the student with biomass gasification processes and construction arrangements
to impart the types and principles of biomass combustors
to familiarize the calorific values and composition of biogas resources.

MODULE I 8L

Introduction to Energy from Waste: Classification of waste asfuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Learning Outcomes:

After the completion of this unit, the student will be able to

· distinguish between different types of waste (L1)
classify the different types of waste for manufacturing different types of fuel (L3)
identify the different conversion devices and their applications(L4)

MODULE II 8L

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Learning Outcomes:

After the completion of this unit, the student will be able to

classify the different types of pyrolysis methods based on speed(L1)
describe the different methods of manufacturing charcoal (L2)
explain the chemical processes involved in the manufacture of pyrolytic oils and gases(L2)

MODULE III 8L

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Learning Outcomes:

After the completion of this unit, the student will be able to

explain the design, construction and operation of different gasifiers(L2)

describe the burner arrangement for thermal heating(L2)

elaborate the gasifier engine arrangement for equilibrium and kinetic considerations(L3)

MODULE IV 8L

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Learning Outcomes:

After the completion of this unit, the student will be able to

· explain the basic principle of biomass combustors(L2)

classify different combustors based on their capacity and efficiency(L3)

describe the construction and operation of fixed bed inclined grate, fluidized bed combustors (L2)

MODULE V 10L

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

Learning Outcomes:

After the completion of this unit, the student will be able to

list the properties of biogas(L1)

elaborate the design, construction and operation of biogas plant(L2)

classify the different biomass resources and their conversion process(L3)

distinguish between different biogas plants and identify their applications(L5)

Text Book(s)

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Outcomes

After the successful completion of the course, the student will be able to

classify different types of waste for their usefulness in preparing different fuels(L3)

describe the biomass pyrolysis process and its yield issues(L2)

outline the different biomass gasification processes and their construction arrangements(L3)

explain the types and principles of biomass combustors(L2)

analyze the calorific values and composition of biogas resources(L5)

19EAC761 UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

L	T	P	C
2	1	0	3

Students would get an initial exposure to human values through this course. Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions. While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self- observation, self-reflection and self-exploration.Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting. Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials)would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

Course Objectives:

- Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
- Strengthening of self-reflection.
- Development of commitment and courage to act.

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education (8L)

- Purpose and motivation for the course, recapitulation from Universal Human Values-I.
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself! (8L)

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
- Understanding the characteristics and activities of 'I' and harmony in 'I'.
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship (8L)

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence (8L)

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.
- Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
- Holistic perception of harmony at all levels of existence.
- Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics (8L)

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order:
- At the level of individual: as socially and ecologically responsible engineers, technologists and managers
- At the level of society: as mutually enriching institutions and organizations
- Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

Textbooks

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Course Outcomes:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

- They would have better critical ability.
- They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
- It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

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19EBT792 TECHNICAL SEMINAR

L	T	P	C
0	0	4	2

Scope & Overview: Students are expected to identify a research problem/case study from the domain to carry out a reconnaissance research on the topic and suggest innovative solutions for the same. It is advisable for students to choose a topic of interest to be continued as M.Tech Project in the 3rd & 4th Semester. The guidelines to carry out the research shall include the following:

1. Literature Review
2. Identification of Gap
3. Objectives and Expected Outcomes
4. Methodology / Innovative solution

Each student has to prepare a power point presentation on a selected technical topic with a novelty and get it evaluated by the faculty assigned for this purpose.

19EBT893 PROJECT WORK I

L	T	P	C
0	0	26	13

Each student is required to submit a report of first part of project work i.e. about the problem definition, literature review and methodology to be adopted including experiments and tests to be performed on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester end.

19EBT894 PROJECT WORK II

L	T	P	C
0	0	2	1
		6	3

Each student is required to submit a detailed project report about the work on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester and Final evaluation will be done at the end of semester as per the guidelines decided by the department from time to time. The candidate shall present/publish one paper in national/international conference/seminar/journal of repute. However candidate may visit research labs/institutions with the due permission of chairperson on recommendation of supervisor concerned.