



ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM

B.TECH.FOOD TECHNOLOGY

CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV

SEMESTER I

| S. No. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|---|----------|------------------|----------|-----------|-----------------------|-----------|
| | | | | L | T | P | | |
| 1. | IP3151 | Induction Programme | - | - | - | - | - | 0 |
| THEORY | | | | | | | | |
| 2. | HS3151 | Professional English - I | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | MA3151 | Matrices and Calculus | BSC | 3 | 1 | 0 | 4 | 4 |
| 4. | PH3151 | Engineering Physics | BSC | 3 | 0 | 0 | 3 | 3 |
| 5. | CY3151 | Engineering Chemistry | BSC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3151 | Problem Solving and Python Programming | ESC | 3 | 0 | 0 | 3 | 3 |
| 7. | GE3172 | அறிவியல் தமிழ் / Scientific Thoughts in Tamil | HSMC | 1 | 0 | 0 | 1 | 1 |
| PRACTICALS | | | | | | | | |
| 8. | GE3171 | Problem Solving & Python Programming Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BS3171 | Physics and Chemistry Laboratory | BSC | 0 | 0 | 4 | 4 | 2 |
| 10. | GE3172 | English Laboratory \$ | EEC | 0 | 0 | 2 | 2 | 1 |
| TOTAL | | | | 16 | 1 | 10 | 27 | 22 |

\$ Skill Based Course

SEMESTER II

| S. No. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|--|-----------|------------------|----------|-----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | HS3251 | Professional English - II | HSMC | 2 | 0 | 0 | 2 | 2 |
| 2. | MA3251 | Statistics and Numerical Methods | BSC | 3 | 1 | 0 | 4 | 4 |
| 3. | PH3258 | Physics of Materials | BSC | 3 | 0 | 0 | 3 | 3 |
| 4. | BE3252 | Basic Electrical, Electronics and Instrumentation Engineering | ESC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3251 | Engineering Graphics | ESC | 2 | 0 | 4 | 6 | 4 |
| 6. | GE3252 | தமிழர் மரபு / Heritage of Tamils | HSMC | 1 | 0 | 0 | 1 | 1 |
| 7. | | NCC Credit Course Level 1# | - | 2 | 0 | 0 | 2 | 3# |
| PRACTICALS | | | | | | | | |
| 8. | GE3271 | Engineering Practices Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BE3272 | Basic Electrical, Electronics & Instrumentation Engineering Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 10. | GE3272 | Communication Laboratory / Foreign Language \$ | EEC | 0 | 0 | 4 | 4 | 2 |
| TOTAL | | | | 14 | 1 | 16 | 31 | 23 |

NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

\$ Skill Based Course

PROGRESS THROUGH KNOWLEDGE

SEMESTER III

| S. NO | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|---|-----------|------------------|----------|-----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | MA3351 | Transforms and Partial Differential Equations | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | FD3301 | Fluid Mechanics and Mechanical Operations | PCC | 3 | 1 | 0 | 4 | 4 |
| 3. | FD3302 | Food Chemistry | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3303 | Food Microbiology | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3304 | Food Process Calculations | PCC | 3 | 1 | 0 | 4 | 4 |
| 6. | FD3305 | Post Harvest Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| PRACTICALS | | | | | | | | |
| 7. | FD3311 | Food Chemistry Lab | PCC | 0 | 0 | 4 | 4 | 2 |
| 8. | FD3312 | Food Microbiology Lab | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | GE33361 | Professional Development ^{\$} | EEC | 0 | 0 | 2 | 2 | 1 |
| TOTAL | | | | 18 | 3 | 10 | 31 | 26 |

^{\$} Skill Based Course

SEMESTER IV

| S. NO | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|---|-----------|------------------|----------|----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | MA3401 | Probability And Operations Research | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | FD3401 | Biochemistry and Nutrition | PCC | 3 | 0 | 0 | 0 | 3 |
| 3. | GE3451 | Environmental Sciences and Sustainability | BSC | 2 | 0 | 0 | 2 | 2 |
| 4. | FD3402 | Food Additives and flavors | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3403 | Heat and Mass transfer in Food Processes | PCC | 3 | 1 | 0 | 4 | 4 |
| 6. | FD3404 | Principles of Thermodynamics | PCC | 3 | 0 | 0 | 0 | 3 |
| 7. | | NCC Credit Course Level 2# | | 3 | 0 | 0 | 3 | 3# |
| PRACTICALS | | | | | | | | |
| 8. | FD3411 | Biochemistry and Nutrition Laboratory | ESC | 0 | 0 | 0 | 4 | 2 |
| 9. | FD 3412 | Unit operations Laboratory | PCC | 0 | 0 | 0 | 4 | 2 |
| 10 | FD3513 | Industrial Training/Internship* | EEC | - | - | - | - | - |
| TOTAL | | | | 17 | 2 | 0 | 21 | 23 |

NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will

be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

*Two weeks industrial training/internship carries one credit. Industrial training/Internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER V

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|--------------------------------------|-----------|------------------|----------|----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | FD3501 | Food Processing and Preservation | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3502 | Food Analysis | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Professional Elective I | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective II | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective III | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Mandatory Course-I ^{&} | MC | 3 | 0 | 0 | 3 | 0 |
| PRACTICALS | | | | | | | | |
| 7. | FD3511 | Food processing and preservation lab | PCC | 0 | 0 | 4 | 4 | 2 |
| 8. | FD3512 | Food Analysis Lab | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | FD3513 | Industrial Training/Internship* | EEC | - | - | - | - | 1 |
| TOTAL | | | | 18 | 0 | 8 | 26 | 20 |

& Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)

*Two weeks industrial training/internship carries one credit. Industrial training/Internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER VI

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|--------------------------------------|-----------|------------------|----------|----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | FD3601 | Food Process Engineering | PCC | 3 | 1 | 0 | 4 | 4 |
| 2. | | Open Elective – I* | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Professional Elective IV | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective V | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective VI | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective VII | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Mandatory Course-II ^{&} | MC | 3 | 0 | 0 | 3 | 0 |
| 8. | | NCC Credit Course Level 3# | | 3 | 0 | 0 | 3 | 3 # |
| PRACTICALS | | | | | | | | |
| 9. | FD3611 | Food Process Engineering Lab | PCC | 0 | 0 | 4 | 2 | 2 |
| 10. | FD3711 | Industrial Training/Internship** | EEC | - | - | - | - | - |
| TOTAL | | | | 21 | 1 | 4 | 24 | 21 |

*Open Elective – I shall be chosen from the emerging technologies.

**Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

& **Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)**

NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

SEMESTER VII/VIII*

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|---|-----------|------------------|----------|----------|-----------------------|-----------|
| | | | | L | T | P | | |
| THEORY | | | | | | | | |
| 1. | FD3701 | Refrigeration and Cold Chain Management | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3702 | Food plant equipment design | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | GE3791 | Human values and Ethics | HSMC | 2 | 0 | 0 | 2 | 2 |
| 4. | | Elective Management # | HSMC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Open Elective – II** | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Open Elective – III*** | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Open Elective – IV*** | OEC | 3 | 0 | 0 | 3 | 3 |
| PRACTICALS | | | | | | | | |
| 8. | FD3711 | Industrial Training/Internship## | EEC | - | - | - | - | 2 |
| TOTAL | | | | 20 | 0 | 0 | 20 | 22 |

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**Open Elective – II shall be chosen from the emerging technologies.

***Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes

Elective- Management shall be chosen from the Elective Management courses

##Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

SEMESTER VIII/VII*

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|-------------------|-------------|---------------------------|-----------|------------------|----------|-----------|-----------------------|-----------|
| | | | | L | T | P | | |
| PRACTICALS | | | | | | | | |
| 1. | FD3811 | Internship#/ Project Work | EEC | 0 | 0 | 20 | 20 | 10 |
| TOTAL | | | | 0 | 0 | 20 | 20 | 10 |

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

#15 weeks of continuous Internship in an organization carries 10 credits.

TOTAL CREDITS: 167

ELECTIVE – MANAGEMENT COURSES

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | GE3751 | Principles of Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 2. | GE3752 | Total Quality Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | GE3753 | Engineering Economics and Financial Accounting | HSMC | 3 | 0 | 0 | 3 | 3 |
| 4. | GE3754 | Human Resource Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3755 | Knowledge Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3792 | Industrial Management | HSMC | 3 | 0 | 0 | 3 | 3 |

MANDATORY COURSES I

| SL. NO | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|--------|-------------|--|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | MX3081 | Introduction to Women and Gender Studies | MC | 3 | 0 | 0 | 3 | 0 |
| 2. | MX3082 | Elements of Literature | MC | 3 | 0 | 0 | 3 | 0 |
| 3. | MX3083 | Film Appreciation | MC | 3 | 0 | 0 | 3 | 0 |
| 4. | MX3084 | Disaster Management | MC | 3 | 0 | 0 | 3 | 0 |

MANDATORY COURSES II

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|---|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | MX3085 | Well Being with traditional practices (Yoga, Ayurveda and Siddha) | MC | 3 | 0 | 0 | 3 | 0 |
| 2. | MX3086 | History of Science and Technology in India | MC | 3 | 0 | 0 | 3 | 0 |
| 3. | MX3087 | Political and Economic Thought for a Humane Society | MC | 3 | 0 | 0 | 3 | 0 |
| 4. | MX3088 | State, Nation Building and Politics in India | MC | 3 | 0 | 0 | 3 | 0 |
| 5. | MX3089 | Industrial Safety | MC | 3 | 0 | 0 | 3 | 0 |

PROFESSIONAL ELECTIVE COURSES : VERTICALS

| Vertical I | Vertical II | Vertical III | Vertical IV | Vertical V | Vertical VI | Vertical VII | Vertical VIII | Vertical IX | Vertical X |
|---|--|--|--|--|---|---|---|--|--|
| DAIRY AND BEVERAGE TECHNOLOGY | FOOD BIOTECHNOLOGY | MEAT, MARINE AND POULTRY TECHNOLOGY | CEREALS, PULSES AND GRAIN TECHNOLOGY | NEXT GENERATION TECHNOLOGIES IN FOOD INDUSTRIES | FRUIT AND VEGETABLE TECHNOLOGY | FOOD PACKAGING TECHNOLOGY | BAKING AND CONFECTIONERY TECHNOLOGY | SPICES AND PLANTATION TECHNOLOGY | FOOD SAFETY MANAGEMENT SYSTEM |
| Dairy chemistry and microbiology | Introduction To Food Biotechnology | Introduction To Meat, Marine , Poultry | Fat & oil Technology | High Performance Computing | Technology Of Fruit And Vegetable Processing | Packaging Design and Sustainable Development | Introduction to baking & bakery products | Processing, Storage of spices & plantation crops | Introduction to food safety Analysis and Quality Risk Management |
| Processing of Dairy Products | Enzymes in Food and Feed Industry | Meat & Poultry Processing | Processing Of Cereals, Oil Seeds And Pulses | Food materials science | Fruits And Vegetables as Nutraceutical | Package Printing inks and Coatings | Flour chemistry & Rheology | Blending and Value Addition | HACCP in Food Processing and Preservation |
| Value added dairy products | Food Fermentation Technology | Byproducts In Meat Processing | Enrichment And Fortification Of Cereals And Oils | Food structuring techniques | Advances In Fruit And Vegetable Processing Technologies | Glass Wood and Metal Processing and Packaging | Confectionery products | Processing of Coffee | FSMS & Food Product and Supply Chain Management |
| Precision fermentation for dairy alternatives | Biological Instrumentation and Process Control | Preservation Technology of Eggs, Meat, Poultry And Seafood | Milling And Fractionation Technologies | Concepts on experimental design and modelling | Beverage Technology | Plastics and Polymers in Packaging | Industrial production of cookies and biscuits | Processing of Tea | Food laws – Indian and International |

| | | | | | | | | | |
|---|--|--|--|-----------------------------------|--|--|---|---|--|
| Cheese technology | Food Allergens and Toxicology | Marine Food Processing | Technology of Malting and Brewing | Statistical tool in data analysis | Fruit And Vegetable Storage | Paper, CFB and Paper Board based Packaging | Industrial production of bun, bread, cakes and pastries | Processing of cocoa and chocolate | Food Safety in Hospitality industry & GLP in Food Industries |
| Innovative Packaging of Dairy products | Genetic Engineering and Genetically Modified Foods | Technology of packing meat and marine products | By Products Management | Food informatics | Innovative Packaging Of Fruit And Vegetables | Packaging laws and Regulations | Packaging of bakery & confectionery products | Packaging of spices. Plantation products | Food Analysis, Testing & Microbial Safety Analysis |
| Quality and Safety Monitoring in Dairy Industry | Functional Foods and Nutraceuticals | Quality, Laws And Regulations In Meat Industries | Quality, Laws And Regulations In grain processing Industries | Applied Genomics and Proteomics | Fruit And Vegetable Industry Safety & Laws | Packaging Performance Testing & Process, Machinery and equipment | Laws and regulations of Bakery and confectionery products | Spice Processing and products laws, quality standards and regulations | Food Quality Assurance and Quality Control |

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation. Students are permitted to choose all Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E./B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to Regulations 2021 Clause 4.10.

PROFESSIONAL ELECTIVE COURSES : VERTICALS

VERTICAL I: DAIRY AND BEVERAGE TECHNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|---|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3001 | Dairy chemistry and microbiology | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3002 | Processing of Dairy Products | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3003 | Value added dairy products | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3004 | Precision fermentation for dairy alternatives | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3005 | Cheese technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3006 | Innovative Packaging of Dairy products | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3007 | Quality and Safety Monitoring in Dairy Industry | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL II: FOOD BIOTECHNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3008 | Introduction To Food Biotechnology | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3009 | Enzymes in Food and Feed Industry | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3010 | Food Fermentation Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3011 | Biological Instrumentation and Process Control | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3012 | Food Allergens and Toxicology | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3013 | Genetic Engineering and Genetically Modified Foods | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3014 | Functional Foods and Nutraceuticals | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL III: MEAT, MARINE AND POULTRY TECGNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3015 | Introduction To Meat, Marine , Poultry | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3016 | Meat & Poultry Processing | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3017 | Byproducts In Meat Processing | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3018 | Preservation Technology of Eggs, Meat, Poultry And Seafood | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3019 | Marine Food Processing | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3020 | Technology of packing meat and marine products | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3021 | Quality, Laws And Regulations In Meat Industries | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL IV: CEREALS, PULSES AND GRAIN TECHNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3022 | Fat & oil Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3023 | Processing Of Cereals, Oil Seeds And Pulses | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3024 | Enrichment And Fortification Of Cereals And Oils | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3025 | Milling And Fractionation Technologies | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3026 | Technology of Malting and Brewing | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3027 | By Products Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3028 | Quality, Laws And Regulations In grain processing Industries | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL V: NEXT GENERATION TECHNOLOGIES IN FOOD INDUSTRIES

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|---|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3029 | High Performance Computing | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3030 | Food materials science | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3031 | Food structuring techniques | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3032 | Concepts on experimental design and modelling | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3033 | Statistical tool in data analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3034 | Food informatics | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3035 | Applied Genomics and Proteomics | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL VI: FRUIT AND VEGETABLE TECHNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|---|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3036 | Technology Of Fruit And Vegetable Processing | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3037 | Fruits And Vegetables as Nutraceutical | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3038 | Advances In Fruit And Vegetable Processing Technologies | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3039 | Beverage Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3040 | Fruit And Vegetable Storage | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3041 | Innovative Packaging Of Fruit And Vegetables | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3042 | Fruit And Vegetable Industry Safety & Laws | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL VII: FOOD PACKAGING TECHNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3043 | Packaging Design and Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3044 | Package Printing inks and Coatings | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3045 | Glass Wood and Metal Processing and Packaging | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3046 | Plastics and Polymers in Packaging | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3047 | Paper, CFB and Paper Board based Packaging | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3048 | Packaging laws and Regulations | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3049 | Packaging Performance Testing & Process, Machinery and equipment | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL VIII: BAKING AND CONFECTIONERY TECHNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|---|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3050 | Introduction to baking & bakery products | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3051 | Flour chemistry & Rheology | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3052 | Confectionery products | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3053 | Industrial production of cookies and biscuits | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3054 | Industrial production of bun, bread, cakes and pastries | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3055 | Packaging of bakery & confectionery products | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3056 | Laws and regulations of Bakery and confectionery products | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL IX: SPICES AND PLANTATION TECHNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|---|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3057 | Processing, Storage of spices & plantation crops | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3058 | Blending and Value Addition | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3059 | Processing of Coffee | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3060 | Processing of Tea | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3061 | Processing of cocoa and chocolate | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3062 | Packaging of spices. Plantation products | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3063 | Spice Processing and products laws, quality standards and regulations | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL X: FOOD SAFETY MANAGEMENT SYSTEM

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|-----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | FD3064 | Introduction to food safety Analysis and Quality Risk Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | FD3065 | HACCP in Food Processing and Preservation | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | FD3066 | FSMS & Food Product and Supply Chain Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | FD3067 | Food laws – Indian and International | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | FD3068 | Food Safety in Hospitality industry & GLP in Food Industries | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | FD3069 | Food Analysis, Testing & Microbial Safety Analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | FD3070 | Food Quality Assurance and Quality Control | PEC | 3 | 0 | 0 | 3 | 3 |

OPEN ELECTIVES

Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.

OPEN ELECTIVE I AND II (EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|---|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | OCS351 | Artificial Intelligence and Machine Learning Fundamentals | OEC | 2 | 0 | 2 | 4 | 3 |
| 2. | OCS352 | IoT Concepts and Applications | OEC | 2 | 0 | 2 | 4 | 3 |
| 3. | OCS353 | Data Science Fundamentals | OEC | 2 | 0 | 2 | 4 | 3 |
| 4. | OCS354 | Augmented and Virtual Reality | OEC | 2 | 0 | 2 | 4 | 3 |

OPEN ELECTIVES – III

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--------------------------------------|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | OHS351 | English for Competitive Examinations | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OCE353 | Lean Concepts, Tools And Practices | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMG352 | NGOs and Sustainable Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMG353 | Democracy and Good Governance | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OME353 | Renewable Energy Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OME354 | Applied Design Thinking | OEC | 2 | 0 | 2 | 4 | 3 |
| 7. | OMF351 | Reverse Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OMF353 | Sustainable Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OAU351 | Electric and Hybrid Vehicle | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | OAS352 | Space Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OIM351 | Industrial Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OIE354 | Quality Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OSF351 | Fire Safety Engineering | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|-----|--------|---|-----|---|---|---|---|---|
| 14. | OML351 | Introduction to non-destructive testing | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | OMR351 | Mechatronics | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | ORA351 | Foundation of Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OAE352 | Fundamentals of Aeronautical engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OGI351 | Remote Sensing Concepts | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OAI351 | Urban Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OEN351 | Drinking Water Supply and Treatment | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OEE352 | Electric Vehicle technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OEI353 | Introduction to PLC Programming | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OBT352 | Biomedical Instrumentation | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | OCH351 | Nano Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | OCH352 | Functional Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OPY352 | IPR for Pharma Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OTT351 | Basics of Textile Finishing | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OTT352 | Industrial Engineering for Garment Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OTT353 | Basics of Textile Manufacture | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OPE351 | Introduction to Petroleum Refining and Petrochemicals | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OPE352 | Energy Conservation and Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OPT351 | Basics of Plastics Processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEC351 | Signals and Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEC352 | Fundamentals of Electronic Devices and Circuits | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OBM351 | Foundation Skills in integrated product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OBM352 | Assistive Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OMA352 | Operations Research | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OMA353 | Algebra and Number Theory | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OMA354 | Linear Algebra | OEC | 3 | 0 | 0 | 3 | 3 |

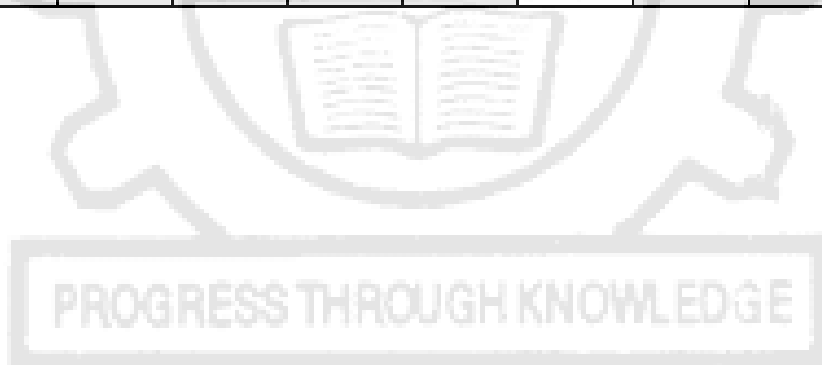
OPEN ELECTIVES – IV

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | OHS352 | Project Report Writing | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OCE354 | Basics of Integrated Water Resources Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMA355 | Advanced Numerical Methods | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMA356 | Random Processes | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OMA357 | Queuing and Reliability Modelling | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OMG354 | Production and Operations Management for Entrepreneurs | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OMG355 | Multivariate Data Analysis | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OME352 | Additive Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OME353 | New Product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | OME355 | Industrial Design & Rapid Prototyping Techniques | OEC | 2 | 0 | 2 | 4 | 3 |
| 11. | OMF352 | Micro and Precision Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OMF354 | Cost Management of Engineering Projects | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OAU352 | Batteries and Management system | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OAU353 | Sensors and Actuators | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | OAS353 | Space Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OIM352 | Management Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OIM353 | Production Planning and Control | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OIE353 | Operations Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OSF352 | Industrial Hygiene | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OSF353 | Chemical Process Safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OML352 | Electrical, Electronic and Magnetic materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OML353 | Nanomaterials and applications | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OMR352 | Hydraulics and Pneumatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | OMR353 | Sensors | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | ORA352 | Foundation of | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|-----|--------|---|-----|---|---|---|---|---|
| | | Automation | | | | | | |
| 26. | ORA353 | Concepts in Mobile Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OMV351 | Marine Propulsion | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OMV352 | Marine Merchant Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OMV353 | Elements of Marine Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OAE353 | Drone Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OGI352 | Geographical Information System | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OAI352 | Agriculture Entrepreneurship Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEN352 | Biodiversity Conservation | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEE353 | Introduction to control systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OEI354 | Introduction to Industrial Automation Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OBT353 | Environment and Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OPY353 | Nutraceuticals | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OCH353 | Energy Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OCH354 | Surface Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OTT354 | Basics of Dyeing and Printing | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OTT355 | Fibre Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 42. | OTT356 | Garment Manufacturing Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 43. | OPE353 | Industrial safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 44. | OPE354 | Unit Operations in Petro Chemical Industries | OEC | 3 | 0 | 0 | 3 | 3 |
| 45. | OPT352 | Plastic Materials for Engineers | OEC | 3 | 0 | 0 | 3 | 3 |
| 46. | OPT353 | Properties and Testing of Plastics | OEC | 3 | 0 | 0 | 3 | 3 |
| 47. | OEC353 | VLSI Design | OEC | 3 | 0 | 0 | 3 | 3 |
| 48. | OEC354 | Industrial IoT and Industry 4.0 | OEC | 2 | 0 | 2 | 4 | 3 |
| 49. | OBM353 | Wearable devices | OEC | 3 | 0 | 0 | 3 | 3 |
| 50. | OBM354 | Medical Informatics | OEC | 3 | 0 | 0 | 3 | 3 |

SUMMARY

| Name of the Programme | | | | | | | | | | |
|-----------------------|---------------------------|----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------|
| S.No | Subject Area | Credits per Semester | | | | | | | | Total Credits |
| | | I | II | III | IV | V | VI | VII/VIII | VIII/VII | |
| 1 | HSMC | 4 | 3 | | | | | 5 | | 12 |
| 2 | BSC | 12 | 7 | 4 | 6 | | | | | 29 |
| 3 | ESC | 5 | 11 | | 2 | | | | | 18 |
| 4 | PCC | | | 21 | 15 | 10 | 6 | 6 | | 58 |
| 5 | PEC | | | | | 9 | 12 | | | 21 |
| 6 | OEC | | | | | | 3 | 9 | | 12 |
| 7 | EEC | 1 | 2 | 1 | | 1 | | 2 | 10 | 17 |
| 8 | Non-Credit (Mandatory) | | | | | √ | √ | | | |
| Total | | 22 | 26 | 26 | 23 | 20 | 21 | 22 | 10 | 167 |



Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 of Regulations 2021.

Verticals FOR MINOR DEGREE (IN ADDITIONS TO ALL THE VERTICALS OF OTHER PROGRAMMES)

| Vertical I Fintech and Block Chain | Vertical II Entrepreneurship | Vertical III Public Administration | Vertical IV Business Data Analytics | Vertical V Environment and Sustainability |
|---|--|---|--|--|
| Financial Management | Foundations of Entrepreneurship | Principles of Public Administration | Statistics For Management | Sustainable infrastructure Development |
| Fundamentals of Investment | Team Building & Leadership Management for Business | Constitution of India | Data Mining For Business Intelligence | Sustainable Agriculture and Environmental Management |
| Banking, Financial Services and Insurance | Creativity & Innovation in Entrepreneurship | Public Personnel Administration | Human Resource Analytics | Sustainable Bio Materials |
| Introduction to Blockchain and its Applications | Principles of Marketing Management For Business | Administrative Theories | Marketing And Social Media Web Analytics | Materials for Energy Sustainability |
| Fintech Personal Finance and Payments | Human Resource Management for Entrepreneurs | Indian Administrative System | Operation And Supply Chain Analytics | Green Technology |
| Introduction to Fintech | Financing New Business Ventures | Public Policy Administration | Financial Analytics | Environmental Quality Monitoring and Analysis |
| - | - | - | - | Integrated Energy Planning for Sustainable Development |
| - | - | - | - | Energy Efficiency for Sustainable Development |

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL 1: FINTECH AND BLOCK CHAIN

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|---|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG331 | Financial Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG332 | Fundamentals of Investment | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG333 | Banking, Financial Services and Insurance | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG334 | Introduction to Blockchain and its Applications | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG335 | Fintech Personal Finance and Payments | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG336 | Introduction to Fintech | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL 2: ENTREPRENEURSHIP

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG337 | Foundations of Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG338 | Team Building & Leadership Management for Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG339 | Creativity & Innovation in Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG340 | Principles of Marketing Management For Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG341 | Human Resource Management for Entrepreneurs | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG342 | Financing New Business Ventures | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL 3: PUBLIC ADMINISTRATION

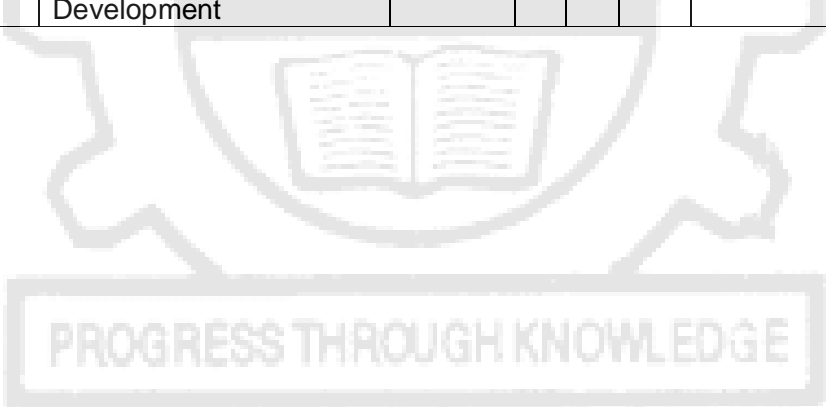
| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|-------------------------------------|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG343 | Principles of Public Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG344 | Constitution of India | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG345 | Public Personnel Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG346 | Administrative Theories | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG347 | Indian Administrative System | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG348 | Public Policy Administration | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL 4: BUSINESS DATA ANALYTICS

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CMG349 | Statistics For Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG350 | Datamining For Business Intelligence | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG351 | Human Resource Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG352 | Marketing And Social Media Web Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG353 | Operation And Supply Chain Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG354 | Financial Analytics | PEC | 3 | 0 | 0 | 3 | 3 |

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

| SL. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---------|-------------|--|----------|------------------|---|---|-----------------------|---------|
| | | | | L | T | P | | |
| 1. | CES331 | Sustainable infrastructure Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CES332 | Sustainable Agriculture and Environmental Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CES333 | Sustainable Bio Materials | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CES334 | Materials for Energy Sustainability | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CES335 | Green Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CES336 | Environmental Quality Monitoring and Analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | CES337 | Integrated Energy Planning for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | CES338 | Energy Efficiency for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |



OBJECTIVES

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS**9 + 3**

Formation of partial differential equations – Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES**9 + 3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**9 + 3**

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT IV FOURIER TRANSFORMS**9 + 3**

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS**9 + 3**

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

TOTAL: 60 PERIODS**OUTCOMES**

Upon successful completion of the course, students should be able to:

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

REFERENCES:

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

FD3301**FLUID MECHANICS AND MECHANICAL OPERATIONS****L T P C
3 1 0 4****OBJECTIVES:**

- To Introduce the students to the mechanics of fluids through a thorough understanding of the properties of the fluids, behaviour of fluids under static conditions.
- The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy.
- To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on vanes.
- To understand the mechanical and Contact equilibrium separation processes of the components and their series of unit operations.

UNIT I PROPERTIES OF FLUIDS**12**

Properties of fluids – definition – units of measurement - Mass density – specific weight, specific volume – specific gravity equation of state – perfect gas - Viscosity – vapour pressure – compressibility and elasticity surface tension – capillarity. Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices– manometer, U-tube, inclined tube, force on submerged bodies (straight, inclined), center of pressure. Basic equations in integral form: Basic laws for a system; continuity equation- in Cartesian co-ordinates - Euler's equation of motion, momentum balance equation-Introduction to Navier Stoke's and Euler's Equation, Types of fluid flow- Introduction to rotational and irrotational flow, momentum correction factor. Fluid pressure and measurement – simple, differential and micro manometers - Mechanical gages – calibration. Pressure diagram – total pressure on curved surface. Archimedes principles

UNIT II FLOW MEASUREMENTS & OPEN CHANNEL FLOW**12**

Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; Hagen-Poiseuille equation; introduction to turbulent flow in a pipe-Prandtl mixing length; energy consideration

in pipe flow, Bernoulli's equation–kinetic energy correction factor; Reynold's experiment, Darcy – Weisbach equation for friction head loss – Chezy's formula – Manning's formula – Hazen-William's formula - Major and minor losses in pipes; friction factor-Fanning and Darcy, Moody diagram; major and minor losses; Pipe fittings and valves, equivalent diameter. Flow measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturi meter; Weirs, concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flowmeter.

UNIT III DIMENSIONAL ANALYSIS & PUMPS

12

Dimensional analysis – concept of geometric, kinematic and dynamic similarity. Important nondimensional numbers – Reynolds, Froude, Euler, Mach and Weber. Fluidization: Introduction; different types of fluidizations; minimum fluidization velocity; governing equation; pneumatic conveying and other industrial uses. Fluid moving machines: Basic classification of pumps: Non-Mechanical Pumps-steam jet ejector, air lift pump, Mechanical pump: Centrifugal pumps- cavitation, NPSH, Positive displacement pumps (rotary, piston, plunger, diaphragm pumps); pump specification; basic characteristics curves for centrifugal pumps; fan, blower and compressor.

UNIT IV SEPARATION AND SIZE REDUCTION

12

Filtration –filter media –constant rate filtration – constant pressure filtration – filter cake resistance-filtration equipment – rotary vacuum filter – filter press- sedimentation – Stoke's law, sedimentation of particles in gas-cyclones – rate of separations – centrifuge equipment. Crystallization – equilibrium - solubility and equilibrium diagram – rate of crystal growth – equilibrium crystallization-crystallization equipment – classification of distillation –Swenson-Walker vacuum crystallizers- Size reduction – grinding and cutting –Rittinger's, Bond's and Kick's laws for crushing-size reduction equipment – crushers – jaw crusher, gyratory crusher-crushing rolls – grinders – hammer mills – rolling compression mills - attrition, rod, ball and tube mills – construction and operation.

UNIT V CONTACT EQUILIBRIUM SEPARATION

12

Contact equilibrium separation processes – concentrations – gas-liquid and solid-liquid equilibrium – equilibrium concentration relationships – operating conditions-calculation of separation in contact – equilibrium processes-gas absorption – rate of gas absorption –equilibrium gas – absorption equipment-properties of tower packing – types – construction – flow through packed towers-extraction – rate of extraction extractor-extraction of fine material – Dorr agitator – continuous leaching – decantation systems – extraction towers-washing – equipment.

TOTAL: 60 PERIODS

OUTCOMES:

- The students will be able to get a basic knowledge of fluids in static, kinematic and dynamic equilibrium.
- They will also gain the knowledge of the applicability of physical laws in addressing problems in hydraulics.

TEXT BOOKS:

1. Modi, P.N. and Seth S.M. "Hydraulics and fluid mechanics". Standard Publishers Distributors, New Delhi,2010.
2. Streeter, V.L. Wylie, E. B. and Bedford K.W, Fluid Mechanics. (9th ed) Tata McGraw Hill, New Delhi, 1998.
3. Geankoplis, C.J. "Transport Processes and Separation Process Principles", 4th Edition, Prentice Hall, 2003.
4. McCabe W.L., Smith J.C. "Unit Operations in Chemical Engineering", 7th Edition, McGraw – Hill Int., 2001.
5. Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.
6. Geankoplis C.J.1999. Transport Process and Unit Operations. Prentice-Hall of India Private Limited, New Delhi.

REFERENCES:

1. Bansal, R.K., "A text book of fluid mechanics and hydraulic machinery", Laxmi publications (P) Ltd., New Delhi, 2002.
 2. Grade, R.J., "Fluid mechanics through problems". Wiley eastern Ltd., Madras, 2002.
- Jain A. K. "Fluid Mechanics". Khanna Publishers 1995.

FD3302

FOOD CHEMISTRY

L T P C
3 0 0 3

OBJECTIVES

The course aims to

- develop the knowledge of students in the basic area of Food Chemistry such as the composition and properties of food and the chemical changes of nutrients during handling, processing, and storage.
- effective understanding of food processing and technology.
- appreciate the similarities and complexities of the chemical components in foods.

UNIT I CARBOHYDRATES

10

The principal carbohydrates in the human diet. Chemical properties of carbohydrates dehydration, caramelization, Maillard reaction. Types Simple Sugars mono and disaccharides, solubility; Artificial sweeteners; Glucose syrup, fructose syrup, Sugar alcohols; Oligosaccharides structure, nomenclature, occurrence, uses in foods. Polysaccharides Starch- amylose and amylopectin- properties, thickening & gelatinization, modified starches, resistant starch, Dextrins and dextrans, Starch hydrolysates – Maltodextrins and dextrins; Structure of glycogen. Fiber_Cellulose & hemicellulose Pectins Gums & seaweeds- gel formation & viscosity.

UNIT II PROTEINS

9

The principal proteins in the human diet. Review of protein structure & conformation; Optical activity, solubility, hydration, swelling, foam formation & stabilization, gel formation, emulsifying effect, thickening & binding, amino acids in Maillard reaction, denaturation; Properties & reactions of proteins in food systems and Food enzymes and its role in food spoilage, application of food enzymes; Texturized proteins; Functional role and uses in foods.

UNIT III LIPIDS

10

Review of structure, composition and nomenclature of fats. Properties of fats & oils Edible oil refining processes, winterization, melting points, plasticity, isomerisation, hydrolysis of triglycerides, Saponification number, iodine value, Reichert-Meissl number. Types of fatty acids; Modification of fats hydrogenation- cis and trans isomers, inter-esterification, acetylation, Hydrolytic rancidity & oxidative rancidity; Shortening power of fats, tenderization, frying - smoke point, auto oxidation, polymerization, lipids having emulsifying properties, its application in food industry and detergents; Shortening power of fats, chemistry of steroids, types of fat substitute.

UNIT IV FOOD COMPOSITION, WATER, MINERALS AND VITAMINS

7

Proximate composition of food, water activity in food, moisture content of food, water quality for food processing. Mineral & vitamin content of foods- stability & degradation during food processing.

UNIT V AROMA & IMPORTANT PHYTOCHEMICALS IN FOOD

9

Naturally occurring colours/pigments in food and impact on antioxidant level, Synthetic food grade Colours, enzymatic browning of food, flavour & aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; and Naturally similar /artificial flavours, Threshold

values, off flavours & food taints. Naturally occurring toxic substances, protease inhibitors, bioactive components phytates, polyphenols, saponins.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO 1 gain knowledge on chemical nature of food components.

CO 2 imparting knowledge on chemical changes of food components during food handling, processing, and storage.

CO 3 facilitate basic platform for further understanding of food analysis.

TEXT BOOKS:

1. Belitz H.-D, Grosch W and Schieberle P. Food Chemistry, 4th Edition, Springer-Verlag, 2009.

2. Meyer, Lillian Hoagland "Food Chemistry". CBS Publishers, 1987.

3. John M. deMan. "Principles of Food Chemistry". 3rd Edition, Springer, 1999.

4. Chopra, H.K. and P.S. Panesar. "Food Chemistry". Alpha Science International Limited, 2010

REFERENCES:

1. Vaclavik, V. A. and Christian E. W. "Essentials of Food Science". 4th Edition, Kluwer_Academic, Springer, 2014.

2. Richard Owusu-Apenten "Introduction to Food Chemistry" CRC Press, 2005.

3. Srinivasan Damodaran, Kirk L. Parkin, "Fennema's Food Chemistry" 5th Edition, CRC Press, 2008.

FD3303

FOOD MICROBIOLOGY

**L T P C
3 0 0 3**

OBJECTIVES:

- The course aims to develop the knowledge of students in the basic area of Food Microbiology.
- This is necessary for effective understanding of food processing and technology subjects as well as food safety.
- This course will enable students to appreciate the role of microbes in food spoilage, preservation of foods and food borne infections.

UNIT I ROLE OF MICROBES IN SPOILAGE OF FOODS

9

Factors affecting spoilage of foods, Microbial flora associated with various food groups their spoilage potential. Microbiological spoilage problems associated with typical food products.

UNIT II CONTROL OF MICROBES IN FOODS

9

Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, benzoates, sorbates / propionates naturally occurring antimicrobials; physical methods- low and high temperatures, drying, radiation and high pressure; tolerance of microbes to chemical and physical methods in various foods.

UNIT III MICROBES IN FOOD FERMENTATIONS

9

Microbes of importance in food fermentations, – homo & hetero-fermentative bacteria, yeasts & fungi; biochemistry of fermentations – pathways involved, lactic acid bacteria fermentation and starter cultures, alcoholic fermentations -yeast fermentations - characteristics and strain selection, fungal fermentations. microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idli, soy products, fermented vegetables and meats.

UNIT IV MICROBIAL AGENTS OF FOOD BORNE ILLNESS**9**

Food borne infections and food poisoning, microbial toxins, Gram Negative and Gram-positive food borne pathogens; toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa.

UNIT V MICROBIAL EXAMINATION OF FOODS**9**

Detection & Enumeration of microbes in foods; Indicator organisms and microbiological criteria; Rapid and automated microbial methods - development and impact on the detection of food borne pathogens; Applications of immunological, techniques to food industry; Detection methods for E. coli, Staphylococci, Yersinia, Campylobacter, B. cereus, Cl. Botulimum & Salmonella, Listeria monocytogenes Norwalk virus, Rotavirus, Hepatitis A virus from food samples.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

On completion of the course the students are expected to

- CO1 Be able to understand and identify the various microbes associated with foods and food groups.
- CO2 Be able to understand and identify the role of these microbes in food spoilage, food preservation.
- CO3 Understand the role of pathogens in food borne infections. • Understand the methods used to detect pathogens in foods.

TEXT BOOKS:

1. Banwart, G.J. "Basic Food Microbiology" 2nd Edition. CBS Publishers, 1998.
2. Vijaya Ramesh. "Food Microbiology". MJP Publishers, Chennai, 2007.
3. Jay, J.M. "Modern Food Microbiology". 4th Edition. CBS Publishers, 2003.
4. Adams, M.R. and M.O. Moss. "Food Microbiology". New Age International, 2002
5. Khetarpaul, Neelam. "Food Microbiology" Daya Publishing House, 2006.

REFERENCES:

1. Montville, Thomas J. and Karl R. Matthews "Food Microbiology: An Introduction". ASM Press, 2005
2. Ray, Bibek and ArunBhunia. "Fundamental Food Microbiology" 4th Edition, CRC Press, 2008
3. Pawsey, R. K. "Case Studies in Food Microbiology for Food Safety and Quality". The Royal Society of Chemistry, 2001.
4. Forsythe, S.J. "The Microbiology of Safe Food". Blackwell Science, 2000.
5. Doyle, Michael P. "Food Microbiology: Fundamentals and Frontiers". 2nd Edition, ASM Press, 2001.

PROGRESS THROUGH KNOWLEDGE

FD3304**FOOD PROCESS CALCULATIONS****L T P C****3 0 0 3****OBJECTIVE:**

To introduce students to basic principles of stoichiometry and its calculations.

UNIT I**9**

Units and dimensions, Basic and derived units, use of model units in calculations, Methods of expression, compositions of mixture and solutions. Ideal and real gas laws – Gas constant - calculations of pressure, volume and temperature using ideal gas law

UNIT II**9**

Fundamental Calculations and Humidity, Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

UNIT III**9**

Basic Principles of Stoichiometry - Importance of material balance and energy balance in a process Industry-Dimensions, nits, conversion factors and their use –Data sources, Humidity and applications. Material Balance: Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallization, drying, extraction, Leaching.

UNIT IV**9**

Energy Balance: Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy

UNIT V**9**

Enthalpy Changes: Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems without chemical reaction.

TOTAL: 45 PERIODS

(Use of Psychometric chart is permitted in the examination)

COURSE OUTCOMES:

At the end of the course the students will be able to

CO 1 make them understand different types of laws of chemistry of materials

CO 2 accurately calculate the stoichiometric relations between the materials involved in the unit operation process.

CO 3 perform elementary material and energy balance for different unit operations.

TEXT BOOKS:

1. Bhatt, B.L and Vora, S.M., "Stoichiometry", Third Edition, McGraw-Hill, New York, 2004.

2. Gavhane, K.A "Introduction to Process Calculations" (Stoichiometry) NiraliPrakashan Publications, Pune, 2009.

REFERENCES: 1. Venkataramani, V. and Anantharaman, N., "Process Calculations" , Prentice Hall of India, New Delhi, 2011.

2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", Eighth Edition, Prentice Hall India, New Delhi, 2015.

FD3305**POST HARVEST ENGINEERING****L T P C
3 0 0 3****OBJECTIVES**

The course aims to

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

UNIT I INTRODUCTION**7**

Post-harvest engineering of crops – objectives - post harvest systems and losses in agricultural commodities structure, engineering properties of agricultural materials, optimum stage of harvest, importance of loss reduction; Post Harvest Handling operations. Pre-drying operation, Moisture content, RH measurement, air-grain measurement.

UNIT II CLEANING, THRESHING AND GRADING**10**

Threshing and shelling operation - principles and operation - various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.

Cleaning – principles and machineries – Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens - rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling, Sorting and Grading - grain grading system, effectiveness of separation and performance index., hydrothermal treatment and conditioning of grains, Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency. Separation - Magnetic separator, de-stoners, electrostatic separators, pneumatic separator

UNIT III MATERIAL HANDLING**10**

Introduction to different conveying equipment used for handling of grains, fruits and vegetables; Scope and importance of material handling devices Classification, principles of operation, conveyor system selection/design. Belt conveyor Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper. Chain conveyor -Principle of operation, advantages, disadvantages, capacity and speed, conveying chain. Screw conveyor Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors. Bucket elevator Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types, power requirement. Pneumatic conveying system types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.

UNIT IV PRINCIPLES AND PRACTICE OF STORAGE**10**

Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables. Damages Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control. Storage structures Traditional storage structures, improved storage structures, modern storage structures; Farm silos Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos. Storage of perishables Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage

UNIT V PEST CONTROL**8**

Primary and secondary insect pests, rodents and microorganisms of stored food grains and their control, integrated pest management, Fumigation and controlled atmosphere storage of food grains, Rodent Control.

TOTAL: 45 PERIODS**OUTCOMES:**

At the end of the course the students will be able to

CO 1 understand and identify the specific processing technologies used for different foods and the various products derived from these materials.

CO 2 understand the application of scientific principles in the processing technologies specific to the materials.

CO 3 understand and design storage systems for different food products

TEXTBOOKS:

1. Sahay, K. M. and K.K.Singh..“Unit operation of Agricultural Processing”, Vikas Publishing House., Pvt Ltd. 2004.
2. Chakravarty et al Handbook of Post-Harvest Technology Marcel Dekker. 2003.
3. Araullo, E.V., dePadna, D.B. and Graham, Michael. Rice Post Harvest Technology.

- International Development Res. Centre, Ottawa, Canada. 1976.
4. Birewar, B.R., Krishnamurthy, K., Girish, G.K., Varma, B.K. and Kanjilal, S.C.. Modern Storage Structures. Indian Grain Storage Institute, Hapur. 1983.
5. Earle, R.L, "Unit Operations in Food Processing". Pergamon Press. Oxford. U.K, 2003

FD3311

FOOD CHEMISTRY LABORATORY

L T P C
0 0 4 2

OBJECTIVES

The course aims to

- Study and understand the chemical properties of foods.
- Study the physical, chemical, thermal properties of various food constituents

LIST OF EXPERIMENTS

1. Experiment to study the properties of carbohydrates- caramelization, Mailard reaction.
2. Experiment on enzymatic and acid hydrolysis of sucrose
3. Preparation of emulsions and study its stability
4. Determination of Foaming properties of proteins
5. Determination of Solubility, specific gravity and Refractive index of oils
6. Estimation of free fatty acid content of oil
7. Determination of peroxide value and Anisidine value of fats.
8. Experiment to study the effect of heat on proteins.
9. Determination of Iso-electric point of casein & experiment to study effect of rennin on milk proteins
10. Experiments to study the gelling properties of starch
11. Experimental study of gluten formation using wheat flour
12. Experimental study on enzymatic Browning in foods

TOTAL: 60 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO 1 gainpractical knowledge on chemical nature of food components.

CO 2 expertise on the protocols of chemical properties of individual components in foods.

CO 3 facilitate for further understanding of food analysis lab.

REFERENCES

1. Weaver, C.M, and J.R. Daniel. "The Food Chemistry Laboratory – A Manual for Experimental Foods, Dietetics & Food Scientists." 2nd Edition, CRC Press, 2005

OBJECTIVES

The course aims to

- Enable students to understand the methods of isolating and characterizing various microbes associated with foods and food groups.
- Enable students to understand and use various microbiological techniques for the study of foods.
- Understand the methods used to detect pathogens in foods.

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS**OUTCOMES:**

At the end of the course the students will be able to

CO 1 different techniques for the identification, isolation and culture of microbes.

CO 2 analyse and identify microbial contamination in food

CO 3 disinfection techniques

REFERENCES

1. Harrigan, W.F. "Laboratory Methods in Food Microbiology" Academic Press, 2011.

MA3401

PROBABILITY AND OPERATIONS RESEARCH

L T P C
3 1 0 4

UNIT I PROBABILITY AND RANDOM VARIABLES

9 + 3

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions - Functions of a random variable.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES

9 + 3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III LINEAR PROGRAMMING

9 + 3

Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.

UNIT IV TRANSPORTATION AND ASSIGNMENT PROBLEMS

9 + 3

Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .

UNIT V NON - LINEAR PROGRAMMING PROBLEMS

9 + 3

Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.

TOTAL: 60 PERIODS

TEXT BOOKS :

1. Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, New Delhi, 5th Edition, 2014.
2. H.A. Taha , " Operations Research, An introduction , 10 th Edition , Pearson Education , New Delhi, 2017.
3. Kanti Swarup, Guptha P.K. and Man Mohan , " Operations Research, Sultan Chand & Sons, New Delhi, 2010.

REFERENCES :

1. John E. Freund's " Mathematical Statistics with Applications " , 8th Edition, Pearson Education , New Delhi, 2017.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 3rd Reprint, 2008.
3. Pradeep Prabhakar Pai , " Operations Research and Practice " , Oxford University Press, New Delhi , 2012.
4. Ravindran , Philips and Solberg " Operations Research, Principles and Practice " Wiley , 2nd Edition , New Delhi , 2007.
5. Frederick S Hillier and Gerald J. Lieberman , " Introduction to Operations Research, Mc Graw Hill, New Delhi, 2017.

FD3401

BIOCHEMISTRY AND NUTRITION

L T P C
3 0 0 3

OBJECTIVES

The course aims to

- Ensure students have a strong grounding in structures and reactions of biomolecules.
- Introduce them to metabolic pathway of the major biomolecules
- Enable the students to understand roles of each nutrients in growth and metabolism

UNIT I INTRODUCTION TO BIOMOLECULES 5

Basic principles of organic chemistry, role of carbon, types of functional groups, biomolecules, chemical nature of water, pH and biological buffers.

UNIT II STRUCTURE AND PROPERTIES OF IMPORTANT BIOMOLECULES 15

Carbohydrates mutarotation, glycosidic bond, reactions of monosaccharides and reducing sugars. Starch, glycogen, cellulose and chitin structures and functions. Proteoglycans, glycosaminoglycans, hyaluronic acid, chondroitin sulfate. Lipids Fatty acids, glycerol, triacylglycerol, phospholipids, glycolipids, sphingolipids. Inherited metabolic disorders of Lipid-metabolism-Tay-Saach's disease, Niemann-Pick's disease and Gaucher's disease. Cholesterol, steroids, Bile acids and salts, Gluco- and Mineralocorticosteroids. Prostaglandins and their functions. Lipoproteins. Cardiovascular disease and correlation with circulating lipid and lipoprotein concentration Amino Acids, Peptides, and Proteins. Classification based on side-chain properties. Structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Nucleic acids Purines, pyrimidines, nucleosides, nucleotides, Chargaff's Rules. Base pairing, A-T and G-C, mRNA, rRNA and tRNA., Watson-Crick structure of DNA. reactions, properties, T_m and hypochromicity, Measurement of DNA and RNA. Nucleoprotein complexes

UNIT III AN OVERVIEW OF NUTRITION AND ENERGY BALANCE 6

Definition, six classes of nutrients, calculating energy values from food, using the RDA, nutritional status, nutritional requirement, malnutrition, nutritional assessment of individuals and populations, dietary recommendations, Balanced diet planning Diet planning principles, dietary guidelines; Glycemic and Non-glycemic carbohydrates, health effects of fiber and starch intake food groups, exchange lists, personal diet analysis; Digestion, Absorption and Transport Anatomy and physiology of the digestive tract, mechanical and chemical digestion, absorption of nutrients. Energy balance; body weight and body composition; health implications; obesity, BMR and BMI calculations.

UNIT IV VITAMINS AND MINERALS 5

Water Soluble Vitamins B vitamins examined individually (Thiamine, Riboflavin, Niacin, Pyridoxine, Biotin, folate B12, choline, pantothenic acid, and carnitine) and in concert; B vitamin deficiencies, toxicities, and food sources; vitamin C roles and recommended intake, deficiency, toxicity and food sources. Fat Soluble Vitamins A, D, E, and K Function, recommended intakes, toxicities, food sources of vitamin A, D, E, and K; Water and Major Minerals Water balance and recommended intakes; fluid/electrolyte balance, acid-base balance; function, recommended intakes, and regulation of sodium, potassium, and calcium. Trace Minerals Food sources, function, recommended intakes, toxicities, deficiencies and transport of iron and zinc; importance of selenium, copper, fluoride, and chromium.

UNIT V INTERMEDIARY METABOLISM AND REGULATION 14

Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt, glyoxalate shunt, fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO 1 understand the fundamentals of biomolecules, biochemical reactions in a living organism.

CO 2 understand the importance of nutrients in growth and metabolism.

CO 3 gain knowledge of importance of nutrients in physiological function and biochemical pathways.

TEXT BOOKS:

1. Nelson, D.L. and M.M. Cox, "Lehninger's Principles of Biochemistry", 4th Edition, W.H. Freeman & Co., 2005.
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
4. Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3rd Edition. Oxford University Press, 2007.
5. Gibney, Michael J., et al., "Introduction to Human Nutrition". 2nd Edition. Blackwell, 2009.

REFERENCES:

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Voet, D. and Voet, J.G., "Biochemistry", 3rd Edition, John Wiley & Sons Inc., 2004.
3. Gropper, Sareen S. and Jack L. Smith "Advanced Nutrition and Human Metabolism". 5th Edition. Wadsworth Publishing, 2008.

GE3451

ENVIRONMENTAL SCIENCE AND SUSTAINABILITY

**L T P C
2 0 0 2**

OBJECTIVES

To the study of nature and the facts about environment.

- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I

6

State of Environment and Unsustainability, Need for Sustainable Development, Traditional conservation systems in India, People in Environment, Need for an attitudinal change and ethics, Need for Environmental Education, Overview of International Treaties and Conventions, Overview of Legal and Regulatory Frameworks.

Environment: Abiotic and biotic factors, Segments of the Environment, Biogeochemical Cycles, Ecosystems (associations, community adaptations, ecological succession, Food webs, Food chain, ecological pyramids), Types of Ecosystems – Terrestrial ecosystems, Ecosystem Services, Economic value of ecosystem services, Threats to ecosystems and conservation strategies.

UNIT II

6

Biodiversity: Species, Genetic & Ecosystem Diversity, Origin of life and significance of biodiversity, Value of Biodiversity, Biodiversity at Global, National and Local Levels, India as a Mega-Diversity Nation (Hotspots) & Protected Area Network, Community Biodiversity Registers. Threats to Biodiversity, Red Data book, Rare, Endangered and Endemic Species of India. Conservation of Biodiversity. People's action. Impacts, causes, effects, control measures, international, legal and regulatory frameworks of: Climate Change, Ozone depletion, Air pollution, Water pollution, Noise pollution, Soil / land degradation / pollution

UNIT III**6**

Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.

Discuss the interrelation of environmental issues with social issues such as: Population, Illiteracy, Poverty, Gender equality, Class discrimination, Social impacts of development on the poor and tribal communities, Conservation movements: people's movements and activism, Indigenous knowledge systems and traditions of conservation.

UNIT IV**6**

Common goods and public goods, natural capital / tragedy of commons, Cost benefit analysis of development projects, Environment Impact Assessment (EIA), Environment Management Plan (EMP), Green business, Eco-labeling, Problems and solutions with case studies. Global and national state of housing and shelter, Urbanization, Effects of unplanned development case studies, Impacts of the building and road construction industry on the environment, Eco-homes / Green buildings, Sustainable communities, Sustainable Cities.

UNIT V**6**

Ethical issues related to resource consumption, Intergenerational ethics, Need for investigation and resolution of the root cause of unsustainability, Traditional value systems of India, Significance of holistic value-based education for true sustainability.

TOTAL: 30 PERIODS**COURSE OUTCOME**

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

CO1 Public awareness of environment at infant stage.

CO2 Ignorance and incomplete knowledge has lead to misconceptions.

CO3 Development and improvement in standard of living has lead to serious environmental disasters.

TEXT BOOKS

1. R. Rajagopalan, Environmental Studies: From Crisis to Cure. Oxford University Press, 2011, 358 pages. ISBN: 9780198072089.
2. Daniel D. Chiras, Environmental Science. Jones & Bartlett Publishers, 01-Feb-2012, 669 pages. ISBN: 9781449645311.

REFERENCES

1. Andy Jones, Michel Pimbert and Janice Jiggins, 2011. Virtuous Circles: Values, Systems, Sustainability. IIED and IUCN CEESP, London.
2. Annenberg Learner, The Habitable Planet, Annenberg Foundation 2015.

FD3402**FOOD ADDITIVES AND FLAVOURS****L T P C
3 0 0 3****OBJECTIVE**

- To expose the students to the use of different chemical additives in foods during food processing and preservation.
- To understand the flavour compounds involved in development of flavor.
- To understand the analytical techniques involved in flavor analysis.

UNIT I ACIDITY REGULATORS, ANTIOXIDANTS AND ANTIMICROBIAL AGENTS 9

Acidity Regulators – definition, chemical structure, role and importance, pH modulation and taste,

acidity profile, permitted acidity regulators, levels of usage and food applications. Antioxidants - Chemistry of oxidative deterioration of food and its constituents and its effect on the quality; defining antioxidant; water soluble and oil soluble antioxidants and their chemical structure, permitted antioxidants; mechanism of action, permitted levels and food application. Preservatives of chemical and microbial origin; mode of action on spoilage organisms and pathogens, factors affecting the performance of preservatives, active forms of preservatives, necessity in a food and levels of usage; permitted preservatives and food applications. Case studies / illustrations.

UNIT II EMULSIFIERS, STABILIZERS AND THICKENERS 9

Emulsion, surface tension, oil in water and water in oil emulsion, Hydrophilic and Lipophilic balance (HLB), role of emulsifiers, different classes of emulsifiers and their chemical structure, their HLB values and role in emulsion stabilization; role of different stabilizers and other substances in emulsion stability; emulsion formation process and equipment; measurement of emulsion stability; permitted emulsifiers and stabilizers and food applications. Optimisation of emulsifiers and stabilizers – case study. Thickeners – definition, chemical structure, role in food processing and product end characteristics, list of permitted thickeners and food applications.

UNIT III COLORS, FLAVORS, FLAVOR ENHANCERS AND SWEETENERS 9

Color – Natural and synthetic food colors, their chemical structure, shades imparted, stability, permitted list of colors, usage levels and food application. Flavouring agents- natural and synthetic flavourings, Flavours from vegetables, cocoa, chocolate, coffee, vanilla beans and Spices. Evaluation tests for flavours. Stability of flavours during food processing, Extraction techniques of flavours, Flavour emulsions; Essential oils and Oleoresins; Flavour enhancers- Chemical properties, Functions in foods, Glutamate in foods, Biochemicals & Toxicology Sweeteners – list, structure, taste profile, permitted list, usage levels and food applications.

UNIT IV FLAVOUR PERCEPTION AND FLAVOUR ANALYSIS 9

Flavour and taste perception, smell and taste sensation, olfaction, flavour compounds, volatile flavour compounds, chemesthesis and chemesthetic responses, tactile response, Aromacompounds, flavour profile, bio-flavour and reconstituted flavour Subjective versus Objective methods of analysis; psychophysics and sensory evaluation; Instrumental analysis; sample handling and artifacts; data handling.

UNIT V OTHER FOOD ADDITIVES & FOOD INGREDIENTS 9

Anticaking agents, Antifoaming, Glazing agents, Bulking agents, Humectants, Firming agents, Softening agents, Crystal modifiers, Flour improvers, Flour treatment agents, Dough conditioners, and Enzymes – definition, role and mode of action, permitted list of agents and food application. Proteins, starches and lipids as functional ingredient; isolation, modification, specifications, functional properties and applications in foods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 To understand the principles of chemical preservation of foods.

CO2 To understand the role of different food additives in the processing of different foods and their specific functions in improving the shelf life, quality, texture and other physical and sensory characteristics of foods.

CO3 To know the regulations and the monitoring agencies involved in controlling the safer use of additives in foods.

CO4 Better understanding and knowledge of contribution of different compounds for the development of flavor and Analytical techniques involved in flavor analysis.

TEXTBOOKS:

1. Branen, A. L. "Food Additives" 2nd Edition, CRC press, 2002.

2. Mahindra, S. N. "Food Additives- Characteristics Detection and Estimation", TATA McGraw Hill, 2000.
3. Reineccius, Gary. "Flavour Chemistry and Technology". 2nd Edition, Taylor & Francis, 2006.

REFERENCES:

1. Thomas. E. Furia, "Handbook of food additives" 2nd Edition, Volume 2, CRC press, 1980
2. P. Michael Davidson, John N. Sofos, and A. L. Branen, "Antimicrobials in food", 3rd Edition, CRC press 2005
3. Peter A Williams and Glyn O Philips, "Gums and stabilizers for the Food Industry", RSC,2007.
4. Madhavi, D. L. S. S. Deshpande, and D. K. Salunkhe. "Food antioxidants", CRC Press, 1996
5. Fisher, Carolyn and Thomas R. Scott. "Food Flavours Biology and Chemistry". The Royal Society of Chemistry, 1997.
6. Heath, H.B. and G. Reineccius. "Flavour Chemistry and Technology". CBS Publishers, 1996.
7. Dr Kay O'Donnell et al, "Sweeteners and sugar alternatives in food technology", wiley& sons, 2012.
8. Carmen Socaciu, "Food Colorants Chemical and functional properties", CRC Press,2007.
9. Gary Reineccius, "Flavor chemistry and technology", 2nd Edition, CRC Press, 2016.
10. Ashurst, Philip R. "Food Flavourings". 3rd Edition, Aspen Publications, 1999.
11. Shahidi, Fereidoon and Chi-Tang Ho. "Flavour Chemistry of Ethnic Foods". Kluwer Academic Plenum, 1999.
12. Titus A. M. Msagati. "The Chemistry of Food Additives and Preservatives", Wiley- Blackwell, 2013.

FD3403

HEAT AND MASS TRANSFER IN FOOD PROCESSES

**LT P C
3 1 0 4**

OBJECTIVES

The course aims to

- learn the principles and applications of heat and mass transfer operations in food industries.
- understand the mechanisms and concept of heat transfer effectively.
- Investigate the mass transfer operational approaches.

UNIT I HEAT TRANSFER – CONDUCTION

12

Basic heat transfer processes - conductors and insulators - conduction – Fourier's law of heat conduction – thermal conductivity and thermal resistance - linear heat flow – heat transfer through homogenous wall, composite walls, radial heat flow through cylinders and sphere – solving problems in heat transfer by conduction.

UNIT II HEAT TRANSFER – CONVECTION

12

Heat transfer - convection – free and forced convection - factors affecting the heat transfer coefficient in free and forced convection heat transfer – overall heat transfer coefficient - solving problems in foods.

UNIT III HEAT TRANSFER – RADIATION AND HEAT EXCHANGER

12

Radiation heat transfer – concept of black and grey body - monochromatic Total emissive power– Kirchhoff's law – Planck's law - Stefan-Boltzmann's law –Heat exchangers – parallel, counter and cross flow- Logarithmic Mean Temperature Difference – overall coefficient of heat transfer in shell and tube heat exchanger for food products.

UNIT IV MASS TRANSFER - DIFFUSION, EVAPORATION AND CONCENTRATION

12

Unit operations in food processing –conservation of mass and energy – overall view of an engineering

process-dimensions and units – dimensional and unit consistency – dimensionless ratios-evaporation – definition – liquid characteristics – single and multiple effect evaporation- performance of evaporators and boiling point elevation – capacity – economy and heat balance- types of evaporators – once through and circulation evaporators – short tube evaporators and long tube evaporators – agitated film evaporator.

Mass transfer in foods – introduction – Fick's law for molecular diffusion - molecular diffusion in gases – equimolar counters diffusion in gases and diffusion of A through non diffusing B, diffusion coefficients for gases - molecular diffusion in liquids, solids, biological solutions and gels.

UNIT V MASS TRANSFER – DISTILLATION

12

Vapour liquid equilibria - Raoult's law- Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe -Thiele method.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO 1 apply the different heat and mass transfer principles in different approaches.

CO 2 gain knowledge on types of heat exchangers used in food industry

CO 3 design the heat and mass transfer equipments.

TEXT BOOKS:

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

REFERENCES:

1. Jacob and Hawkins. "Elements of Heat Transfer". John Willey and Sons Inc. New York, 1983.
2. Eckert, E.R.G. "Heat and Mass Transfer". McGraw Hill Book Co., New York, 1981.
3. Holman, E.P. "Heat Transfer". McGraw-Hill Publishing Co. New Delhi, 2001.
4. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th Edition, Vol.I & II, Butterworth – Heinman (an imprint of Elsevier), 2004.
5. McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6th Edition, McGraw Hill, 2003.

FD3404

PRINCIPLES OF THERMODYNAMICS

**LT P C
3 0 0 3**

OBJECTIVES

The course aims to

- train the students on the basics and applications of energy in Mechanical Engineering
- impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

UNIT I BASIC CONCEPTS

9

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive, Total and specific quantities. System and their types. Thermodynamic Equilibrium State, path and process. Quasi_static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work. P-V diagram.

UNIT II LAWS OF THERMODYNAMICS

9

Zeroth law of thermodynamics – concept of temperature and thermal equilibrium– relationship between temperature scales –new temperature scales. First law of thermodynamics – application to closed and open systems – steady and unsteady flow processes. Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. Applications of II Law. High- and low-grade energy. Available and non-available energy of a source and finite body. Energy and irreversibility. Expressions for the energy of a closed system and open systems. Energy balance and entropy generation. Irreversibility. I and II law Efficiency.

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles.

UNIT IV IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS 9

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties. Compressibility factor- Principle of Corresponding states. - Generalised Compressibility Chart and its use-. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations.

UNIT V GAS MIXTURES AND PSYCHROMETRY 9

Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function. Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO 1 apply thermodynamic principles to Engineering Applications

CO 2 apply mathematical fundamentals to study the properties of steam, gas and gas mixture.

CO 3 apply fundamentals of thermodynamics and to perform thermal analysis on their behaviour and performance

TEXT BOOKS:

1. Nag P. K. Thermodynamics, 2005. 5th edition, Tata Mc Graw Hill, New Delhi. 2001.
2. Ethirajan Rathakrishnan. Fundamentals of Engineering Thermodynamics. (PHI). 2010.
3. Y. Cengel and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill, 7th Edition, 2011.
4. Chattopadhyay, P, "Engineering Thermodynamics", 2nd Ed. Oxford University Press, 2014.
5. Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India) Limited, 2007.
6. E. Rathakrishnan, "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
7. Van Wylen and Sonntag, "Classical Thermodynamics", Wiley Eastern, 1987.

OBJECTIVES

The course aims to

- Learn and understand the principles behind the qualitative and quantitative estimation of biomolecules.
- Understand the quantitative methods in assessing nutritional status of individuals and groups.

LIST OF EXPERIMENTS

1. Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices.
2. Preparation of buffer –titration of a weak acid and a weak base.
3. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.
4. Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from amino acid.
5. Protein estimation by Biuret and Lowry's methods.
6. Protein estimation by Bradford and spectroscopic methods.
7. Extraction of lipids and analysis by TLC.
8. Enzymatic assay phosphatase from potato.
9. Nutritional anthropometry - Standards for reference – WHO, Body Mass Index and reference value
10. Techniques of measuring height, weight, head, chest and arm circumference, waist to hip ratio, skin-fold thickness, Calculation of percent Body fat using skin folds callipers
11. Calculation of the calories from nutrient composition of foods
12. Comparison of Food Composition data bases

TOTAL: 60 PERIODS**OUTCOMES:**

At the end of the course the students will be able to

CO 1 understand the experimental protocols for qualitative and quantitative analysis of biomolecules.

CO 2 familiarize with the calculation of energy values of foods and composition table.

CO 3 gain knowledge of Nutritional anthropometry techniques.

TEXT BOOKS:

1. Gupta. R.C. and Bhargavan. S. Practical Biochemistry. 5th Edition, CBS Publishers and Distributors 2013.
2. David T. Phummer. Introduction of Practical Biochemistry, 3rd Edition. McGraw- Hill Publishing co. 2017.
3. Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3rd Edition. OxfordUniversity Press, 2007.

REFERENCES:

1. R.K. Murray, D.K. Granner, P.A. Mayes and V.W.Rodwell, Harpers Biochemistry.McGraw- Hill Co. 26th Edition. 2003.
2. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Publishers.7th Edition. 2010.
3. .Gibney, Michael J., et al., "Introduction to Human Nutrition". 2nd Edition. Blackwell, 2009.

OBJECTIVE:

- To develop knowledge in handling basic operation equipment's

EXPERIMENTS:

- 1.Flow measurement a) Orifice meter b) Venturimeter, c) Rotameter
- 2.Determination of economy and thermal efficiency of rotary flash evaporator
- 3.Solving problems on single and multiple effect evaporator
- 4.Determination of separation efficiency of centrifugal separator.
- 5.Determination of collection efficiency in cyclone separator.
- 6.Determination of efficiency of liquid solid separation by filtration.
- 7.Determination of absorption efficiency in a packing tower
- 8.Determination of porosity, coefficient of friction and angle of repose of grains.
- 9.Determination of particle size of granular foods by sieve analysis.
- 10.Determination of performance characteristics in size reduction using the burr mill.
- 11.Determination of energy requirement in size reduction using the ball mill and hammer mill.
- 12.Performance evaluation of pin mill and hammer mill.
- 13.Performance evaluation of a steam distillation process.
- 14.Visit to a solvent extraction, sugar industry.

TOTAL: 60 PERIODS**Equipment Needed for 30 Students**

Orifice meter – 1
 Venturi meter-1
 Rotameter-1
 Packed column-1
 Centrifugal separator-1
 Steam distillation unit-2
 Fluidized bed column-1
 Rotary flash evaporator-1
 Cyclone separator-1
 Ball mill-1
 Hammer mill-1
 Burr mill-1
 Pin mill

COURSE OUTCOMES:

- Upon completion of this practical course the student will
- CO1 Have knowledge on the basic principles of chemical engineering and its applications.
- CO2 Be able to apply the skill of material balance and energy balance in unit operations unit process.