# Syllabus for Bachelor of Technology
# In
# Food Engineering and Technology

## (Under the National Education Policy, NEP 2020)
## (2023-2024)


## Department of Food Engineering and Technology
## INSTITUTE OF CHEMICAL TECHNOLOGY

(University Under Section-3 of UGC Act, 1956)

**Elite Status and Center for Excellence**

**Government of Maharashtra**

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## A. Preamble

The undergraduate programmes at the Institute of Chemical Technology are reputed worldwide. Alumni from these programmes have found a place of pride in the Indian chemical industry including some top names and many as entrepreneurs, in Universities/ Institutes and Research Organisations throughout India and the world. The B. Tech. programmes in the then Department of Chemical Technology, University of Mumbai started in 1934 as post B.Sc., second graduation as B.Sc. (Tech.). Keeping national, societal needs in focus, post-independence, the programme grew into multiple branches keeping connection with chemical engineering content. Once the Institute became a university in 2009, these became independent B. Tech. programmes retaining their dual core nature. The Institute of Chemical Technology is committed to keeping its syllabi updated and globally relevant for the industry. We have revamped the syllabi of all the B. Tech. programmes now in 2023 as per NEP 2020. The 176-credit programme each has the following Credit Distribution.

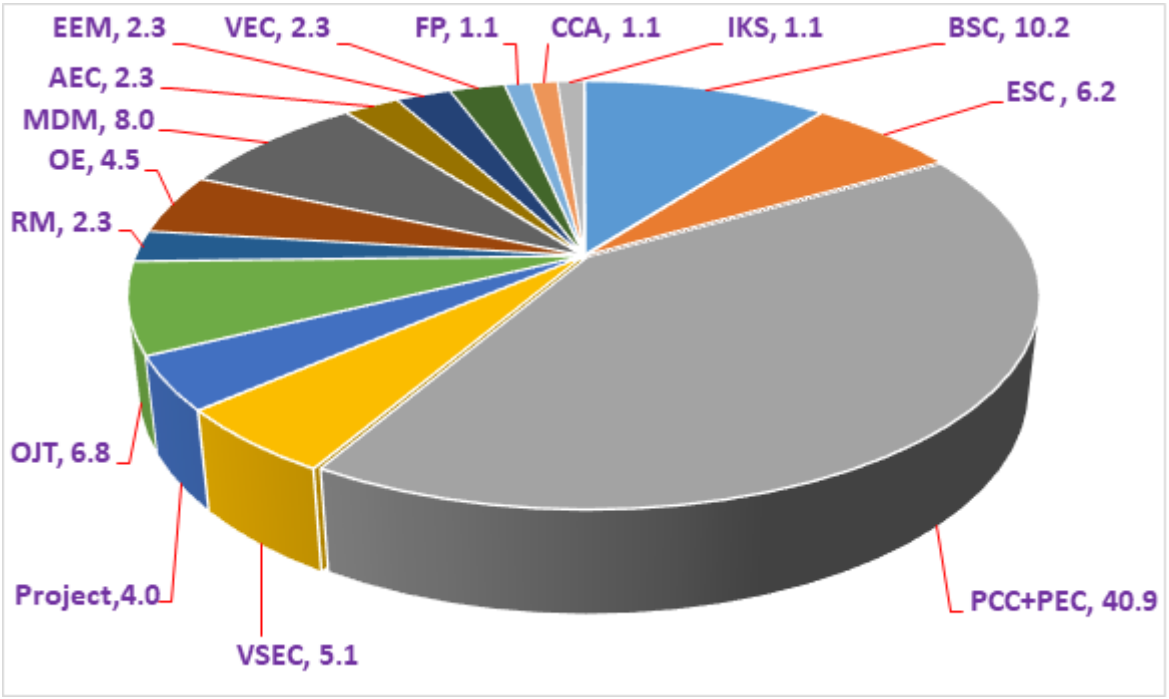


*Figure 1 Distribution of various course types (in percentage) for the programme as per the guidelines of NEP 2020. This distribution does not include honors courses having 18 credits in total.*

All the courses are credit based and the evaluations are grade based. The credit system is a systematic way of describing an educational programme by attaching credits to its components. The definition of credits is based on student workload, learning outcomes and contact hours. This system is described in detail in Regulation No.9 of the Institute. Each theory course consists of Lectures and tutorials. During tutorial session, it is expected that the problem solving / case studies / relevant real-life applications/ student presentations / home assignments/individual or group projects are discussed in the presence of the teacher. Teachers can have the freedom to interchange lectures / tutorials depending upon the topic. The institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation.

## B. Programme Educational Objectives

| | | |
|---|---|---|
| **PEO1** | **Successful Career** | Graduates from the programme will have successful careers in food and allied industries at various levels of management |
| **PEO2** | **Higher Study** | Graduates from the programme will pursue higher study related to food engineering and technology and allied disciplines in premier institutions across the world and make a career in academics or research |
| **PEO3** | **Multi-disciplinary Skills** | Graduates from the programme will work in a multi-disciplinary environment in the domain of food technology. |

## C. Program Outcomes as defined by the National Board of Accreditation (NBA): 12 Graduate Attributes

| | | |
|---|---|---|
| **PO1** | **Engineering knowledge** | Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| **PO2** | **Problem analysis** | Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences |
| **PO3** | **Design/development of solutions** | Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations |
| **PO4** | **Conduct investigations of complex problems** | Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| **PO5** | **Modern tool usage** | Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations |
| **PO6** | **The engineer and society** | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| **PO7** | **Environment and sustainability** | Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development |
| **PO8** | **Ethics** | Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice |
| **PO9** | **Individual and teamwork** | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO10** | **Communication** | Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| **PO11** | **Project management and finance** | Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments |
| **PO12** | **Life-long learning** | Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change. |

## D. Programme Specific Outcomes (PSOs) for B. Tech. (Food Engineering & Technology)

| | |
|---|---|
| **PSO1** | Able to apply analytical techniques for food safety and quality assurance. |
| **PSO2** | Able to translate emerging science in various commodity products and newer technologies. |
| **PSO3** | Able to apply the knowledge in food and nutritional security |
| **PSO4** | Able to translate knowledge of packaging techniques in food system |
| **PSO5** | Able to apply the knowledge of biological sciences in food processing and preservation |
| **PSO6** | Able to apply the knowledge in interdisciplinary areas |

**EXIT Policy**

Based on the National Education Policy guidelines (NEP-2020), the following rules and regulations shall be applicable for the exit from the Degree program where the candidate is currently registered. After the First year, Second Year, and Third Year of the students can exit at each level of their four-year B. Tech Food Engineering and Technology program as follows:

a. A candidate who has earned a total of 44 credits after the first year of the degree course AND completed eight weeks of practical training can exit the degree course with a Certificate in a relevant degree program.
b. A candidate who has earned a total of 88 credits after the second year of the degree course AND has completed eight weeks of practical training/Internship can exit the degree course with Diploma in a relevant degree program.
c. A candidate who has earned a total of 132 credits after the third year of the degree course AND has completed eight weeks of practical training/ Internship can exit the degree with B. Sc (Tech) in a relevant degree program.
d. The candidate shall apply for the exit from the program by this exit policy in a standard format. The letter will be addressed to The Dean, Academic Program. The exit will be permitted only on completion of the training program as prescribed by the Regulations.

| Sr. No. | Exit Year | Activity | Credits | Duration (No of Weeks) |
|---|---|---|---|---|
| 1 | 1st Year (After Semester II) | 8 credit course workshop/chemistry lab (after semester 2) | 8 | 8 weeks |
| 2 | 2nd Year (After Semester IV) | Certificate Course in Practice of Chemical Technology (CCPCT) | 8 | 8 weeks |
| 3 | 3rd Year (After Semester VI) | In-plant training | 8 | 8 weeks |

**Structure of the Syllabus**
**for**
**Bachelor of Technology in Food Engineering and Technology**
**(Under NEP 2020)**
**Institute of Chemical Technology, Mumbai**

| **Semester – I** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subject Code | Subject | Course Type | Credits | Hrs/Week | | | Marks for various Exams | | | |
| | | | | L | T | P | CA | MS | ES | Total |
| CHT1405 | Physical Chemistry | BSC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| CHP1406 | Analytical Chemistry | BSC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| MAT1301 | Engineering Mathematics | ESC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| PYT1205 | Applied Physics | BSC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| GEP1129 | Engineering Graphics and Computer Aided Drafting | VSEC | 3 | 1 | 0 | 4 | - | 30 | 50 | 100 |
| FDT1055 | **SPL-1:** Introduction to Food Science and Technology | ESC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| HUT1110B | Communication Skills | AEC | 2 | 0 | 0 | 4 | 20 | 30 | 50 | 100 |
| XXXXXX | OPEN Activity - Sports/ Fine arts/Yoga/ Music/NSS** | CCA | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| PYP1101 | Physics Laboratory | BSC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| | **Total** | | **22** | **9** | **5** | **16** | - | - | - | 900 |

| **Semester – II** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subject Code | Subject | Course Type | Credits | Hrs/Week | | | Marks for various Exams | | | |
| CHT1407 | Organic Chemistry | BSC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| CHT1408 | Industrial Chemistry | BSC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDT1056 | **SPL-2:** Principles of Food Analysis | PCC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| GET1306 | Basic Mechanical Engineering | ESC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| GET1125 | Electrical Engineering and Electronics | ESC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| CEP1720 | Process Calculations | ESC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| CHP1343 | Physical and Analytical Chemistry Laboratory | BSC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| CHP1132 | Organic Chemistry Laboratory | VSEC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| XXXXXX | OPEN Activity- Sports/ Fine Arts/Yoga/ Music/NSS** | CCA | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| HUT1117 | **MOOC**- Indian Knowledge System | IKS | 2 | 2 | 0 | 0 | 20 | 30 | 50 | 100 |
| | **TOTAL:** | | **22** | **9** | **5** | **16** | - | - | - | 1000 |

**Note:**

- Universal Human Values (UHV) an audit course to be taken in inter-semester break after Semester – II to be taken as MOOC course.
- ** Students will undertake these co-curricular activities such as sports / Fine Arts / Yoga / Music / Literature etc. administered through various clubs under Technological Association approved by Dean, Students Affairs.

| **Semester – III** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subject Code | Subject | Course Type | Credits | Hrs/Week | | | Marks for various Exams | | | |
| | | | | L | T | P | CA | MS | ES | Total |
| FDT1057 | **SPL-3:** Biochemistry and Microbiology | PCC | 4 | 3 | 1 | 0 | 4 | 3 | 1 | 0 |
| FDT1058 | **SPL-4:** Nutrition | PCC | 2 | 1 | 1 | 0 | 2 | 1 | 1 | 0 |
| XXXXXX | From Basic Sciences (Chemistry/ Physics/Biology / Maths / Humanities) | OE | 4 | 3 | 1 | 0 | 4 | 3 | 1 | 0 |
| HUPXXX | Modern Indian Language (Marathi / Hindi or Any other language will be chosen using MOOCS) | AEC | 2 | 0 | 0 | 4 | 50 | 0 | 50 | 100 |
| HUT1205 | Basic Economics and Finance | EEM | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | Value Enhancement in Emerging Areas (NPTEL) | VEC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **MDM-I** | MDM | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDP1013 | **Pr-1:** Lab-1: Food Microbiology | PCC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| FDP1014 | **Pr-2:** Lab 2: Biochemistry | PCC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| | **Total** | | **22** | **10** | **6** | **12** | - | - | - | 900 |

| **Semester – IV** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subject Code | Subject | Course Type | Credits | Hrs/Week | | | Marks for various Exams | | | |
| | | | | L | T | P | CA | MS | ES | Total |
| CET1105 | Transport Phenomena | PCC | 4 | 3 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDT1013 | **SPL-5:** Food Chemistry | PCC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDT1028 | **SPL-6:** Food Safety, Quality and Regulations | PCC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | From Basic Sciences (Chemistry/ Physics/ Biology / Maths) or Humanities Discipline | OE | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| CET1805 | Chemical Process Economics | EEM | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| HUT1206 | Environmental Sciences and Technology | VEC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **MDM-II** | MDM | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | Community Projects # | CEP/ FP | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FDP1036 | **Pr-3:** Lab-3: Technical Analysis Laboratory-1 | VSEC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| | **Total** | | **22** | **11** | **7** | **8** | - | - | - | 900 |

**Note:** # During summer vacation, students will undertake community projects as individual or group related to study of societal technological activities through various organization such as Lions club, Teach India, Marathi Vidnyan Parishad, CSR projects outsourced by various industries, ISR activities administered through Technological Association approved by the Dean, Student Affairs.

| **Semester – V** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subject Code | Subject | Course Type | Credits | Hrs/Week | | | Marks for various Exams | | | |
| | | | | L | T | P | CA | MS | ES | Total |
| CET1806 | Chemical Reaction Engineering | PCC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| CET1807 | Chemical Engineering Operations | PCC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDT1012 | **SPL-7:** Food Additives and Ingredients | PCC | 4 | 3 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **SPL-8:** FET Elective 1 /MOOCs | PEC | 4 | 3 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **MOOCS-**From Basic Sciences or Humanities Discipline | OE | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **MDM-III** | MDM | 4 | 2 | 0 | 4 | 20 | 30 | 50 | 100 |
| FDP1015 | **Pr-4:** Lab 4: Food Chemistry Lab | PCC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| FDP1037 | **Pr-5:** Lab 5: Technical Analysis Laboratory-II | PCC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| FDT1064 | **Honors Course-I** | PCC | 4 | 3 | 1 | 0 | 20 | 30 | 50 | 100 |
| | **TOTAL:** | | **26** | **14** | **6** | **12** | - | - | - | 900 |

| **Semester – VI** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subject Code | Subject | Course Type | Credits | Hrs/Week | | | Marks for various Exams | | | |
| FDT1014 | **SPL-9:** Food Microbiology | PCC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDT1059 | **SPL-10:** Principles of Food Preservation | PCC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **SPL-11:** FET Elective 2 /MOOCs | PEC | 4 | 3 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDT1025 | **SPL-12:** Technology of Dairy and Animal Products | PCC | 4 | 3 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **MDM IV** | MDM | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| CEP1714 | Chemical Engineering Laboratory | VSEC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| FDP1018 | **Pr-6:** Lab-6 Food Analysis Lab I | PCC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| - | **Pr-7:** FET Elective 3 /MOOCs | PEC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| FDT1027 | **Honors Course-II** | PCC | 4 | 3 | 1 | 0 | 20 | 30 | 50 | 100 |
| | **TOTAL:** | | **26** | **14** | **6** | **12** | - | - | - | 900 |

| Semester – VII | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subject Code | Subject | Course Type | Credits | Hrs/Week | | | Marks for various Exams | | | |
| | | | | L | T | P | CA | MS | ES | Total |
| FDT1023 | **SPL-13**: Technology of Cereals, Legumes and Oilseeds | PCC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDT1061 | **SPL-14:** Technology of Plantation Products-I | PCC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **SPL-15:** FET Elective 4 /MOOCS | PEC | 3 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **SPL-16:** FET Elective 5 /MOOCS | PEC | 2 | 2 | 0 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **MDM-V** | MDM | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDP1038 | Literature Review (Research Methodology I) | RM-1 | 2 | 1 | 0 | 2 | 20 | 30 | 50 | 100 |
| FDP1039 | Design and Analysis of Experiments (Research Methodology II) | RM-2 | 2 | 1 | 0 | 2 | 20 | 30 | 50 | 100 |
| FDP1040 | Project-I (Literature Search + Expt) | Project | 4 | 0 | 0 | 8 | - | 50 | 50 | 100 |
| FDP1021 | **Pr 8:** Lab 8: Food Analysis-II | PCC | 2 | 0 | 0 | 4 | - | 50 | 50 | 100 |
| FDP1041 | **Honors Course-III** | PCC | 4 | 0 | 0 | 8 | - | 50 | 50 | 100 |
| | **Total** | | **26** | **10** | **4** | **24** | - | - | - | 1000 |

| Semester – VIII (10 Weeks) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subject Code | Subject | Course Type | Credits | Hrs/Week | | | Marks for various Exams | | | |
| | | | | L | T | P | CA | MS | ES | Total |
| FDT1017 | **SPL-17:** Technology of Fruits, Vegetables and Tubers | PCC | 3 | 5 | 1 | 0 | 20 | 30 | 50 | 100 |
| XXXXXX | **MDM VI** | MDM | 2 | 2 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDP1041 | Project-II (Experiments) | PCC | 3 | 0 | 0 | 16 | 50 | 0 | 50 | 100 |
| - | **SPL-18:** FET Elective 5 /MOOCs | PEC | 2 | 1 | 1 | 0 | 20 | 30 | 50 | 100 |
| | | | | | | | | | | |
| FDT1066 | **Honors Course-IV** | PCC | 3 | 5 | 1 | 0 | 20 | 30 | 50 | 100 |
| FDT1067 | **Honors Course-V** | PCC | 3 | 5 | 1 | 0 | 20 | 30 | 50 | 100 |
| **Semester – VIII (12-16 Weeks)** | | | | | | | | | | |
| FDP 1042 | Internship with Industry (12-16 Weeks) | Internship/ On Job Training Project | 12 | 0 | 0 | 0 | 50 | 0 | 50 | 100 |
| | **Total** | | **28** | **18** | **5** | **16** | - | - | - | 700 |

**BSC**: Basic Science Course,
**ESC**: Engineering Science Course

**PCC**: Program Core Course, PEC: Program Elective Course
**MDM**: Multi-disciplinary Minor: Different discipline of engineering or different faculty altogether
**OE**: Open Elective: To be chosen compulsorily from faculty other than major discipline
**VSEC**: Vocational and Skill Enhancement Course: Hands on training corresponding to major/minor
**AEC**: Ability Enhancement Course: English 2 credit, Modern Indian Language 2 credit
**IKS**: Indian Knowledge System: Indian Architecture/Maths/Medicine
**VEC**: Value Enhancement Course: e.g. Understanding India, Environmental Science / Education / Digital and Tech solutions
**RM**: Research Methodology
**CCA**: Co-curricular activities: Health and wellness / Yoga / Sports / Cultural activities / NSS/NCC/Applied visual performing arts
**EEM:** Entrepreneurship/Economics/Management

## E. Detailed Syllabus

# FIRST YEAR: SEMESTER – I

| BSC | Course Code: CHT 1405 | Course Title: Physical Chemistry | Credits = 3 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: I | Total contact hours: 45 | 2 | 1 | 0 |

| | |
|---|---|
| | |
| **List of Prerequisite Courses** | |
| Standard XII Chemistry | |
| **List of Courses where this course will be prerequisite** | |
| Multidisciplinary courses on Chemistry/Chemical Engineering. | |
| **Description of relevance of this course in the B. Tech. Program** | |
| The course will enable the students to understand and apply the principles of thermodynamics to real-world systems. The students would be able to apply the insights to understand the stability of solutions, spontaneity of physical/chemical processes, effect of thermodynamics parameters on phase and chemical equilibria, etc. | |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | **Laws of thermodynamics** –<br>a) Enthalpy and heat capacities, application of first law to gases, thermochemistry- Hess law<br>b) Statements and applications of second law of thermodynamics, Clausius inequality, entropy as a state function, entropy changes for reversible and irreversible processes, entropy and probability<br>Third law of thermodynamics, absolute entropies, verification of third law | 06 |
| 2 | **Spontaneous process and equilibrium** –Helmholtz and Gibbs free energy, spontaneity and free energy, Maxwell's relations, effect of T and P on free energy | 03 |
| 3 | **Multicomponent system –** free energy and entropy of mixing, partial molar quantities and chemical potential, Gibbs Duhem equation | 06 |
| 4 | **Equilibrium in solutions –** ideal and non-ideal solutions, Henry's law and Raoult's law, colligative properties, activity and activity coefficients, thermodynamic properties of electrolytes in solution | 07 |
| 5 | **Solubility equilibria** – solubility constant, common ion effect, effect of added salts on solubility pH, weak and strong acids and bases, buffer solutions, ionic solutions<br>**Chemical Equilibria –** le Chaterlier's principle, Effect of temperature, pressure and composition on equilibrium | 05 |
| 6 | **Introduction** – concept of reaction rates and order, experimental methods in kinetic studies, differential and integral methods to formulate rate equations of zero, first and second order reactions<br>Experimental methods of kinetic studies | 03 |
| 7 | **Kinetics and reaction mechanism** – rate determining step, steady state approximation<br>**Complex reactions**- parallel, consecutive and reversible reactions<br>Mechanism of thermal, photochemical chain reactions, polymerization reactions<br>**Fast reactions –** experimental techniques | 06 |
| 8 | **Homogenous catalysis** – homogeneous acid / base catalysis (specific and general acid catalysis), enzyme catalysis (Michelis Menten kinetics) | 06 |
| 9 | **Reactions at interface –** Adsorption isotherms, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions | 03 |
| | **Total** | **45** |

| | **List of Textbooks/ Reference Books** |
|---|---|
| 1 | Atkins, Peter W.; Paula, Julio de; Keeler, James. Atkin's Physical Chemistry; 11th ed.; Oxford University Press (2018) |

| | | |
|---|---|---|
| 2 | Elements of Physical Chemistry (7th edition) by P. W. Atkins and J. de Paula, Oxford University Press, 2016. | |
| 3 | Chemical Kinetics (3rd edition) by Keith J. Laidler, New York : Harper & Row, 1987. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Understand the concepts of thermodynamics and relate them to measurable quantities | K2 |
| CO2 | Elucidate the effect of thermodynamic quantities on physical and chemical equilibria | K4 |
| CO3 | Correlate the thermodynamic properties of chemical systems with the observed outcomes and predict the optimum conditions | K3 |
| CO4 | Comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect | K2 |
| CO5 | Examine kinetics for complex, fast and interfacial reactions | K3 |
| CO6 | Comprehend different theories in kinetics to explain the molecular origin of kinetic phenomena | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 0 | 0 | 1 | 0 | 2 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 0 | 0 | 1 | 0 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 0 | 1 | 0 | 1 |
| CO6 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 2 | 1 | 1 | 2 |
| CO2 | 2 | 1 | 1 | 0 | 0 | 1 |
| CO3 | 2 | 2 | 2 | 1 | 1 | 1 |
| CO4 | 2 | 2 | 2 | 1 | 1 | 2 |
| CO5 | 2 | 1 | 2 | 0 | 0 | 2 |
| CO6 | 2 | 1 | 1 | 1 | 1 | 2 |

| **BSC** | **Course Code: CHT 1406** | **Course Title: Analytical Chemistry** | **Credits = 3** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: I** | **Total contact hours: 45** | **2** | **1** | **0** |

| **List of Prerequisite Courses** | |
|---|---|
| Standard XII Chemistry | |
| **List of Courses where this course will be prerequisite** | |
| Food Chemistry Laboratory, Technical Analysis Lab | |
| **Description of relevance of this course in the B. Tech. Program** | |
| The course introduces the students to key concepts of chemical analysis – sampling, selection of analytical method and data analysis. It presents basic techniques like spectroscopy and chromatography. The students should be able to select an appropriate analytical technique and apply it in accordance with its strengths and limitations. | |
| **Course Contents (Topics and subtopics)** | **Required Hours** |

| | | |
|---|---|---|
| 1 | Introduction to chemical analysis, terminology (technique / method / procedure / protocol), broad classification of analytical techniques, good laboratory practices | 05 |
| 2 | Criteria for selecting analytical methods – accuracy, precision, sensitivity, selectivity, and detection limit<br>Calibration and validation | 08 |
| 3 | **Data analysis**: errors – systematic and random errors, statistical treatment of experimental results (F, Q and t tests, rejection of data, and confidence intervals), least square method, correlation coefficients | 06 |
| 4 | **Spectroscopic methods**: General principle, instrumentation and applications of<br>- UV-visible spectroscopy<br>- Infrared spectroscopy<br>- Fluorescence spectroscopy | 08 |
| 5 | **Electrochemical methods:** General principle, instrumentation and applications of<br>- Conductometry<br>- Potentiometry | 08 |
| 6 | **Chromatographic methods:** General principle, instrumentation and applications of<br>- Gas chromatography (GC)<br>- HPLC | 10 |
| | **Total** | **45** |

| **List of Textbooks/ Reference Books** | |
|---|---|
| 1 | David Harvey. Modern Analytical Chemistry; McGraw-Hill (1999) |
| 2 | R. A. Day and A. L. Underwood. Quantitative Analysis, Prentice Hall of India (2001) |
| 3 | H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle. Instrumental Methods of Analysis, 7th ed.; Wadsworth Publishing, USA (2004) |
| 4 | D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch. Fundamentals of Analytical Chemistry; 9th ed.; Cengage Learning (2013) |
| 5 | D. A. Skoog, F. James Holler and S. R. Crouch. Principles of Instrumental Analysis; 6th ed.; Cengage Learning (2016) |

| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Explain the principles of UV-visible and fluorescence spectroscopic methods | K3 |
| CO2 | Explain the principles of electrochemical methods | K3 |
| CO3 | Understand the principles of chromatographic separations | K3 |
| CO4 | Evaluate the results of chemical analysis in terms of accuracy and precision | K4 |
| CO5 | Apply the principles of sampling to design an optimum analytical protocol | K4 |
| CO6 | Identify conditions to minimize the error and increase the sensitivity of analysis | K5 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 1 |
| CO2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 0 | 1 |
| CO3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 0 | 1 | 1 | 0 | 1 |
| CO4 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 0 | 1 |
| CO5 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| CO6 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 1 | 1 | 2 |
| CO2 | 1 | 2 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 2 | 2 | 1 | 2 | 1 |
| CO4 | 1 | 2 | 1 | 2 | 1 | 2 |
| CO5 | 1 | 2 | 1 | 1 | 1 | 2 |
| CO6 | 1 | 2 | 1 | 1 | 1 | 2 |

| | **Course Code: MAT 1301** | **Course Title: Engineering Mathematics** | **Credits = 3** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: I** | **Total contact hours: 45** | **3** | **0** | **0** |

**List of Prerequisite Courses**

HSC Standard Mathematics

**List of Courses where this course will be prerequisite**

This is a basic Mathematics course. This knowledge will be required in almost all subjects later.

**Description of relevance of this course in the B. Tech. Program**

This is a basic Mathematics course which will give the students the required foundations of mathematics to understand engineering concepts in the later part of the technology programs in ICT Mumbai. This course will also introduce probability distributions and basic statistics will be helpful to understand various data science studies in different engineering disciplines.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | **Linear Algebra:** Vectors in $\mathbb{R}^n$, notion of linear independence and dependence. $\mathbb{R}^n$ as a vector space, vector subspaces of $\mathbb{R}^n$, basis of a vector subspace, row space, null space, and column space, rank of a matrix. Determinants and rank of matrices.<br>Linear transformations in $\mathbb{R}^n$ , Matrix of a linear transformation, change of basis and similarity, rank-nullity theorem, and its applications.<br>Inner product spaces, orthonormal bases, Gram-Schmidt orthogonalization process, Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special Orthogonal projection and its application to least square methods, Diagonalization of matrices and its applications to stochastic matrices | 15 |
| 2 | **Differential Calculus:** Higher order differentiation and Leibnitz Rule for the derivative, Taylor's and Maclaurin's theorems, Maxima/Minima, convexity of functions and applications.<br>Functions of two or more variables, Limit and continuity, Partial differentiation, Total derivatives, Taylor's theorem for multivariable functions and its application to error calculations, Maxima/Minima, Method of Lagrange Multipliers, Introduction to double and triple integrals. | 15 |
| 3 | **Probability & Statistics:** Random variables and cumulative distribution function; probability mass function and probability density function; Some common univariate distributions: Binomial, Poisson, Uniform, exponential, Normal; Expectation and Moments; Moment generating function, Multiple random variables, and Joint distribution; marginal distributions, Covariance and Correlation.<br>Concept of parameter estimation: maximum likelihood estimation; method of least squares and simple linear regression; nonlinear regression | 15 |
| | **Total** | **45** |

**List of Textbooks/ Reference Books**


| | |
|---|---|
| 1 | G. Strang, Linear Algebra and its Applications (4th Edition), Thomson (2006). |
| 2 | Howard Anton, Elementary Linear Algebra, John Wiley & Sons (2016) |

| | |
|---|---|
| 3 | Stewart, James, Single Variable Calculus, 6th Edition, Cenage learning (2016) |
| 4 | Hughes-Hallett et al., Calculus - Single and Multivariable (3rd Edition), John-Wiley and Sons (2003). |
| 5 | E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999). (Officially prescribed) |
| 6 | S. R. K. Iyengar, R. K. Jain, Advanced Engineering Mathematics Narosa, (2020) |
| 7 | A First Course in Probability, Sheldon Ross, Pearson Prentice Hall, 9th Edition (2018) |
| 8 | W.W. Hines, D. C. Montgomery, D.M. Goldsman, John-Wiely, Probability and Statistics in Engineering, John Wiley & Sons (2008) |
| 9 | Alexander M. Mood, Duane C. Boes, and Franklin A. Graybill, Introduction to the Theory of Statistics, Mc GrawHill, (1973) |


| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Understand the notion of differentiability and be able to find maxima and minima of functions of one and several variables. | K3 |
| CO2 | Understand the notion of integrability and be able to compute multiple integrals and apply them in engineering applications. | K3 |
| CO3 | Understand the computational and geometrical concepts related to linear transformations, eigenvalues and eigenvectors and apply them to solve computational problems | K3 |
| CO4 | Demonstrate understanding of different concepts in linear algebra in solving computational problems related to vectors and matrices and apply them to solve problems arising the Engineering especially in AI and ML. | K4 |
| CO5 | Understand the concepts of various probability distributions and apply them to analyze various engineering problems and make inference about the system | K3 |
| CO6 | Understand the method of linear and nonlinear least squares method and apply it to choose appropriate mathematical functions for modelling real data sets, arising from engineering disciplines | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| CO3 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| CO4 | 2 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| CO6 | 2 | 3 | 3 | 1 | 2 | 1 | 0 | 0 | 3 | 1 | 0 | 3 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 0 | 1 | 1 | 0 | 1 |
| CO2 | 2 | 1 | 1 | 2 | 0 | 2 |
| CO3 | 1 | 0 | 2 | 1 | 0 | 1 |
| CO4 | 2 | 1 | 1 | 2 | 0 | 2 |
| CO5 | 1 | 0 | 1 | 1 | 0 | 2 |
| CO6 | 2 | 1 | 1 | 2 | 0 | 0 |

| **BSC** | **Course Code: PYT 1205** | **Course Title: Applied Physics** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: I** | **Total contact hours: 30** | **2** | **0** | **0** |

| | | |
|---|---|---|
| | | |
| **List of Prerequisite Courses** | | |
| Standard XI and XII Physics and Chemistry Course | | |
| **List of Courses where this course will be prerequisite** | | |
| NIL | | |
| | | |
| **Description of relevance of this course in the B. Tech. Program** | | |
| The physics of solids and fluids play a key role in the various areas of chemical technology. The Applied Physics course will provide the students with the necessary fundamentals to develop a broad understanding of various aspects related to solids and fluids, and thereby equip them with the ability to apply it wherever required in their course of study. | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| *Solid State Physics* | | |
| 1 | Crystal Structure of Solids: A revision of concepts of a lattice, a basis, unit cell, different crystal systems (SC, BCC, FCC, HCP), co-ordination number and packing fractions. Single crystalline, Polycrystalline, and Amorphous materials. | 03 |
| 2 | Crystallographic planes and directions: concept of Miller indices and its determination, examples; calculation of inter-planar spacing in terms of Miller indices. | 03 |
| 3 | Determination of crystal structure using X-rays: Bragg's law of X-ray diffraction, types of diffractometers, Indexing diffraction peaks and calculation of various lattice parameters and crystallite size | 04 |
| 4 | Energy band in solids and classification of solids, the concept of Fermi level and Fermi distribution function, Intrinsic and extrinsic semiconductors, Transport properties of semiconductors: Conductivity in semiconductors and its dependence of carrier concentration and mobility. | 05 |
| *Physics of Fluids* | | |
| 5 | A revision of the basic concepts of hydrostatics and ideal fluid flow: Equation of continuity and Bernoulli's equation. | 04 |
| 6 | The concept of viscosity, Newton's law of viscosity, Reynold's number, Poiseuille's equation for streamline flows | 04 |
| 7 | An introduction to Rheology: Parameters of viscous flows, Newtonian and non-Newtonian behaviour, Variation of viscosity with shear rate, shear time, temperature, and pressure (qualitative ideas with illustrative examples), measuring properties of viscous flows. | 07 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Fundamentals of Physics – Halliday, Resnick, Walker – 6th Edition – John Wiley | |
| 2 | Sears and Zeemansky's University Physics – Young and Freedman – 12th Edition – Pearson Education | |
| 3 | A Textbook of Engineering Physics – M N Avadhanulu, P G Kshirsagar, TVS Arun Murthy – 11th Edition – S. Chand Publishers | |
| 4 | Solid State Physics – S. O. Pillai – 10th Edition – New Age Publishers | |
| 5 | Solid State Physics – A. J. Dekker – MacMillan India | |
| 6 | Engineering Physics – V Rajendran – 6th Edition – McGraw Hill Publishers | |
| 7 | Introduction to Rheology – H. A. Barnes, J. F. Hutton and K. Walters – 4th Edition – Elsevier Science. | |
| 8 | Viscoelastic Properties of Polymers – J. D. Ferry – 3rd Edition – Wiley | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Assign Miller indices to various crystallographic planes and directions in a crystal lattice, thereby understand periodicity in the crystal lattice. | K4 |
| CO2 | Analyze a given x-ray diffraction pattern to deduce the crystal structure of the material and calculate the values of the basic structural parameters. | K4 |

| | | |
|---|---|---|
| CO3 | Classify solids, and in turn semiconductors, based on electron occupancy and calculate basic quantities related to charge transport in them. | K3 |
| CO4 | Analyze simple ideal fluid flows by applying the continuity equation and Bernoulli's equation. | K3 |
| CO5 | Describe the basic behaviour of viscous flows and the relationships between various flow parameters. | K4 |
| CO6 | Understand simple models that are used to describe viscoelastic flows. | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO4 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO5 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 3 |
| CO6 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 3 | 1 | 0 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 0 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 2 | 1 |
| CO4 | 2 | 3 | 3 | 2 | 1 | 2 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 3 |
| CO6 | 3 | 2 | 2 | 2 | 0 | 2 |

| **VSEC** | **Course Code: GEP1129** | **Course Title: Engineering Graphics and Computer Aided Drawing** | **Credits = 3** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: I** | **Total contact hours: 75** | **1** | **0** | **4** |

**List of Prerequisite Courses**

Standard XII Mathematics

**List of Courses where this course will be prerequisite**

Professional Career (Industrial drawing, Equipment Design, Manufacturing and designing of any component, industrial 3D product modelling etc.)

**Description of relevance of this course in the B. Tech. Program**

Drawing is a language used by engineers and technologists. A student is required to know the various processes and the equipment used to carry out the processes. Some of the elementary areas like product sizing, manufacturing etc., are very common to all the branches of technology. These and many other processes require machines and equipment's. One should be familiar with the design, manufacturing, working, maintenance of such machines and equipments. The subject of "drawing" is a medium through which, one can learn all such matter, because the "drawings" are used to represent objects and various processes on the paper. Through the drawings, a lot of accurate information is conveyed which will not be practicable through a spoken word or a written text. This course is required in many subjects as well as later in the professional career.

| **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|

| | | |
|---|---|---|
| 1 | **Orthographic projections:** Introduction, Principles of Projection, Methods of Projection, Planes of projection, Quadrants, First-angle method of projection, Third-angle method of projection, and concept of orthographic projections. | 15 (3L+12P) |
| 2 | **Sectional Projections and Missing Views:** Need for the drawing sectional views, concept of sectioning and section lines, Sectional drawings of different solids and machine components, Auxiliary planes, and views. | 15 (3L+12P) |
| 3 | **Missing Views:** Concept of recognizing missing views and their interpretation, drawing of missing views from given orthographic drawings. | 10 (2L+8P) |
| 4 | **Isometric projections:** Concept of isometric views, isometric projections and isometric scale, Iso metric projections of different solids and machine components | 10 (2L+8P) |
| 5 | **Computer Aided Drafting and Assembly drawing:** Basic introduction to CAD softwares, Design and Development of new products, Application of CAD, 2D, 3D part modelling on softwares, drawing modification and dimensioning, modelling of different machine components. Basics of Assembly drawing, preparation of 2D, 3D components and assembling on CAD software, conversions, labelling and table creation for bill of materials. | 25 (5L+20P) |
| | **Total** | **75** |

| **List of Textbooks/ Reference Books** | |
|---|---|
| 1 | Engineering Drawing by N.D.Bhat |
| 2 | Engineering Drawing by N.H.Dubey |
| 3 | CAD/CAM: Theory and Practice by Ibrahim Zeid and R Sivasubramanian |

| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Draw Orthographic Projections of Solid objects. | K4 |
| CO2 | Draw Third view of solid object when two views are given | K4 |
| CO3 | Draw isometric Projections of Solid objects. | K4 |
| CO4 | Draw assembly of various machine components | K4 |
| CO5 | Understand basic commands of CAD software | K2 |
| CO6 | Use CAD software for drafting and editing 2 dimensional drawings | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CO2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CO3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CO4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CO5 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 3 |
| CO6 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 3 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 1 | 0 | 1 | 1 | 0 | 1 |
| CO3 | 2 | 0 | 1 | 2 | 2 | 2 |
| CO4 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO5 | 1 | 0 | 1 | 1 | 2 | 1 |
| CO6 | 2 | 0 | 1 | 1 | 0 | 2 |

| **ESC** | **Course Code: FDT 1055** | | **Credits = 2** |
|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| | | **Course Title: SPL-1: Introduction to Food Science and Technology** | **L** | **T** | **P** |
| | **Semester: I** | **Total contact hours: 30** | **1** | **1** | **0** |

| | |
|---|---|
| **List of Prerequisite Courses** | |
| None | |
| **List of Courses where this course will be prerequisite** | |
| Food Chemistry, Food additives and ingredients, Food Microbiology, Technical Analysis Lab, Food Chemistry Lab | |
| **Description of relevance of this course in the B. Tech. Program** | |
| This basic course will be useful for getting better understanding about physico-chemical properties and chemical structures of food constituents, method of preparation and applications of food constituents. This course will provide important knowledge about mechanism of the reactions of food constituents taking place during food processing and storage, role of food constituents responsible for nutritional/anti-nutritional and aesthetic quality of foods (such as texture, flavor, and color). | |

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | An introduction to food resources and its general composition. Proximate analysis of foods, water in food systems – concept of free and bound water, water activity and its impact on food preservation and storage. Basic concept of taste, colour, flavour and texture, sensory analysis, anti-nutritional constituents in foods. | 04 |
| 2 | Carbohydrates- classification, structure, properties. Chemical reactions such as caramelization, Maillard reaction, and dehydration; identification and estimations; Sucrose – manufacture from sugar cane and sugar beet; hydrolysis of sucrose (inversion), Starches – isolation from varied sources; amylose/amylopectin, size/shape, gelatinization, gelation, retrogradation, pasting behaviour, functional properties, modification; Commercially important products – glucose, glucose syrup, high fructose corn syrup, maltodextrins.<br>Glycosides in nature; pectin – structure, gelling behaviour of HMP vs. LMP, sources-manufacture and applications; Cellulose and other components of dietary fibre, hydrocolloids (plant/seaweed/ microbial polysaccharides), mucopolysaccharides; chitin and chitosan – sources, structure, manufacture and applications. | 09 |
| 3 | Proteins- chemistry of amino acids, structure, classification and their properties (isoelectric pH, solubility profile), special amino acids, non-protein amino acids; Peptides, bioactive peptides; Classification of proteins; protein structure (primary, secondary, tertiary and quaternary); Denaturation of proteins; determination of primary sequence, quantitative estimation of amino acids and proteins in foods; functional properties of proteins, isolation and purification methods for proteins; Isolation of food proteins (soya, fish, whey); Maillard browning; concept of modified proteins; Major food protein systems (milk, egg, wheat, meat) | 09 |
| 4 | Chemistry of lipids- fatty acids, mono-, di and triacylglycerols; Classification of lipids-simple, compound and derived; unsaponifiable constituents of lipids such as sterols and hydrocarbons and waxes; Nutritional overview on fats and oils. | 08 |
| | **Total** | **30** |

| | **List of Textbooks/ Reference Books** |
|---|---|
| 1 | Belitz, H.D, Grosch, W., & Schieberle, P. Food Chemistry; 3rd ed.; Springer, Germany; 2005. |
| 2 | Damodaran, S., & Parkin, K.L. Fennema's Food Chemistry; 5th ed.; CRC Press, Boca Raton; 2017. |
| 3 | Velisek, J., The Chemistry of Food; Wiley-Blackwell; 2013. |
| 4 | Meyer, L.H., Food Chemistry. Cbs Publisher; 2004. |
| 5 | Velisek, J., Koplik, R., Cejpek, K. The Chemistry of Food; 2nd ed.; Wiley-Blackwell; 2020 |

**Course Outcomes (students will be able to….)**

| | | |
|---|---|---|
| CO1 | Describe the various constituents present in foods and their roles therein and solve practical problems in food quality | K3 |
| CO2 | Describe the properties, method of preparation and applications of food constituents | K2 |
| CO3 | Describe the mechanisms and significance of physicochemical reactions involved in food processing and storage | K2 |
| CO4 | Explain the significance of water in food quality, preservation and storage | K2 |
| CO5 | Describe and demonstrate the role of food constituents on nutritional/anti-nutritional and aesthetic quality of raw and processed foods | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 2 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 1 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 1 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 1 | 3 |
| CO6 | 2 | 2 | 2 | 2 | 1 | 2 |

| **BSC** | **Course Code: PYP 1101** | **Course Title: Physics Laboratory** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: I** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

Applied Physics

**List of Courses where this course will be prerequisite**

NIL

**Description of relevance of this course in the B. Tech. Program**

The hands-on experience gained by the students in the Applied Physics laboratory course will equip them with basic experimental skills related to measurement of various important physical quantities. These skills will act as a useful foundation for other laboratory and theory courses in their area of specialization.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Determination of Co-efficient of Viscosity by Poiseuille's method | 4 |
| 2 | Thermistor characteristics: Determination of Bandgap of a semiconductor | 4 |
| 3 | Determination of compressibility of liquids using an Ultrasonic Interferometer | 4 |
| 4 | Measurement of thermal conductivity of a solid: Lee's disc method | 4 |
| 5 | Photoelectric effect: Determination of h/e | 4 |
| 6 | Hall effect-I (sample current variation) Determination of carrier type and concentration in a semiconductor | 4 |

| | | |
|---|---|---|
| 7 | Hall effect-II (magnetic field variation) Determination of carrier type and concentration in a semiconductor | 4 |
| 8 | Newton's rings: Determination of wavelength of light | 4 |
| 9 | Laser Diffraction: Determination of particle size | 4 |
| 10 | Studying variation of compressibility of liquid as function of temperature | 4 |
| 11 | Estimating resistivity of semiconductor using four probe method | 4 |
| 12 | Determination of magnetic susceptibility of paramagnetic liquid using Quincke's method | 4 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Fundamentals of Physics - Halliday, Resnick, Walker - 6th Edition - John Wiley | |
| 2 | Sears and Zeemansky's University Physics - Young and Freedman - 12th Edition - Pearson Education | |
| 3 | Engineering Physics - V Rajendran - 6th Edition - McGraw Hill Publishers | |
| 4 | Fundamentals of Optics - F. Jenkins and H. White - 4th Edition McGraw Hill | |
| 5 | ICT Physics Laboratory Manual (supplied to students) | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Independently set up, handle, and use basic setups to measure and obtain various physical quantities. | K4 |
| CO2 | Use basic instruments like vernier-caliper, screw-gauge, travelling microscope, thermometer, etc. to make accurate measurements. | K4 |
| CO3 | Correlate and use directly measured quantities to obtain the relevant parameters through appropriate formulae, calculations, and/or graphical plotting, thereby understand the measurement principle involved in the experimental setups. | K3 |
| CO4 | Preliminarily treat the obtained datasets statistically to obtain errors in the experiments. | K5 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 1 | 1 | 0 |
| CO2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 1 | 1 | 0 |
| CO3 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| CO4 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 3 | 2 | 0 | 1 |
| CO2 | 3 | 3 | 3 | 1 | 1 | 0 |
| CO3 | 3 | 1 | 2 | 2 | 0 | 0 |
| CO4 | 2 | 2 | 3 | 1 | 2 | 1 |

| **AEC** | **Course Code: HUT 1110B** | **Course Title: Communication Skills (English)** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: I** | **Total contact hours: 60** | **0** | **0** | **4** |
| | | | | | |
| **List of Prerequisite Courses** | | | | | |
| Standard XII$^{th}$ English | | | | | |
| **List of Courses where this course will be prerequisite** | | | | | |

| All courses in this and subsequent semesters | | |
|---|---|---|
| **Description of relevance of this course in the B. Tech. Program** | | |
| This is an important course for the effective functioning of an Engineer and a Technologist. Communication skills are required in all courses and professional career. | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | Communication as a way of life<br>Process of communication and its elements<br>Functions of communication and importance in future careers<br>Essentials of good communication | 6 |
| 2 | The communication cycle<br>The 5 step communication cycle:<br>Idea formation<br>Message encoding<br>Message transmission<br>Decoding<br>Feedback | 4 |
| 3 | Factors affecting effective communication<br>Planning for effective communication<br>Modes of communication | 3 |
| 4 | Non verbal communication<br>Gestures<br>Facial expressions<br>Posture and movement<br>Paralinguistics<br>Eye contact<br>Image management | 4 |
| 5 | Presentation skills<br>What makes good presentation<br>Prsenting the message<br>Presenting oneself<br>Visual Communication | 8 |
| 6 | Introduction to research study<br>Introduction to databases<br>Introduction to citation and referencing styles<br>How to conduct literature review<br>Preparation of a report based on literature review | 5 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Elements of Style – Strunk and White | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Student would be able to illustrate the 5 step communication process | K2 |
| CO2 | Student would be able to explain the end goal of communication | K2 |
| CO3 | Student would be able to explain barriers to clear communication | K2 |
| CO4 | Student would be able to articulate the role of visual communication within society and implement the creative process to express himself/herself. | K2 |
| CO5 | Student would be able to identify the most relevant textbooks, reviews, papers and journals | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 | 2 | 3 |
| CO2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 | 2 | 3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 | 2 | 3 |
| CO4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 | 2 | 3 |
| CO5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 | 2 | 3 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO3 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO4 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO5 | 0 | 0 | 0 | 0 | 0 | 0 |

| **CCA** | **Course Code: XXXXXXX** | **Course Title: Yoga and Self Development** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: I** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

It may be necessary to gather some basic information about the students, such as their age, marital status, academic schedules, and recreational activities, whether they have any sleep issues and stress because of any situation. It shall be better to know how the students deal with stress, and whether they have proper nutrition. We also might need information about any injuries past or current and any other medical condition that may interfere in the program.

**List of Courses where this course will be prerequisite**

Applicable throughout professional and personal lives

**Description of relevance of this course in the B. Tech. Program**

Yoga is not course but a journey. The benefits of Yoga are many. It brings in calmness of mind besides the physical fitness by doing Yoga Aasanas. Apart from flexibility developed by regular physical activities, it makes one aware of his own potential. Professional and personal lives are full of situations that can be stressful. Yoga helps the students to withstand the stress coming from the expectations and demands of their own lives.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | **Yoga**<br>The principles and foundations of yoga. Both concentrative and insight meditation techniques may be practiced for each session. Behavioural techniques of self-monitoring should also be practiced observing the stream of consciousness from the perspective of a vigilant but detached observer.<br>The students shall be trained to practice different models of mindfulness and meditation so as to elicit a state of deep physical and behavioural relaxation. They may work on selectively influencing or changing the symmetry in hemispheric brain activity. Positive addiction, meta-cognitive practices etc. are exercised to make the students experience the universal human capacity through spiritual experiences. The students may learn to turn-off or bypass the cognitive processing of usual daily preoccupations and concerns, allowing access to mindful, spiritual and meditative state of self-realization<br>The students shall keep a small journal to write down their own journey/progress on physical flexibility, strength building and most importantly, how they deal with stressful conditions. This record will form the paper assessment of the student.<br>Yoga helps to develop many mental skills like mindfulness, self-control, focus, and even self-compassion. It's mainly a physical practice. The students are taken through different movements and poses during the yoga sessions. | 40 |

| | | |
|---|---|---|
| 2 | **Assessment: The** following assessments are recommended:<br>Regular attendance<br>**Paper Assessment**: A paper assessment may include assessing student's understanding of the basic philosophy of yoga<br>Verbal Assessment on the basis of his/her ability to assimilate the philosophy of yoga and practicing in daily life.<br>Mobility & Flexibility assessment is to assess the strength and flexibility, like twist. | 20 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata | |
| 2 | RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakashan, Delhi 2016 | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Keep physically fit and mentally agile | K2 |
| CO2 | Manage stress in studies and later in life | K2 |
| CO3 | Coordinate body and mind together | K2 |
| CO4 | Understand own emotions and maintain healthy daily routine | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 2 |
| CO2 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 2 |
| CO3 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 2 |
| CO4 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 2 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 1 | 1 | 1 | 1 | 1 | 1 |

| **Course Code:** | **Course Title: Fine Arts and Performing Arts** | **Credits = 2** | | |
|---|---|---|---|---|
| | | **L** | **T** | **P** |
| **Semester: I** | **Total contact hours: 30** | **2** | **0** | **0** |

| **List of Prerequisite Courses** |
|---|
| NIL |
| **List of Courses where this course will be prerequisite** |
| NIL |
| **Description of relevance of this course in the B. Tech. Program** |
| Cultivation of arts is an integral part of the development of human beings since the arts are what make us most human, most complete as people. They offer us the experience of wholeness because they touch us at the deepest levels of mind and personality. They come into being not when we move beyond necessity but when we move to a deeper necessity, to the deeper human need to create order, beauty and meaning out of chaos. They are the expressions of deepest human urges, imperatives and aspirations |

| | **Course Contents (Topics and subtopics)** | **Reqd. hours** |
|---|---|---|
| 1 | The Institute offers a range of courses in different art forms: music, dance, theatre, painting, and other art forms.<br>Students will be given an option to choose a particular art form, and learn and practice it under an artist-instructor. At the end of the course, a student should be able to demonstrate basic proficiency in that particular art form. | 30 |
| | **Total** | **30** |

| **Course Outcomes (students will be able to…..)** | | |
|---|---|---|
| CO1 | Enhance perceptual and cognitive skills | |
| CO2 | Develop self-esteem, motivation, aesthetic awareness, cultural exposure | |
| CO3 | Be creative with improved emotional expression | |
| CO4 | Develop social harmony and appreciation of diversity. | |
| CO5 | Develop an understanding and sharing of culture, with social skills that enhance the awareness and respect of others | |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| CO2 | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| CO3 | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| CO4 | 0 | 0 | 2 | 0 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| CO5 | 0 | 0 | 2 | 0 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO3 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO4 | 0 | 0 | 0 | 0 | 0 | 0 |

# FIRST YEAR: SEMESTER – II

| BSC | Course Code: CHT1407 | Course Title: Organic Chemistry | Credits = 3 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: II | Total contact hours: 45 | 2 | 1 | 0 |

**List of Prerequisite Courses**

Standard XII Chemistry

**List of Courses where this course will be prerequisite**

Food Chemistry, Biochemistry and several special subjects of Chemical Technology Departments.

**Description of relevance of this course in the B. Tech. Program**

To acquaint the students with IUPAC and other types of Nomenclature of organic compounds, fundamentals of Organic Chemistry including reaction mechanisms, organic transformations, types of reactions, selectivity of chemical transformations, etc., stereochemical implications of organic reactions, functional group identification and reactions.

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | **Chemistry of Carbonyl Compounds**<br>Concept of acidity and tautomerism of carbonyl compounds, General methods of preparation and Nucleophilic Addition reactions Enolate chemistry, Aldol and related condensation reactions, Michael reaction, Robinson annulation, Claisen condensation, Dieckmann condensation, Mannich reaction. | 09 |
| 2 | **Aromatic Substitution Reactions**<br>**A) Electrophilic Substitution Reactions**<br>Nitration, Halogenation, Alkylation, Acylation and Sulfonation<br>Activating, deactivating and orienting effects of functional groups in mono- and poly-substituted benzenes Friedel-Crafts alkylation, Acylation, Gattermann, Gattermann-Koch, Riemer-Tiemann reactions.<br>**B) Nucleophilic Substitution Reactions**<br>Addition and elimination mechanism, Benzyne mechanism, Sandmeyer reaction. | 10 |
| 3 | **Heteroaromatic Compounds**<br>IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines | 08 |
| 4 | **Named Organic Reactions**<br>Perkin reaction (Mauvine synthesis-dyes), Fischer indole synthesis, (dyes), Jacobson Corey epoxide synthesis (Pharmaceutical), Ziegler Natta polymerisation (polymer), Multicomponent reactions, Mailard reaction (foods), Strecker amino acid synthesis (Pharmaceuticals & Food), Wittig reactions, Prilezhaev reaction | 10 |
| 5 | **Stereochemistry of Organic Compounds**<br>Containing one and two asymmetric carbon atoms, Stereo descriptors – R/S, E/Z, erythro and thero, Conformation – Ethane and butane.<br>Enantiomers and Diastereomers, meso compounds, different representations of stereoisomers – Saw-horse, Newmann, Wedge and dash and Fischer and their interconversions | 08 |
| | **Total** | **45** |

**List of Textbooks/ Reference Books**


| | |
|---|---|
| 1 | Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press (2012) |
| 2 | Graham Solomons, T. W.; Fryhle, Craig B.; Snyder, Scott A. Organic Chemistry; 12th Ed.; John Wiley & Sons. Inc. (2016) |
| 3 | Smith, M. B.; March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure; 7th ed.; Wiley, India (2015) |

| | |
|---|---|
| 4 | Carey F. A., Sundberg, R. J. Advanced Organic Chemistry: Part A: Structure and Mechanisms; 5th ed.; Springer (2005) |
| 5 | Carey F. A., Sundberg, R. J.; Advanced Organic Chemistry: Part B: Reaction and Synthesis; 5th ed.; Springer (2007) |
| 6 | Wade, L. G.; Simek, J. W.; Singh, M. S. Organic Chemistry; 9th ed.; Pearson Education (2019) |
| 7 | Eliel, E. L. Stereochemistry of Carbon Compounds; Mcgraw-Hill (2001) |
| 8 | Bruice, Paula, Y. Organic Chemistry; 8th Ed.; Pearson Education (2020) |


| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Draw structures of organic compounds and write their IUPAC names correctly | K2 |
| CO2 | Understand principles of aromatic chemistry and interpret the outcome of general transformations | K3 |
| CO3 | Understand the importance of heterocycles, learn the properties and synthetic routes, interpret the IUPAC of compounds and decipher outcomes of various transformations involving heterocycles | K3 |
| CO4 | Apply the knowledge obtained through the course to predict the outcome of reactions and devise solutions to unknown problems | K4 |
| CO5 | Appreciate the stereo-chemical implications of organic compounds and visualize and appreciate the chirality concept | K4 |
| CO6 | Understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation | K4 |
| CO7 | Interpret and analyze reactions having different functionalities, deduce and solve problems related to the reactions as well as apply them | K5 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 1 | 2 | 1 | 1 | 1 | 0 | 2 | 1 | 0 | 2 | 0 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 0 | 2 |
| CO3 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 0 | 1 | 1 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 1 | 0 | 2 | 1 | 1 |
| CO5 | 2 | 3 | 3 | 1 | 2 | 1 | 3 | 1 | 0 | 1 | 0 | 1 |
| CO6 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 0 | 1 | 1 | 0 | 1 |
| CO7 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 1 | 3 | 2 | 1 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 2 |
| CO6 | 3 | 3 | 3 | 3 | 2 | 3 |
| | 3 | 3 | 3 | 3 | 2 | 2 |

| BSC | Course Code: CHT1408 | Course Title: Industrial Chemistry | Credits = 3 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: II | Total contact hours: 45 | 2 | 1 | 0 |

| List of Prerequisite Courses |
|---|
| Standard XII Chemistry |
| **List of Courses where this course will be prerequisite** |
| NIL |
| **Description of relevance of this course in the B. Tech. Program** |
| To acquaint the students with synthesis, properties and applications of various industrial inorganic chemicals |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Introduction to Chemical Industry: Bulk chemicals, fine chemicals, intermediates, active pharmaceutical ingredients (API), etc. | 03 |
| 2 | Petrochemical Industry: operations and processes in manufacture of ethers, hydrocarbons, aromatic compounds, etc. | 06 |
| 3 | **Primary inorganic materials:** Water, Hydrogen, Hydrogen Peroxide and Inorganic Peroxo Compounds, Nitrogen and Nitrogen Compounds, Phosphorus and its Compounds, Sulfur and Sulfur Compounds, Halogens and Halogen Compounds, | 08 |
| 4 | **Mineral fertilizers:** Phosphorus-Containing Fertilizers, Nitrogen-Containing Fertilizers, Potassium-Containing Fertilizers | 04 |
| 5 | **Metals and their compounds:** Alkali and Alkaline Earth Metals and their Compounds Aluminum and its Compounds, Chromium Compounds and Chromium, Silicon and its Inorganic Compounds, Manganese Compounds and Manganese | 08 |
| 6 | **Organic bulk chemicals:** Manufacture of methanol, acetic acid, ethanol, ethylene, propylene, butadiene, acetaldehyde, acetylene, BTX, alkyl benzenes, acetone, phenol, styrene, esters, ethylene oxide, phthalic acid, Vinyl-Halogen and Vinyl-Oxygen Compounds, azo dyes, Polyamides, Propene Conversion Products, Aromatics - Production and Oxidation Products of Xylene and Naphthalene | 08 |
| 7 | Important pharmaceutically active ingredients, agrochemicals, insecticides, pesticides, perfumery chemicals. | 08 |
| | **Total** | **45** |

| List of Textbooks/ Reference Books | |
|---|---|
| 1 | Industrial Organic Chemistry, 3rd, Completely Revised Edition, Klaus Weissermel, Hans-Jürgen Arpe ISBN: 978-3-527-61459-2 July 2008. |
| 2 | Industrial Inorganic Chemistry, 2nd Completely Revised Edition, Karl Heinz Buchel, Hans-Heinrich Moretto, Dietmar Werner, ISBN: 978-3-527-61333-5, 667 pages, November 2008, Wiley-VCH. |
| 3 | Inorganic Chemistry – an industrial and environmental perspective, T.W. Swaddle, ISBN 0-12- 678550-3 , 482 pages, Academic Press. |

| Course Outcomes (students will be able to….) | | |
|---|---|---|
| CO1 | Understand the important chemical principles applied to various industrial processes | K2 |
| CO2 | Describe the fundamental processes underlying manufacture of important organic chemicals | K2 |
| CO3 | Describe the fundamental processes underlying manufacture of important inorganic chemicals | K2 |
| CO4 | Review and assess the impact of the chemical factors on the efficiency of industries and feedstock manufacturing | K3 |
| CO5 | Modify existing applications for improving the efficiencies in terms of yields, energy requirement and environmental impact | K4 |
| CO6 | Evaluate the modifications in terms of long-term environmental implications | K5 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 1 | 1 | 3 | 0 | 2 |
| CO2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO5 | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 0 | 0 |
| CO6 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | 0 |

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 2 | 2 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 0 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 1 | 1 | 1 | 0 | 1 | 1 |
| CO5 | 1 | 2 | 2 | 1 | 1 | 1 |
| CO6 | 2 | 2 | 2 | 2 | 2 | 0 |

| **PCC** | **Course Code: FDT1056** | **Course Title: SPL2: Principles of Food Analysis** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 30** | **1** | **1** | **0** |

**List of Prerequisite Courses**

Technical analysis lab, Food analysis Lab

**List of Courses where this course will be prerequisite**

Food Safety and Quality Regulations

**Description of relevance of this course in the B. Tech. Program**

This course is designed to comprehend the basic principles of physical, chemical, biological and instrumental techniques used in food analysis for quality assurance. As well knowledge of this course will help to design labels for food products on the basis of food analysis, to develop analytical techniques for on-line monitoring of food quality during processing and storage, to ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | Types of samples analysed, steps in analysis, choice of methods; sampling procedures, considerations and sample preparation; Evaluation of analytical data – accuracy and precision, sources of errors, specificity, sensitivity and detection limits, regression analysis, reporting results | 04 |
| 2 | Analysis of chemical constituents, their characterization and significance- moisture, ash, minerals, lipids, fat, proteins, fibre, titratable acidity, starch, reducing sugars | 07 |
| 3 | Spectroscopic analysis of foods – basic principles, UV, visible, fluorescence, IR, AAS, MS, NMR. Chromatographic analysis of foods – basic principles, HPLC, GC, GLC, principles and applications | 12 |
| 4 | Analysis of vitamins, extraneous matter, pesticides and mycotoxins. enzymatic, immunoassays, thermal analysis, and rheological profile. | 07 |
| | **Total** | **30** |

**List of Textbooks/ Reference Books**

| | |
|---|---|
| 1 | AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities |
| 2 | Kirk, RS and Sawyer, R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Harlow, UK, Longman Scientific and Technical. |
| 3 | Leo ML.2004. Handbook of Food Analysis. 2nd Edition. Vol 1,2 and 3, Marcel Dekker. |
| 4 | Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH. |
| 5 | Nielsen, S.(Eds) 1994. Introduction to Chemical Analysis of Foods. Jones & Bartlett |
| 6 | Pomrenz Y & Meloan CE. 1996. Food Analysis - Theory and Practice. 3rd Ed. CBS. |
| 7 | Ranganna, S. 2001. Handbook of Analysis and Quality Control for Fruit and Vegetable Products, 2nd Ed, Tata-McGraw-Hill Publ |
| 8 | Cruz RMS, Khmelinskii, I & Vieira MC. 2016. Methods in Food Analysis, CRC Press. |
| 9 | Galanakis CM (Editor). 2020. Innovative Food Analysis. Elsevier Science. |
| 10 | Gruenwedel. 2017. Food Analysis: Principles and Techniques (4 volumes). CRC Press. |
| 11 | Gentili A. & Fanali C. 2019. Advances in Food Analysis. MDPI AG. |


| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Describe the basic principles of physical, chemical, biological and instrumental techniques used in food analysis for quality assurance. | K2 |
| CO2 | Explain newer and relevant analytical techniques in food systems and design labels for food products on the basis of food analysis. | K3 |
| CO3 | Develop analytical techniques for on-line monitoring of food quality during processing and storage. | K3 |
| CO4 | Ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements. | K3 |
| CO5 | Assess the environmental impact of products life from farm to fork. | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 |
| CO3 | 2 | 3 | 2 | 3 | 1 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 1 |
| CO5 | 1 | 2 | 2 | 2 | 1 | 3 |
| CO6 | 2 | 2 | 1 | 2 | 1 | 0 |

| **ESC** | **Course Code: GET1306** | **Course Title: Basic Mechanical Engineering** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 30** | **1** | **1** | **0** |
| | | | | | |
| **List of Prerequisite Courses** | | | | | |
| Applied Physics(PYT1205), Engineering Mathematics(MAT1301) | | | | | |

| List of Courses where this course will be prerequisite | | |
|---|---|---|
| Professional Career | | |
| **Description of relevance of this course in the B. Tech. Program** | | |
| Students will be able to understand various equipments like steam turbine, gas turbine, pumps, compressors, and power transmission system. | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | **Introduction- Concept of Stress:** Condition of Equilibrium for concurrent coplanar and non-concurrent coplanar forces. Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations volumetric, linear and shear strains. | 06 |
| 2 | **Introduction to Thermodynamics:** First Law of Thermodynamics, Steady-flow energy equation, Second Law of Thermodynamics | 04 |
| 3 | **Basics of Power Station**: Steam Generators Fire tube and Water tube boiler, Low pressure, and high-pressure boilers, Mountings and accessories, Boiler efficiency - Steam Turbines Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines. -Compressors/Pumps Different Types of Compressors and their applications, Different Types of Pumps, and their applications | 08 |
| 4 | **Transmission of Power:** Introduction to various drives such as belt, rope, chain and gear drives, Introduction to mechanical elements such as keys, couplings, and bearings in power transmission (No numerical) | 04 |
| 5 | **Refrigeration and Air-conditioning**: Vapour compression refrigeration cycle, Vapour absorption refrigeration systems, Properties of air such as DBT, WBT, DPT, relative humidity, Psychometric chart. | 04 |
| 6 | **Renewable Energy:** Role and importance of non-conventional and alternate energy sources such as solar, wind, ocean, bio-mass and geothermal, hydrogen energy | 04 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd | |
| 2 | Thermodynamics by P.K. Nag | |
| 3 | Power plant by Morse | |
| 4 | Heat Engines by P.L. Balani | |
| 5 | Hydraulic Machines by Jagdish Lal | |
| 6 | Renewable Energy resources by Tiwari and ghosal, Narosa publication. | |
| 7 | Non-conventional energy sources, Khanna publications | |
| 8 | Refrigeration and air conditioning by C.P. Arora | |
| 9 | Theory of Machines by Rattan. S.S | |
| 10 | Gas turbine theory by HiH Saravanamutoo | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Understand different types of stresses and their effects on bodies. | K2 |
| CO2 | Understand and apply the physics of laws of thermodynamics and mass-balancing. | K3 |
| CO3 | Analyze the working of steam boilers, boiler mountings, and accessories, gas turbines, types of pumps, types of compressors and its working process. | K4 |
| CO4 | Discuss different types of power transmission systems and their typical applications. | K5 |
| CO5 | Understand the working principle of vapor compression and vapor absorption refrigeration systems. | K2 |
| CO6 | Understand the importance of non-conventional energy sources as an alternative source of fuels. | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 |
| CO2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 2 |
| CO3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 2 |
| CO4 | 3 | 3 | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| CO5 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 2 |
| CO6 | 2 | 0 | 0 | 0 | 0 | 1 | 3 | 2 | 0 | 0 | 0 | 2 |

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 2 | 1 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 0 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 1 | 1 | 2 |
| CO4 | 3 | 2 | 1 | 2 | 1 | 1 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 2 |
| CO6 | 1 | 0 | 0 | 0 | 0 | 1 |

| **ESC** | **Course Code: GET1125** | **Course Title: Electrical Engineering and Electronics** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 30** | **1** | **1** | **0** |

**List of Prerequisite Courses**

XII Science, Applied Physics((PYT1101), Engineering Mathematics (MAT1301)

**List of Courses where this course will be prerequisite**

Various Technology Courses and Professional Career

**Description of relevance of this course in the B. Tech. Program**

In this course, students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand the basics of electricity, selection of different types of drives for a given application process. They will get basic knowledge as regards to Power supplies, instrumentation amplifiers and thyristor application in industries.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | **Fundamentals of DC Circuits** Voltage and Current Sources, Basic Laws, Network Theorems, Superposition Theorem and Thevenin's Theorem | 04 |
| 2 | **AC Fundamentals:** A.C. through resistance, inductance and capacitance, simple RL, RC and RLC circuits. Power, power factor | 04 |
| 3 | **Three Phase Systems:** Three phase system of emfs and currents, Star and Delta connections, three phase power | 05 |
| 4 | **Single phase transformers:** Principle of working, Efficiency, regulation. | 05 |
| 5 | **Electrical drives:** Basic concepts of different types of Electrical motors as drives, Their suitability for various applications. | 05 |
| 6 | **Regulated power supplies**, Diodes as rectifiers, Half wave and Full wave rectifier, Filters and Regulators | 05 |
| 7 | **Bipolar junction transistors:** Different configurations, Characteristics, Concept of basic amplifier circuits, Amplifier gain, Transistor as switch | 05 |
| 8 | **Introduction to Integrated circuits:** Basic concepts of ICs | 02 |

| | | |
|---|---|---|
| 9 | **Introduction to data acquisition and signal conditioning**: Basic concept and Block diagram, Concept of conversion of physical quantity to electrical signal, signal conditioning, Introduction to A/D and D/A converters | 03 |
| 10 | **Introduction to instrumentation amplifiers and their applications:** Operational Amplifier – Notation, Pin diagram, Differential and common mode gain, CMRR, Introduction to various applications such as Non-inverting, inverting amplifiers, adder, subtractor, integrator, differentiator. | 03 |
| | **Total** | **45** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Electrical Engineering Fundamentals by Vincent Deltoro | |
| 2 | Electronic devices and circuits by Boylstead, Nashelsky | |
| 3 | Electrical Machines by Nagrath, Kothari | |
| 4 | Electrical Technology by B.L.Theraja, A.K.Theraja vol I,II,IV | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Understand the basic concepts of D.C. supply and circuits, Solve basic electrical circuit problems | K2 |
| CO2 | Understand the basic concepts single phase and three phase AC supply and circuits, Solve basic electrical circuit problems | K2 |
| CO3 | Understand the basic concepts of transformers, evaluate, and calculate efficiency at various load condition. | K2 |
| CO4 | Understand the concept of motors and their uses as various industrial drives. | K2 |
| CO5 | Understand the basic concepts of electronic devices and their applications in power supplies, amplification and instrumentation | K2 |
| CO6 | Understand the basic concepts of operational amplifiers and their applications, | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 2 | 0 | 0 |
| CO2 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 2 | 0 | 0 |
| CO3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 2 | 0 | 0 |
| CO4 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 2 | 0 | 0 |
| CO5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 2 | 0 | 0 |
| CO6 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 2 | 0 | 0 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 0 |
| CO2 | 3 | 2 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 1 | 2 | 1 |
| CO5 | 0 | 1 | 2 | 3 | 2 | 1 |
| CO6 | 1 | 0 | 2 | 0 | 2 | 2 |

| **ESC** | **Course Code:** **CEP1720** | **Course Title: Process Calculations** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 60** | **0** | **0** | **4** |
| | | | | | |

| List of Prerequisite Courses | | |
|---|---|---|
| Standard XII$^{th}$ Mathematics, Chemistry, Applied Physics( PYT1205) | | |
| **List of Courses where this course will be prerequisite** | | |
| This is a basic Course. This knowledge will be required in ALL subjects later. | | |
| **Description of relevance of this course in the B. Tech. Program** | | |
| This is a basic course. This knowledge will be required in almost all subjects later. This subject introduces the various concepts used in Chemical Engineering to the students. The knowledge of this subject is required for in All B. Tech. courses, etc. It can be applied in various situations such as process selection, economics, sustainability, environmental impacts. | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | Introduction to Chemical process calculations, overview of single stage and multistage operations, concept of process flow sheets | 02 |
| 2 | Revision of Units and Dimensions, Dimensional analysis of equations, Mathematical techniques | 04 |
| 3 | Mole concept, composition relationship, types of flow rates | 02 |
| 4 | Material balance in non-reacting systems: application to single and multistage processes | 08 |
| 5 | Stoichiometry | 02 |
| 6 | Material balance in reacting systems: application to single and multistage processes | 06 |
| 7 | Behavior of gases and vapors | 04 |
| 8 | Introduction to psychrometry, humidity and air-conditioning calculations. | 06 |
| 9 | Calculation of X-Y diagrams based on Raoult's law. | 02 |
| 10 | Applications of material balances to Multiphase systems | 06 |
| 11 | Basic concepts of types of Energy and calculations | 02 |
| 12 | Application of Energy balance to non-reacting systems | 06 |
| 13 | Application of Energy balance to reacting systems | 06 |
| 14 | Fuels and combustion. | 04 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau, | |
| 2 | Chemical Process Principles, Hougen O.A., Watson K. M. | |
| 3 | Basic Principles and Calculations in Chemical Engineering, Himmelblau, | |
| 4 | Stoichiometry, Bhatt B.I. and Vora S.M. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Calculate friction factor, pressure drop, power requirements of singe phase flow in a circular pipe | K3 |
| CO2 | Select appropriate pump based on flow and head requirements | K3 |
| CO3 | Calculate heat transfer coefficients and do basic sizing of double pipe and shell and tube heat exchangers | K3 |
| CO4 | Perform preliminary sizing of phase change equipment such as reboilers and condensers | K3 |
| CO5 | Calculate mass transfer coefficients and estimate mass transfer rates in simple situations | K3 |
| CO6 | Understand empirical correlations and solve various equations analytically or numerically | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 1 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO6 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 2 | 3 | 3 | 3 | 0 |
| CO3 | 1 | 2 | 3 | 3 | 3 | 0 |
| CO4 | 1 | 1 | 2 | 3 | 2 | 1 |
| CO5 | 1 | 1 | 2 | 3 | 3 | 2 |
| CO6 | 1 | 1 | 2 | 2 | 2 | 1 |

| **BSC** | **Course Code:** **CHP1343** | **Course Title:** **Physical and Analytical Chemistry Laboratory** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

Standard XII Chemistry, Physical Chemistry (CHT1405) and Analytical Chemistry(CHT1406)

**List of Courses where this course will be prerequisite**

This is a basic Course. This knowledge will be required in Applied Chemistry subjects later.

**Description of relevance of this course in the B. Tech. Program**

The laboratory course is mainly focused on imparting critical experimental skills in Physical and Analytical Chemistry to the undergraduate students. It is expected that they will not only become familiar with laboratory experimental skills but also planning of experiments and interpretation of experimental tasks. The course will help them to understand the relevance of chemical principles in real-life applications.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | To determine the total hardness of given water sample | 04 |
| 2 | To determine the dissociation constants of a polybasic acid using pH meter | 04 |
| 3 | To determine pKa of the given weak acid by potentiometric titration | 04 |
| 4 | To determine the critical micelle concentration (CMC) of the given surfactant by surface tension measurement using a stalagmometer | 04 |
| 5 | To determine the normality and volume of weak acid and strong acid in the given mixture using conductometric titration | 04 |
| 6 | To determine the rate constant of hydrolysis of an ester catalyzed by an acid | 04 |
| 7 | To study the kinetics of the reaction between K2S2O8 and KI and hence, determine rate of the reaction | 04 |
| 8 | To verify Beer – Lambert's Law | 04 |
| 9 | To determine the equivalent conductance of strong electrolyte at infinite dilution and verify Ostwald's law of dilution, for dissociation of weak electrolyte | 04 |
| 10 | To determine the molecular weight of the given polymer by viscosity measurements | 04 |
| 11 | To determine the vitamin C concentration from the given tablet sample by titration | 04 |
| 12 | Demo of Gas chromatography and FT-IR | 04 |
| | **Total** | **60** |

| List of Textbooks/ Reference Books | | |
|---|---|---|
| 1 | Practical physical Chemistry – B.Viswanthan and P.S. Raghavan | |
| 2 | Practical physical Chemistry- Alexander Findlay | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Perform quantitative analysis of samples to determine purity / composition | K3 |
| CO2 | Use common laboratory instruments with appropriate calibration and safety protocols | K3 |
| CO3 | Apply concepts of equilibria and kinetics to determine properties of molecules / processes | K4 |
| CO4 | Design experiments for acquiring physicochemical data and to interpret results for addressing specific queries / requirements | K4 |
| CO5 | Evaluate the results in terms of accuracy and estimated precision | K4 |
| CO6 | Identify the sources of errors and design steps to minimise the same | K5 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 1 | 1 | 3 | 0 | 2 |
| CO2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 2 |
| CO6 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 3 | 1 | 1 | 0 |
| CO2 | 2 | 2 | 3 | 1 | 2 | 2 |
| CO3 | 1 | 2 | 3 | 2 | 2 | 2 |
| CO4 | 1 | 2 | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 3 | 1 | 2 | 1 |
| CO6 | 1 | 2 | 3 | 2 | 2 | 2 |

| **VSEC** | **Course Code:** | **Course Title:** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | **CHP1132** | **Organic Chemistry Laboratory** | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 60** | **0** | **0** | **4** |

| List of Prerequisite Courses | |
|---|---|
| Standard XII Chemistry, Organic Chemistry (CHT1407) | |
| **List of Courses where this course will be prerequisite** | |
| All the Applied Chemistry Practical's. | |
| **Description of relevance of this course in the B. Tech. Program** | |
| Students are introduced to basics of organic separations and identification of organic compounds based on their physicochemical properties. The course is relevant for training the students for working with binary mixtures. The laboratory training is crucial for the students to carry out work-up of organic reactions leading to separation of crude products followed by purification using recrystallization and/or distillation or related methods. | |
| **Course Contents (Topics and subtopics)** | **Required Hours** |

| | | |
|---|---|---|
| 1 | Principles of qualitative separation of organic mixtures using physical properties, chemical properties and their combination. | 4 |
| 2 | Principles of quantitative separation of organic mixtures using physical properties, chemical properties and their combination | 4 |
| 3 | Separation of solid-solid water insoluble binary organic mixtures | 5*4 |
| 4 | Separation of solid-solid partly water soluble binary organic mixtures | 4*2 |
| 5 | Separation of solid-solid mixtures by fractional crystallization | 4*2 |
| 6 | Separation of liquid-liquid mixtures by distillation | 4*2 |
| 7 | Separation of liquid-liquid mixtures by solvent extraction | 4*2 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Arthur, Vogel. Textbook of Practical Organic Chemistry, 5th edition, publishers Longman group Ltd, 1989 | |
| 2 | F.G. Mann and B.C. Saunders, Practical Organic Chemistry, 4th edition published by Orient Longman | |
| 3 | Keese, R, Martin P. B, and Trevor P. Toube. Practical Organic Synthesis: A Student's Guide. John Wiley & Sons, 2006. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Understand basic principles for separation of binary organic mixtures qualitatively and quantitatively | K3 |
| CO2 | Estimate the components of binary mixtures quantitatively | K3 |
| CO3 | Separate binary organic mixtures by multiple techniques and test the purity | K3 |
| CO4 | Determine the purity of the individual components through quantitative analysis | K4 |
| CO5 | Design experimental protocols to improve the purity of isolated components | K5 |
| CO6 | Follow GLP protocols and work safely in the organic chemistry laboratory | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |
| CO3 | 1 | 2 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 2 |
| CO4 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO6 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 2 | 1 | 1 | 2 | 2 |
| CO2 | 1 | 2 | 2 | 2 | 2 | 3 |
| CO3 | 1 | 1 | 1 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 2 |
| CO5 | 2 | 2 | 3 | 3 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 3 | 3 | 2 |

| **CCA** | **Course Code:** | **Course Title: Physical Activities (Sports & games)** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 60** | 0 | **0** | 4 |
| **List of Prerequisite Courses** | | | | | |

| None | | |
|---|---|---|
| **List of Courses where this course will be prerequisite** | | |
| Not Applicable | | |
| **Description of relevance of this course in the B. Tech. Program** | | |
| Games and sports are necessary and useful for all. Games play an important part in life. Education is incomplete without games. Games are necessary to keep the body fit and trim. Moreover, they provide recreation. As a result, one feels smart and cheerful throughout the day. If one is cheerful and healthy, he or she is able to get the best out of life. A player really enjoys life. For him, life is a song and a beauty. Games teach us the lesson of discipline, team-work, patience and punctuality. In the playground, the players obey the captain and abide by the rules of the games. Games also teach us that we should play a game for game's sake, not for victory or defeat. A healthy man is always hopeful and cheerful. | | |
| | | |
| | **Course Contents (Topics and subtopics)** | **Reqd. hours** |
| 1 | The students shall select participating a specific sports/game/physical activity of their choice in morning/evening or at other suitable times according to the local climate. This would involve a routine of physical activity with games and sports.<br>Physical activity means any bodily movement produced by skeletal muscles requiring energy expenditure, for example, Walking, gardening, climbing the stairs, playing soccer.<br>Activities can be considered vigorous, moderate, or light in intensity. Activity makes one breathe harder and one's heart beat faster.<br>**Moderate physical activities** include:<br>- Walking briskly (about 3½ miles per hour)<br>- Bicycling (less than 10 miles per hour)<br>- General gardening (raking, trimming shrubs)<br>- Dancing  Golf (walking and carrying clubs)<br>- Water aerobics<br>- Canoeing<br>- Tennis (doubles)<br><br>**Vigorous physical activities** include:<br>- Running/jogging (5 miles per hour)<br>- Walking very fast (4½ miles per hour)<br>- Bicycling (more than 10 miles per hour)<br>- Heavy yard work, such as chopping wood<br>- Swimming (freestyle laps)<br>- Aerobics<br>- Basketball (competitive)<br>-  Tennis (singles) | 60 |
| **Course Outcomes (students will be able to…..)** | | |
| CO1 | Keep physically fit and mentally agile | K2 |
| CO2 | Manage stress in studies and later in life | K2 |
| CO3 | Coordinate body and mind together | K2 |
| CO4 | Understand own emotions and maintain healthy daily routine | K2 |
| CO5 | Develop team work and an ability to work with others for a common goal | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO2 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO3 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO4 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO5 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO5 | 1 | 1 | 1 | 1 | 1 | 1 |

| **IKS** | **Course Code: HUT1117** | **Course Title: Traditional Indian Chemical Technology** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

NIL

**List of Courses where this course will be prerequisite**

NIL

**Description of relevance of this course in the B. Tech. Program**

To acquaint the students with major chronological developments in Indian science and technology.· To review the ancient discoveries and research related to chemicals in Pharmaceuticals, flavours and fragrances, metallurgy, architecture, textile, agriculture and Ayurveda etc. To know the fundamental principles of Indian health systems such as Ayurveda, which is useful in
maintaining well-being. To facilitate the students to identify and develop interest in the ancient knowledge systems to make meaningful contributions to the development of science today. To develop respect and pride about Indigenous Knowledge thereby to assist the learners' understanding about conclusions/products from ancient Indian knowledge system for verifying them on modern scientific and technological footings.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | **Introduction to Indian Knowledge System (IKS):**<br>- Introduction, Definition and History<br>- Need to study it in current times<br>Chemists and texts of the ancient era | 2 |
| 2 | **Traditional Indian Pharmaceutical Sciences and Technology:**<br>Alternative systems of Medicine/ Welfare of the society: Principles of Ayurveda<br>- Medicinal plants and crude drugs<br>- Reappraisal of Ayurvedic Phytochemistry<br>- Ayurvedic Dosage forms and similarity to that of modern dosage forms<br>- Extraction of herbs in Ayurvedic System and comparison to that of modern extraction process<br>- Detoxification of poisonous plants (*Shodhan Prakriya*)<br>Ancient perspective of Adulterants and Substitutes | 6 |
| 3 | **Traditional Indian Knowledge on Oils, Perfumery and Flavoring agents**<br>- Essential oils and fixed oils<br>Applications in perfumery and flavoring-fragrance industry | 3 |
| 4 | **Traditional Indian Knowledge on Textile and Fibres**<br>- Types of fibers | 2 |

| | | |
|---|---|---|
| | - Textile patterns across the country<br>Methods and Techniques | |
| 5 | **Traditional Indian Knowledge on Dyes, Pigments, mordents and specialty chemicals**<br>- Natural dyes and pigments<br>Sources, Methods of dying | 2 |
| 6 | **Traditional Indian Knowledge on Polymers and surface coatings**<br>Waxes, Gums, Carbohydrates | 2 |
| 7 | **Traditional Indian Food Technology** | 2 |
| 8 | Traditional Indian Knowledge about Metallurgy and Materials Science | 3 |
| 9 | **Traditional Indian Preservation Technology**<br>- Methods of preservation: Food, monuments and artifacts<br>Materials used in Preservation | 3 |
| 10 | Science associated with traditional Indian practices during festivals | 2 |
| 11 | Connecting The traditional Indian Knowledge with Modern Science | 3 |
| | **Total** | **60** |

| **List of Textbooks/ Reference Books** | |
|---|---|
| 1 | Acharya Prafulla Chandra Ray, A History of Hindu Chemistry, 1902, republ., Shaibya Prakashan Bibhag, centenary edition, Kolkata, 2002 |
| 2 | B. Mahadevan and Vinayak Rajat Bhat, INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM: CONCEPTS AND APPLICATIONS, **PHI Learning publication, 2022** |
| 3 | The Positive Sciences of the Ancient Hindus; Brijendra Nath Seal; 4th Edition; 2016 |
| 4 | Fine Arts & Technical Sciences in Ancient India with special reference to Someśvara's Mānasollāsa; Dr. Shiv Shekhar Mishra, Krishnadas Academy, Varanasi 1982 |
| 5 | A Concise History of Science in India, ed. D M Bose, S N Sen and B V Subbarayappa; INSA; 2009 |
| 6 | Science and Technology in Medieval India - A Bibliography of Source Materials in Sanskrit, Arabic and Persian by A Rahman, M A Alvi, S A Khan Ghori and K V Samba Murthy; 1982. |
| 7 | Vaidya Navnitlal B. Pandya, Fundamental principles of ayurveda part – 1. October 1982 Ancient Science of Life. |
| 8 | Vasant Lad, Textbook of Ayurveda: Fundamental Principle, reprint 2010 |
| 9 | Lakshmi chandra Mishra (Editor), Scientific Basis for Ayurvedic Therapies, CRC Press LLC 2003 |
| 10 | H.Panda, **Handbook on Speciality Gums, Adhesives , Oils, Rosin & Derivatives, Resins, Oleoresins, Katha, Chemicals with other Natural Products,** Asia Pacific Business Press Inc., 2022 |
| 11 | Achyut Godbole, Anna, Madhushree Publication, 2022, Marathi edition |
| 12 | Bhojanakutuhalam, Raghunatha Suri (Author), FRLHT (Contributor), DR. M. A. Alwar (Editor), DR. Padma Venkat, The Medplan Conservatory Society, 2019. |
| 13 | R.M. Pujari, Pradeep Kolhe, N. R. Kumar, 'Pride of India: A Glimpse into India's Scientific Heritage', Samskrita Bharati Publication. |
| 14 | 'Indian Contribution to science', compiled by Vijnana Bharati. |
| 15 | 'Knowledge traditions and practices of India',Kapil Kapoor, Michel Danino, CBSE, India |

| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | List the key achievements of Ancient India in different areas of Chemical Technology | K3 |
| CO2 | Describe the various features of traditional Indian knowledge in different areas of Chemical Technology | K2 |
| CO3 | Describe Key Principles of Traditional Indian Health Systems | K2 |
| CO4 | Describe the various products and key technology aspects based on traditional Indian Knowledge in context of Modern science | K2 |
| CO5 | Understanding the applications of IKS in current practices. | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 1 | 3 | 0 | 1 | 3 | 3 | 1 | 0 |
| CO2 | 3 | 2 | 2 | 1 | 1 | 3 | 0 | 1 | 3 | 3 | 1 | 0 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 3 | 0 | 1 | 3 | 3 | 1 | 0 |
| CO4 | 3 | 2 | 2 | 1 | 1 | 3 | 0 | 1 | 3 | 3 | 1 | 0 |
| CO5 | 2 | 1 | 1 | 3 | 1 | 1 | 0 | 1 | 1 | 3 | 1 | 1 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 1 | 1 | 2 | 0 |
| CO2 | 1 | 0 | 2 | 0 | 1 | 2 |
| CO3 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO4 | 3 | 1 | 2 | 1 | 2 | 1 |
| CO5 | 2 | 2 | 1 | 1 | 2 | 1 |

| ??? | **Course Code: XXXXXXX** | **Course Title: Universal Human Values-I** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: II** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

NA

**List of Courses where this course will be prerequisite**

NA

**Description of relevance of this course in the B.Tech. Program**

This **audit course with no extra credit** gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting staff in the hostel and department, be sensitive to others, etc.
A module in Universal Human Values provides the base of character building. The objective of the course is four fold:
1. Sensitization of student towards self, family (relationship), society and nature.
2. Understanding (or developing clarity) of nature, society and larger systems, on the basis of human relationships and resolved individuals.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.
5. The second-year mark list, this course with result a s Pass/Fail with mandate hrs in place.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Purpose and motivation for the course | **60** |
| 2 | Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations | |
| 3 | Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority | |
| 4 | Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario | |
| 5 | Method to fulfil the above human aspirations: understanding and living in harmony at various levels. | |
| 6 | **Methodology of this Course:** Methodology of teaching this content must not be through do's and dont's, but get the students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, | |

| | | |
|---|---|---|
| | and realizing values. The teachers must come from all the departments rather than only one department like HSS or from outside of the Institute.<br>Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking | |
| | **Total** | **60** |
| **List of Text Books** | | |
| 1 | Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010 | |
| 2 | Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999 | |
| 3 | The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi | |
| 4 | Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Become more aware of their surroundings, society, social problems and their sustainable solutions, while keeping human relationships and human nature in mind. | K2 |
| CO2 | Develop better critical ability. | K2 |
| CO3 | Become sensitive to their commitment towards what they believe in (humane values. humane relationships and humane society). | K3 |
| CO4 | Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO2 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO3 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO4 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO3 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO4 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO5 | 0 | 0 | 0 | 0 | 0 | 0 |

# SECOND YEAR: SEMESTER – III

| PCC | Course Code: FDT1057 | Course Title: SPL3: Biochemistry and Microbiology | Credits = 4 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: III | Total contact hours: 60 | 3 | 1 | 0 |

| List of Prerequisite Courses | |
|---|---|
| Standard XII Biology and Chemistry | |

| List of Courses where this course will be prerequisite |
|---|
| Principles of Food Preservation, Food Microbiology, Nutrition |

**Description of relevance of this course in the B. Tech. Program**

This course is designed to train the students with respect to the core chemistry principles involved in functioning of biological systems, structural and chemical biology of macromolecules, including proteins, carbohydrates, lipids, nucleic acid and vitamins, structure, function and kinetic properties of enzymes and their role in metabolism of living cells, major catabolic as well as anabolic pathways involved in cell metabolism and quantitative aspects of biochemical analysis of macromolecules

Knowledge of this course will help students to familiarize with diverse microorganisms in different industries like food, dairy, bio-based fermentation, oil, pharmaceutical industry and bioenergy, with diversity of microorganisms, microbial cell structure and function, microbial growth and metabolism, environmental factors affecting their growth and cultivate/control growth of microbes using physical and chemical technologies; with basics of microbial replication, transcription, translation and mutagenesis and involvement of microorganisms in diseases and role of immune system in defending invading pathogens

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| | **Biochemistry** | |
| 1 | **Carbohydrates:** Fundamentals of chemistry of carbohydrates; Qualitative tests / colour reaction; Metabolic pathways and energy yield for breakdown of carbohydrates<br>**Lipids:** Types; Functions & comparative distribution of lipids; beta-oxidation; functions; quantitatie analysis<br>**Proteins:** Chemistry; types, qualitative and quantitative analysis; Structural analysis | 15 |
| 2 | **Nucleic acids**: Types; Chemistry; Functions; Genetic code<br>**Enzymes**: definition, function, nomenclature, classification, mechanism of enzyme action, enzyme kinetics, enzyme inhibition and regulation<br>**Vitamins & Co-enzymes**: Structures& function of Nicotinamide, nicotinic acid, riboflavin, lipoic acid, biotin, thiamine, B6, folic acid, B12, pantothenic acid, ascorbic acid, vitamins A, D, K, and E | 15 |
| | **Microbiology** | |
| 3 | **Introduction,** Prokaryotes and Eukaryotes (morphology, structure and function of microbial cells and their components)<br>Major groups of microorganisms - Bacteria, Virus, Yeasts and Molds, Rickettsia, Chlamydia and Algae | 10 |
| 4 | **Characterization**: Gram character and staining techniques, Isolation, preservation and maintenance of pure cultures | 05 |
| 5 | **Growth Studies**: (lag phase, log phase, stationary phase, death phase); concept of generation time; Physical and chemical factors affecting growth of microbes<br>**Nutrient requirements** of microorganism, Composition, preparation and sterilization of microbiological media; Classification of media, Methods of sterilization, disinfection, sanitation, asepsis<br>Growth studies | 08 |
| 6 | **Microscopy** (dark, Fluorscence, atomic force, scanning tunnel, confocal etc.);<br>Enumeration of microorganisms (TPC, Yeast and molds count, MPN, turbidometry, rapid methods like flow cytometry, etc.) | 05 |
| 7 | **Introduction to immunology** | 02 |
| | **Total** | **60** |

| List of Textbooks/ Reference Books | | |
|---|---|---|
| 1 | Principles of Biochemistry, Lehninger AL, Nelson DL and Cox MM, 5th Edition, 2008, MacMillan | |
| 2 | Biochemistry, Stryer L, Berg JM and Tymoczko JL, 5th Edition, 2002, Freeman & Co. | |
| 3 | Fundamentals of Biochemistry – Voet DJ and Voet JG, Upgrade edition, 2002, John Wiley & Sons | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Apply of fundamental knowledge of chemistry to biological systems and understand and elucidate structural as well as metabolic role of different macromolecules in the cell | K3 |
| CO2 | Apply analytical tests involved in detection of macromolecules in/derived from biological samples | K3 |
| CO3 | Understand the role of enzymes in cellular environment and their use in industrial applications for their practical applications and evaluate and elucidate impact of different catalytic reactions involved in metabolic pathway | K4 |
| CO4 | Explain the application of diverse microorganisms in different industries like food, dairy, oil, pharmaceutical, bio-based fermentation and bio-energy | K2 |
| CO5 | Describe the cultivation/control methods for diversity of microorganisms, their physiology and metabolism | K2 |
| CO6 | Understand and apply the significance of microorganisms in diseases and basic immune system against invading pathogens | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |
| CO6 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 2 | 0 | 1 | 2 | 0 |
| CO2 | 1 | 1 | 3 | 2 | 2 | 1 |
| CO3 | 1 | 1 | 2 | 2 | 1 | 2 |
| CO4 | 2 | 0 | 1 | 2 | 3 | 2 |
| CO5 | 1 | 0 | 1 | 1 | 1 | 3 |

| **PCC** | **Course Code: FDT1058** | **Course Title: SPL4: Nutrition** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: III** | **Total contact hours: 30** | **1** | **1** | **0** |

| List of Prerequisite Courses | |
|---|---|
| Principles of Food Analysis, Introduction to Food Science and Technology | |
| **List of Courses where this course will be prerequisite** | |
| Food Chemistry, Nutraceuticals and Functional Foods | |
| **Description of relevance of this course in the B. Tech. Program** | |

| | | |
|---|---|---|
| This course is designed to understand basic concepts of nutrition, compute energy value of foods and understand body's need for energy, role of different constituents of carbohydrates and lipids in human nutrition, role of proteins in human nutrition, explain concept of protein quality and methods of estimation and to identify anti-nutritional factors in food sources. Knowledge of this course will help to understand the requirements and role of micronutrients (vitamins /minerals) in human health, formulation of diets, techniques of health surveys, nutritional assessment etc. | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | Food composition and nutrients present in foods, terminologies used in nutrition, Food pyramid, my pyramid, my plate, Food exchanges and measures used, Energy value of foods, bomb calorimeter, physiological fuel value, estimation of energy value of foods from proximate composition. Basal Metabolic Energy, factors affecting, and calorie needs for B. M. E., physical activity and diet induced thermogenesis; energy imbalance and body weight regulation; Nutrition through lifecycle. | 05 |
| 2 | Role of carbohydrates in human nutrition- nutritionally important carbohydrates, physiological functions, digestion and absorption of available carbohydrates, dietary fiber, non-digestible oligosaccharides, resistant starch and its types, carbohydrates as prebiotics, dental carries and role of sugar, Lactose intolerance and galactosemia, Glycemic index and glycemic load of carbohydrate containing foods.<br>Role of lipids in Human Nutrition- nutritionally important lipid constituents, physiological functions, digestion and absorption of lipids, conjugated linoleic acid, trans fats, medium chain triglycerides, fat replacers and mimetics, keto diet, Cholesterol, Phytosterols, blood lipids (LDL, HDL, VLDL etc), essential fatty acids, their functions and deficiency, omega 3 and omega 6 PUFAs and their dietary sources, eicosanoids. | 07 |
| 3 | Role of proteins in Human Nutrition- essential/ non-essential amino acids, complete/ incomplete proteins, limiting amino acid, complementary proteins, physiological functions of proteins, daily protein requirements, digestion absorption and utilization of proteins, common food sources of proteins, protein deficiency (PEM/PCM)- prevalence, causes, effects, remedial measures<br>Concept and estimation of protein quality – in vitro (scoring methods, indices, microbiological methods, enzymatic methods) and in vivo methods (growth response methods like PER and Nitrogen balance methods like BV), PDCAAS;<br>Anti-nutritional factors present in foods- antiproteins (trypsin inhibitor), antiminerals (phytate), anti- vitamins (ascorbic acid oxidase) and others- their chemistry, occurrence in food sources, mechanism of anti-nutritional action, processing stability, and remedial measures to reduce them | 06 |
| 4 | Role of micronutrients (Vitamins and minerals)<br>Vitamins– classification- water soluble (all the B vitamins and C) and fat soluble (Vitamins A, D, E and K); Chemistry, structure and properties; physiological functions; absorption and metabolism; food sources, deficiency and hypervitaminosis; RDA<br>Minerals- Nutritional and anti-nutritional mineral elements in food, their physiological role, food sources, deficiency diseases, bioavailability,<br>Fortification of foods with vitamins and minerals | 08 |
| 5 | Principles of Diet Therapy and Therapeutic Nutrition; Formulation of diets and foods for special needs; Techniques of diet and health surveys; Assessment of nutritional status; Effect of food processing, preservation and storage on nutritional quality of foods; Food nutrification; Sports nutrition; | 04 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Maurice E. Shils, James A. Olson, Moshe Shike, A. Catherine Ross Modern Nutrition in Health & Disease by Young & Shils. Jones & Bartlett Learning; Subsequent edition. 1999. ISBN-10: 068330769X | |

| | |
|---|---|
| 2 | Food, Nutrition and Diet Therapy by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350 |
| 3 | Nutritive Value of Indian Foods by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published by National Institute of Nutrition, Indian Council of Medical Research, 1989 |
| 4 | Introduction to Human Nutrition by Gibney, Lahnam-New, Cassidy and Vorster, 2009, Nutrition Society Textbook Series, Second Edition, Wiley Blackwell Publisher |
| 5 | Molecular Basis of Human Nutrition by Sanders and Emery, 2003, Taylor & Francis Publication, ISBN 0-415-29917-9 (hbk) |
| 6 | Principles of Human Nutrition by M. Eastwood, 2003, Blackwell Science. ISBN 0-632-05811-0 |

**Course Outcomes (students will be able to….)**

| | | |
|---|---|---|
| CO1 | Explain basic concepts of nutrition, compute energy value of foods and understand body's need for energy | K3 |
| CO2 | Explain the role of different constituents of carbohydrates and lipids in human nutrition | K3 |
| CO3 | Describe the role of proteins in human nutrition, explain concept of protein quality and methods of estimation and identify anti-nutritional factors in food sources | K2 |
| CO4 | Describe the requirements and role of micronutrients (vitamins /minerals) in human health. | K2 |
| CO5 | Explain formulation of diets, techniques of health surveys, nutritional assessment etc. | K3 |

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating

**Mapping of Course Outcomes (COs) with Programme Outcomes (POs)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

**Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | 2 | 1 | 3 |
| CO2 | 2 | 3 | 2 | 2 | 2 | 3 |
| CO3 | 1 | 1 | 1 | 1 | 0 | 0 |
| CO4 | 1 | 0 | 1 | 0 | 2 | 2 |
| CO5 | 2 | 1 | 2 | 2 | 0 | 2 |

| **EEM** | **Course Code: HUT1205** | **Course Title: Basic Economics and Finance** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: III** | **Total contact hours: 30** | **2** | **0** | **0** |

**List of Prerequisite Courses**

NIL

**List of Courses where this course will be prerequisite**

Chemical Process Economics (CET1805), Project-II (PHP1449)

**Description of relevance of this course in the B. Tech. Program**

A Chemical Technology student will be experience the importance of Basic Economics and Finance in various industrial processes.

| Course Contents (Topics and subtopics) | | Required Hours |
|---|---|---|
| 1 | INTRODUCTION<br>Explaining the Economy<br>The Supply and Demand Model<br>Using the Supply and Demand Model | 03 |
| 2 | THE COMPETITIVE EQUILIBRIUM MODEL<br>Deriving Demand<br>Deriving Supply<br>Market Equilibrium and Efficiency | 05 |
| 3 | DEVIATIONS FROM COMPETITION<br>Monopoly and Market Power<br>Between Monopoly and Competition<br>Antitrust Policy and Regulation | 05 |
| 4 | MACRO FACTS AND MEASURES<br>Getting Started with Macroeconomic Ideas<br>Measuring Production, Income and Spending of Nations | 05 |
| 5 | ACCOUNTING TRANSACTIONS<br>Journal entries<br>Debit credit rules<br>Compound journal entry<br>Journal and ledger<br>Rules of posting entries<br>Trial balance | 05 |
| 6 | CAPITAL AND REVENUE<br>Income and expenditure<br>Expired costs and income<br>Final accounts<br>Manufacturing accounts<br>Trading accounts<br>Profit and Loss account<br>Suspense account<br>Balance sheet | 05 |
| 7 | CONCEPT OF DEPRECIATION | 02 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Finance and Accounting for Nonfinancial Managers: All the Basics You Need to Know, -William G. Droms and Jay O. Wright | |
| 2 | Microeconomics: Basic Principles and Applications- A A Temu, D W Ndyetabula, et al | |
| 3 | PRINCIPLES OF ECONOMICS(12e)- E. Case Karl, C. Fair Ray, et al | |
| 4 | Basic Finance for Nonfinancial Managers: A Guide to Finance and Accounting Principles for Nonfinancial Managers- Kendrick Fernandez | |
| 5 | Microeconomic Theory: Basic Principles and Extensions- Walter Nicholson and Christopher Snyder | |
| 6 | Macroeconomics(10e) Part of: Pearson Series in Economics (23 books) - by Froyen | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Know and apply accounting and finance theory. | K3 |
| CO2 | Understand the mechanics of preparation of financial statements, their analysis and interpretation | K2 |
| CO3 | Explain basic economic terms, concepts, and theories | K2 |
| CO4 | Identify key macroeconomic indicators | K3 |
| CO5 | Apply knowledge during the project cost calculation | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) |
|---|

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 1 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 0 |
| CO3 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 1 | 1 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 2 | 1 | 2 | 0 |
| CO2 | 2 | 0 | 2 | 0 | 2 | 0 |
| CO3 | 1 | 2 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 2 | 1 | 2 | 2 |
| CO5 | 2 | 1 | 2 | 1 | 2 | 3 |

| **PCC** | **Course Code: FDP1013** | **Course Title: Pr2: Food Microbiology Lab** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: III** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

None

**List of Courses where this course will be prerequisite**

Food Microbiology, Principles of Food Preservation

**Description of relevance of this course in the B. Tech. Program**

This course is designed to understand the principles of different staining techniques used for specific group of microorganism and chemical compounds within the cells, to identify and enumerate the contaminating microorganisms in the food samples. Knowledge of this course will help to identify the microbial resistance towards different types of disinfectants and the effects of physiochemical factors for microbes and to develop a specific media and isolate microorganisms from different food samples.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | Working and handling of common laboratory equipment and materials | 04 |
| 2 | Monochrome staining, Cell wall staining | 04 |
| 3 | Gram staining | 04 |
| 4 | Negative staining. Hanging drop technique | 04 |
| 5 | Capsule staining, Bacterial endospore staining | 04 |
| 6 | Study of Yeast, Mold and Bacteria | 04 |
| 7 | Phenol Coefficient of disinfectant | 04 |
| 8 | Microchemical test for reserve material | 04 |
| 9 | Isolation of Microbes from a food sample | 04 |
| 10 | Composition, preparation, sterilization of routine lab media | 04 |
| 11 | Enumeration, characterization, isolation and maintenance from air and surface | 04 |
| 12 | Effect of physicochemical factors and nutritional requirements on growth of microorganisms | 04 |
| 13 | Isolation and characterization of microbes based on morphological & physiological characteristics | 04 |
| 14 | Evaluations of microbial quality of milk and water samples | 04 |

| | | |
|---|---|---|
| 15 | Spread Plate, pour Plate methods for cultivation of microbes, Streaking, and point inoculation methods for bacteria, fungi, and actinomycetes. | 04 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Laboratory Experiments in Microbiology (10th Edition) - by Ted R. Johnson and Christine L. Case, (2012). Publisher: Benjamin Cummings, ISBN: 0321794389 | |
| 2 | Microbiology Lab Manual (8th Edition) - by John Harley. (2010). Publisher: McGraw-Hill Science, ISBN: 0077292812 | |
| 3 | Fundamental Food Microbiology (3rd Edition) – by Bibek Ray. CRC Press: ISBN - 0-8493-1610-3 | |
| 4 | Modern Food Microbiology (Seventh Edition) – by James M. Jay, Martin J. Loessner and David A. Golden. Springer-Food Science Text Series ISBN 0·387·23180-3 | |
| 5 | {FSSAI Lab Manual 14} Manual of Methods of Analysis of Foods [Microbiological Testing]. FSSAI, MoHFW, GoI - 2012 | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Describe and analyze the principles of different staining techniques used for bacteria, yeast and chemical compounds within the cells | K4+P2 |
| CO2 | Describe and apply the procedure for enumerating the microorganisms in the food samples | K3+P2 |
| CO3 | Analyse the effect of different media composition and physiochemical factors for microbes | K4+P2 |
| CO4 | Isolate and characterize different microorganisms from food samples | K4+P2 |
| CO5 | Isolate and characterize different microorganisms from food samples | K4+P2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 2 | 1 | 2 | 0 |
| CO2 | 2 | 0 | 2 | 0 | 2 | 0 |
| CO3 | 1 | 2 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 2 | 1 | 2 | 2 |
| CO5 | 2 | 1 | 2 | 1 | 2 | 3 |

| **PCC** | **Course Code: FDP 1014** | **Course Title: Pr1: Biochemistry Lab** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: III** | **Total contact hours: 60** | **0** | **0** | **4** |
| | | | | | |
| **List of Prerequisite Courses** | | | | | |
| None | | | | | |
| **List of Courses where this course will be prerequisite** | | | | | |

| | | |
|---|---|---|
| Food Chemistry, Chemistry of Food Constituents, Food Chemistry Lab, Food Analysis Lab. | | |
| **Description of relevance of this course in the B. Tech. Program** | | |
| This course is designed to understand the principles of analytical methods used for protein, sugar and vitamin estimation, to decipher on extraction and assay of quality indicator enzymes in food. Knowledge of this course will help to develop analytical protocols for quantifying the sensitivity of critical nutrients in foods. | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | Estimation of protein by Biuret Method & Folin-Lowry method | 04 |
| 2 | Estimation of protein by Microkjeldahl method & Pope & Steven's method | 04 |
| 3 | Estimation of proteins by Bradford method & Dye binding method | 04 |
| 4 | Estimation of sugar by DNSA method & Phenol-$H_2SO_4$ method | 04 |
| 5 | Estimation of sugar by Resorcinol method & Anthrone method | 04 |
| 6 | Estimation of amylose & amylopectin | 04 |
| 7 | Estimation of polyphenols by Folin-Denis method & Ferrous Tartarate method | 04 |
| 8 | Study of Amylase and kinetic study | 04 |
| 9 | Study of Proteases | 04 |
| 10 | Study of Lipases | 04 |
| 11 | Enzymes as indicators of thermal processing | 04 |
| 12 | Enzyme purification by ammonium sulphate | 04 |
| 13 | Estimation of trypsin inhibitors | 04 |
| 14 | Estimation of thiamine and vitamin C | 04 |
| 15 | Estimation of vitamin E | 04 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Boyer R., Biochemistry Laboratory: Modern Theory and Techniques; 2nd Ed.; Pearson Prentice Hall; 2012; ISBN: 978-0-13-604302-7 | |
| 2 | Holtzhauer M., Basic Methods for the Biochemical Lab; Springer, New York; 2006; ISBN: 978-3-540-32786-8 | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Analyze different analytical methods used for protein and sugar estimation | K4+P2 |
| CO2 | Analyze different enzyme assay, their purification and applications | K4+P2 |
| CO3 | Demonstrate and analyze the analytical methods for vitamin estimation | K4+P2 |
| CO4 | Develop analytical protocols of important nutrients in foods | K3+P2 |
| CO5 | Apply the concept of biochemical analysis in quality assurance of food industry | K3+P2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

**Mapping of Course Outcomes (COs) with Programme Outcomes (POs)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| Course | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

**Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | 1 | 2 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO2 | 1 | 2 | 2 | 0 | 2 | 0 |
| CO3 | 1 | 2 | 1 | 2 | 1 | 2 |
| CO4 | 0 | 0 | 2 | 1 | 2 | 1 |
| CO5 | 2 | 2 | 2 | 1 | 2 | 1 |

# SECOND YEAR: SEMESTER – IV

| PCC | Course Code: CET1105 | Course Title: Transport Phenomena | Credits = 4 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: IV | Total contact hours: 60 | 3 | 1 | 0 |

**List of Prerequisite Courses**

Applied Physics (PYT1205), Engineering Mathematics (MAT1301), Process Calculations (CEP1720)

**List of Courses where this course will be prerequisite**

This is a basic course required in special subjects that deal with flow of fluids, heat and mass transfer, etc.

**Description of relevance of this course in the B. Tech. Program**

This basic course introduces concepts of momentum, heat and mass transfer to students. Various other concepts such as pressure, momentum, energy are introduced as well. Laws related to conservation of momentum, energy, mass are taught. Applications of these laws to various engineering and technological situations and process equipments are explained with the help of several problems.

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Fluid Statics and applications to engineering importance. | 04 |
| 2 | Applications of Bernoulli's Equation, Pressure drop in pipes and Fittings,meters, and fluid moving machinery such as pumps. | 10 |
| 3 | Particle Dynamics, Flow through Fixed and Fluidised Beds | 04 |
| 4 | Equations of Continuity and Motion in laminar flows and its applicationsfor simple Couette flow and Poiseuille flow applications | 06 |
| 5 | Heat conduction. Convective heat transfer and concept of heat transfercoefficient. | 04 |
| 6 | Design and constructional aspects of exchangers: Types of flows: Concurrent, counter-current and cross flows, log mean temperature difference, double pipe and Shell and tube heat exchangers. Introduction to other heat exchangers like, PHE, finned tube heat exchangers, graphite block, etc. | 10 |
| 7 | Heat transfer aspects in agitated tanks, condensers, reboilers and evaporators. | 06 |
| 8 | Fundamentals of mass transfer: Molecular diffusion in fluids, concept ofmass transfer coefficients, and interface mass transfer. | 04 |
| 9 | Theories of Mass transfer, Analogies for heat and mass transfer, Empirical correlations | 04 |
| 10 | Mass transfer applications in simple 1-D situations. | 08 |
| | **Total** | **60** |

**List of Textbooks/ Reference Books**

| | |
|---|---|
| 1 | Transport Phenomena, Bird R.B., Stewart W.E., Lightfoot E.N. |
| 2 | Fluid Mechanics, Kundu Pijush K. |
| 3 | Fluid Mechanics, F. W. White |
| 4 | Unit Operations of Chemical Engineering, McCabe, Smith |

**Course Outcomes (students will be able to….)**

| | | |
|---|---|---|
| CO1 | Calculate friction factor, pressure drop, power requirements of singe phase flow in a circular pipe | K2 |
| CO2 | Select appropriate pump based on flow and head requirements | K3 |
| CO3 | Calculate heat transfer coefficients and do basic sizing of double pipe and shell and tube heat exchangers | K3 |
| CO4 | Perform preliminary sizing of phase change equipment such as reboilers and condensers | K3 |
| CO5 | Calculate mass transfer coefficients and estimate mass transfer rates in simple situations | K3 |
| CO6 | Understand empirical correlations and solve various equations analytically or numerically | K2 |

| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating |
|---|

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |
| CO2 | 1 | 2 | 2 | 0 | 2 | 0 | 1 | 2 | 2 | 0 | 2 | 0 |
| CO3 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| CO4 | 0 | 0 | 2 | 1 | 2 | 1 | 0 | 0 | 2 | 1 | 2 | 1 |
| CO5 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 |
| CO6 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 1 | 1 | 2 | 2 | 1 |
| CO2 | 2 | 1 | 1 | 2 | 3 | 0 |
| CO3 | 2 | 2 | 2 | 3 | 3 | 0 |
| CO4 | 1 | 1 | 2 | 3 | 3 | 1 |
| CO5 | 1 | 1 | 1 | 2 | 3 | 1 |
| | 1 | 1 | 1 | 2 | 3 | 1 |

| **PCC** | **Course Code: FDT 1013** | **Course Title: SPL5: Food Chemistry** | **Credits = 3** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: IV** | **Total contact hours: 45** | **2** | **1** | **0** |

**List of Prerequisite Courses**

Basics of Organic, Inorganic, Physical and Analytical Chemistry and SPL 1: Chemistry of Food Constituents, Organic Chemistry I, Physical Chemistry-I, Analytical Chemistry, Industrial Inorganic Chemistry

**List of Courses where this course will be prerequisite**

Food chemistry Lab, PR 3: Technical Analysis Lab, Principles of Food Analysis, Food Safety, Quality & Regulations

**Description of relevance of this course in the B. Tech. Program**

This course is designed to understand the interactions of different constituents within the food systems and their effects on processing, nutritional and sensory quality. Knowledge of this course will help to understand the various anti-nutritional factors, contaminants and toxicants present in food systems.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | Interactions amongst food constituents including those between the constituents themselves and with each other (water, protein, lipids, carbohydrates, minerals, vitamins), and the consequences thereof on nutritional, safety & sensory quality such as color & texture of foods. Examples include starch-lipid complexes, protein-polysaccharide interactions, protein-protein interactions leading to unnatural amino acids and racemization of amino acids, starch-polyphenol complexes. | 09 |
| 2 | Interactions of food constituents with external agents such as with flavours, food additives; among food additives; packaging materials and flavours; and the consequences thereof on nutritional, safety and sensory quality of foods | 06 |
| 3 | Contaminants generated during food processing (acrylamide, benzene, hydroxymethyl furfural, nitrosamines) and those that find their way in to foods as environmental contaminants (polychlorinated biphenyls, polychlorinated aromatic hydrocarbons, dioxins and furans, pesticide residues) | 06 |

| | | |
|---|---|---|
| 4 | Anti-nutritional factors of significance in foods (trypsin inhibitors, phytates, tannins, hemagglutinins) and ways to mitigate them in products as legumes and millets | 03 |
| 5 | Microbial toxins of concern in foods and the effect of food processing therein. Examples are aflatoxin, patulin, bacterial toxins, zearalenone and such others. | 03 |
| 6 | Browning reactions in foods – Caramelization, enzymatic, non-enzymatic, ascorbic acid induced, and approaches to mitigate them. Impact of food processing on browning reactions, Role of browning reactions in foods; beneficial and adverse impacts of browning reactions on food organoleptic properties, browning and food quality, impact of browning reactions on nutritive value of foods. | 07 |
| 7 | Natural colors in foods: chemical structure, extraction, stability in food products and during processing | 02 |
| 8 | Flavours in foods – classification of flavours (natural, nature-identical and artificial); chemical pathways for generation of flavours in thermally processed and biochemical pathways for generation of flavours in fermented foods; quality assurance of flavours; selection of flavours for different types of foods, e.g. bakery, confectionary, microwaveable foods etc; off flavours and taints in foods | 09 |
| | **Total** | **45** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Food Chemistry – Belitz H.D, Grosch W, and Schieberle. P.3rd Edn. Springer Berlin / Heidelberg | |
| 2 | Food Chemistry- Fennema O.R 2nd Edn., Marcel Dekker, New york. (1985) | |
| 3 | Principles of Food Chemistry by JM deMan, JW Finley, WJ Hurst, CY Lee. Springer Nature. Fourth Edition (2018). ISBN – 9783319636078 | |
| 4 | Ingredient interactions: Effects on food quality by AK Gaonkar, Andrew McPherson. CRC Press, 2nd Edition (2016). ISBN 9780824757489 | |
| 5 | Interactions of food components, Dose DJ & Robertson A, Campden Food Preservation Research Association (1990). | |
| 6 | Natural toxic compounds of foods by J Davidek. CRC Press (2018). ISBN 9781315895833 | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Describe the chemical composition of various food commodities and the interactions of different constituents within the food systems | K2 |
| CO2 | Describe the standards of identity based on authentic chemical composition and analytical techniques | K2 |
| CO3 | Explain the various contaminants and toxicants present in the food systems | K2 |
| CO4 | Describe the presence of different anti-nutritional factors in foods | K2 |
| CO5 | Extrapolate the knowledge gained to judge the quality and authenticity of the food | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 0 | 1 | 2 | 0 | 1 | 2 |
| CO3 | 2 | 1 | 2 | 2 | 1 | 2 |
| CO4 | 1 | 0 | 0 | 1 | 0 | 0 |
| CO5 | 1 | 2 | 2 | 1 | 2 | 2 |

| PCC | Course Code: FDT 1028 | Course Title: SPL6: Food Safety and Quality Regulations | Credits = 3 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: IV | Total contact hours: 45 | 2 | 1 | 0 |

| List of Prerequisite Courses | |
|---|---|
| Introduction to Food Science and Technology, Principles of Food Analysis | |

| List of Courses where this course will be prerequisite |
|---|
| None |

| Description of relevance of this course in the B. Tech. Program |
|---|
| This course is designed to explain the functional role and safety issues of food contaminants, food adulteration, hygiene and sanitation in food processing plant, equipment, storage and handling, various quality attributes of food and emphasizing on microbial quality control in food and water quality. Knowledge of this course will help to conduct a food safety-based risk assessment at different stages of production of food and thereby designing the HACCP, VACCP and TACCP system. Students will get acquitted with role, standard and law set by Indian and global regulatory authorities with respect to food quality control. |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | **Indian Regulations:** Overview of FSSAI. Detail of FSS Regulations relevant to products and labelling. (FSS Licensing & Registration including Schedule IV, Product Standards & Additives, Labelling & Display, Advertisement & Claims) Introduction to food safety and security: Hygienic design of food plants and equipment. | 15 |
| 2 | **Food quality**: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities. | 08 |
| 3 | **Food Safety Management System**: Food Safety, Threat and Fraud Management based on international standards (HACCP / VACCP / TACCP). | 14 |
| 4 | **Global regulations:** FAO, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection, Convention (IPPC).<br>Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.<br>**Overview of US and EU regulations for food** | 08 |
| | **Total** | **45** |

| List of Textbooks/ Reference Books | |
|---|---|
| 1 | Handbook of Food Toxicology by S. S. Deshpande |
| 2 | The Food Safety Information Handbook by Cynthia A. Robert, 2009 |
| 3 | Nutritional and Safety Aspects of Food Processing by Tannenbaum SR |
| 4 | Microbiological Safety of Food by Hobbs BC, 1973 |
| 5 | Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick |

| | Course Outcomes (students will be able to….) | |
|---|---|---|
| CO1 | Describe the functional role and safety issues of food contaminants, food adulteration, food additives, food packaging & labelling | K2 |
| CO2 | Design the hygiene and sanitation in food processing plant, equipment, storage, and handling | K3 |
| CO3 | Analyse the various quality attributes of food and especially on microbial quality control of food and water in Food Processing Industry | K4 |
| CO4 | Identify and analyze the critical quality control point in different stages of production of food and thereby designing the HACCP system | K4 |
| CO5 | Explain the role, standard and law set by Indian and global regulatory authorities with respect to food quality control | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 3 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 1 | 2 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 2 |

| VEC | Course Code: HUT1206 | Course Title: Environmental Science and Technology | Credits = 2 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: IV | Total contact hours: 30 | 1 | 1 | 0 |

**List of Prerequisite Courses**

NIL

**List of Courses where this course will be prerequisite**

Research Project and Professional Career

**Description of relevance of this course in the B. Tech. Program**

The course is very useful for the future Chemical Engineers and Technologists for assessing and appreciating impact of chemical processes and technologies on the Environment. The students will be exposed to the nitty-gritties of the impact of design principles on the Environment. Thorough understanding of these technology aspects is going to help in innovative solutions with positive impact on the environment.

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Introduction to all prevailing international standards of Health, Safety, and Environment (HSE); Environmental laws and regulations; Standards (air quality, noise, water), ISO14000+ | 3 |
| 2 | Environmental impact assessment, Life cycle assessment (LCA) | 3 |
| 3 | Pollution prevention in chemical manufacturing, effluent valorization | 2 |
| 4 | Air pollution; Air pollutants: sources (specific pollutants), effects, and dispersion modelling, air pollution, air quality, pollutants minimisation and control, fugitive emissions (source and control), Noise pollution | 4 |
| 5 | Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste | 4 |
| 6 | Inherent safety; Major disasters (e.g. Flixborough, UK; Bhopal, India; Seveso, Italy; Pasadena, Texas; Texas City, Texas; Jacksonville, Florida; Port Wentworth, Georgia) | 5 |
| 7 | Toxicology; Industrial hygiene | 2 |
| 8 | Source models; Toxic release and dispersion models | 5 |
| 9 | Fires and explosions; Concepts to prevent fires and explosions | 3 |
| 10 | Chemical reactivity | 2 |

| | | |
|---|---|---|
| 11 | Reliefs and reliefs sizing; Hazard identification; Risk assessment | 4 |
| 12 | Safety procedures and designs | 4 |
| 13 | Some case histories | 4 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Environmental Studies by R. Rajagopalan, Oxford University Press. | |
| 2 | Essentials of Environmental Studies by Kurian Joseph & Nagendran, Pearson | |
| 3 | Education Renewable Energy by Godfrey Boyle, Oxford Publications | |
| 4 | Perspective of Environmental Studies, by Kaushik and Kaushik, New Age | |
| 5 | International Environmental Studies by. Anandita Basak, Pearson Education | |
| 6 | Textbook of Environmental Studies by Dave and Katewa, Cengage Learning | |
| 7 | Environmental Studies by Benny Joseph, Tata McGraw Hill | |
| 8 | Textbook of Environmental studies by Erach Books Bharucha, University Press. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Calculate BOD / COD for a given composition of effluent stream, estimation of biokinetics. | K3 |
| CO2 | Calculate adiabatic lapse rate and determine conditions for suitability of atmospheric dispersion, effective stack height, chimney design. | K3 |
| CO3 | Calculate concentrative of pollutant at any point in the neighbourhood of emission given atmospheric conditions like wind, dispersion, environmental factors, etc. | K3 |
| CO4 | Calculate size/time/power required for primary clarifier, secondary treatment, tertiary treatment, sizing of different types of Biological treatments etc. | K3 |
| CO5 | Identify hazards in a given process and assess the same and provide solutions for operating safely. | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO3 | 3 | 3 | 0 | 2 | 2 | 3 | 1 | 3 | 3 | 1 | 3 | 2 |
| CO4 | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 0 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 3 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 1 | 2 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 2 |

| **EEM** | **Course Code: CET1805** | **Course Title: Chemical Process Economics** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: IV** | **Total contact hours: 30** | **2** | **0** | **0** |
| | | | | | |
| **List of Prerequisite Courses** | | | | | |

| | | |
|---|---|---|
| Process Calculations (CEP1720), Basics of Economics and Finance (HUT1205) | | |
| **List of Courses where this course will be prerequisite** | | |
| Home Paper I and II | | |
| **Description of relevance of this course in the B. Tech. Program** | | |
| This course is required for the future professional career | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | Estimation of Plant and Machinery cost, Capacity Index, Cost Indices | 08 |
| 2 | Relationship between price of a product and project cost and cost of production, EV analysis.<br>Elements of cost of production, monitoring of the same in a plant, Meaning of Administrative expenses, sales expenses etc. Introduction to various components of project cost and their estimation.<br>Project financing, debt: equity ratio, promoters, contributors, shareholders | 08 |
| 3 | Project financing, debt: equity ratio, promoters, contributors, shareholders contribution, source of finance, time value of money. Concept of interest, time value of money, selection of various alternative equipment or system based on this concept. Indian norms, EMI calculations. Depreciation concept, Indian norms and their utility in estimate of working results of project. Working capital concept and its relevance to project. | 08 |
| 4 | Estimate of working results of proposed project. Capacity utilization, Gross profit, operating profit, profit before tax, Corporate tax, dividend, Net cash accruals. Project evaluation: Cumulative cash flow analysis Break-Even analysis, incremental analysis, various ratios analysis, Discounted cash flow analysis | 06 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Chemical Project Economics, Mahajani V.V. and Mokashi SM. | |
| 2 | Plant Design and Economics for Chemical Engineers,Peters M.S.,Timmerhaus K.D. | |
| 3 | Process Plant and Equipment Cost Estimation, Kharbanda O.P. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Calculate working capital requirement for a given project | K3 |
| CO2 | Calculate cost of equipment used in a plant total project cost | K3 |
| CO3 | Calculate cash-flow from a given project | K3 |
| CO4 | Select a site for the project from given alternatives | K4 |
| CO5 | List out various milestones related to project concept to commissioning | K2 |
| CO6 | Calculate overall profitability and rate of return for a given project | K5 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 3 | 1 | 3 | 3 |
| CO2 | 3 | 3 | 1 | 2 | 2 | 1 | 2 | 1 | 3 | 1 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 1 | 3 | 3 |
| CO6 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 3 | 1 | 3 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 2 | 2 | 1 | 2 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO2 | 1 | 2 | 2 | 1 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 1 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 3 | 1 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 2 |

| PCC | Course Code: FDP 1036 | Course Title: Pr3: Technical Analysis Lab I | Credits = 2 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: IV | Total contact hours: 60 | 0 | 0 | 4 |

**List of Prerequisite Courses**

None

**List of Courses where this course will be prerequisite**

SPL 2: Principle of Food Preservation, Food Analysis - I Lab

**Description of relevance of this course in the B. Tech. Program**

This course is designed to understand the principles behind analytical techniques associated with sugar & water sample. Knowledge of this course will help to select the appropriate analytical technique when presented with a practical problem, demonstrate practical proficiency in a food analysis laboratory, use different analytical techniques to find out the properties of foods and food waste samples.

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Hardness of Water | 04 |
| 2 | Water Hardness by Soap Titration | 04 |
| 3 | Estimation of Alkalinity of Water | 04 |
| 4 | Estimation of Sulphates in Water | 04 |
| 5 | Estimation of Chloride by Mohr's Method | 04 |
| 6 | Qualitative Analysis of Amino Acid | 04 |
| 7 | Estimation of Copper | 04 |
| 8 | Estimation of Ferric Ions | 04 |
| 9 | Estimation of Zinc | 04 |
| 10 | Estimation of Manganese | 04 |
| 11 | Estimation of Nitrite | 04 |
| 12 | Estimation of Phosphate | 04 |
| 13 | Chemical Oxygen Demand | 04 |
| 14 | Biochemical Oxygen Demand | 04 |
| | **Total** | **60** |

**List of Textbooks/ Reference Books**


| | |
|---|---|
| 1 | Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education. |
| 2 | Kirk, S., & Sawyer, R. (1991). *Pearson's composition and analysis of foods* (No. Ed. 9). Longman Group Ltd.. |


**Course Outcomes (students will be able to….)**

| | | |
|---|---|---|
| CO1 | Perform and demonstrate the analytical techniques associated with sugar & water samples | K3+P2 |
| CO2 | Demonstrate the analytical techniques associated with mineral estimation in food samples | K3+P2 |
| CO3 | Select the appropriate analytical technique when presented with a practical problem | K4+P2 |
| CO4 | Demonstrate practical proficiency in a food analysis laboratory | K3+P2 |
| CO5 | Categorize and recommend suitable analytical technique to find out the properties of foods and food waste samples | K4+P2 |

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating

| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 – Embody |
|---|

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 1 | 1 | 2 | 1 |
| CO2 | 1 | 0 | 1 | 1 | 2 | 2 |
| CO3 | 2 | 1 | 0 | 1 | 0 | 1 |
| CO4 | 2 | 1 | 1 | 2 | 2 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 2 | 1 |

| **CEP/ FP** | **Course Code:** XXXXXXX | **Course Title:** Community Engagement Projects | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: IV** | **Total contact hours: 60** | **0** | **0** | **4** |

| **List of Prerequisite Courses** | |
|---|---|
| NIL | |
| **List of Courses where this course will be prerequisite** | |
| NIL | |
| **Description of relevance of this course in the B. Tech. Program** | |
| Students will explore the various community projects as individual, or groups related to study of societal technological activities through various organizations. | |

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Chemical Technology has the main objective of making the knowledge useful for the benefit of society.<br>Students, individually or in a group of not more than 5, shall identify the problems faced by the society in their neighborhood or city, or the state. They shall collect necessary data, collate relevant information and identify a problem that can be solved using their knowledge of own field or general sciences and propose an affordable solution. The team shall then execute the project with support from Institute, Local Society groups, NGOs, Industry.<br>OR<br>Community service: Helping students in studies, making colorful charts, short notes, activity games, teaching street children, helping in school assignments, visiting old age homes and childcare Centre etc. | 60 |
| | Some of the suggested projects (not limited to) are:<br>• Food Safety awareness<br>• Food adulteration<br>• Food regulations awareness programs<br>• Nutritional security related project | |

| | | |
|---|---|---|
| | • Food security related projects<br>• Mid-day meal options<br>• Food waste management at different organisations<br>• Sustainable food packaging | |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | General Books, News paper etc | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | This course will help students to contribute of social networking as a bridge between the various government schemes and the people of India. The course also outlines the benefits of community engagement through research and innovation. | K2 |
| CO2 | Sensitivity towards the environment and education, safety and energy, enthusiasm towards physical, mental and spiritual health along with simple living and high thinking have been explained for better understanding of the students. | K2 |
| CO3 | Students will be able to understand the various problems of any community and the possible ways to address the same. | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 |
| CO2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 |
| CO3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 2 | 3 | 1 | 1 | 2 |
| CO2 | 2 | 2 | 3 | 1 | 2 | 2 |
| CO3 | 1 | 2 | 3 | 1 | 2 | 2 |

# THIRD YEAR: SEMESTER – V

| PCC | Course Code: CET1806 | Course Title: Chemical Reaction Engineering | Credits = 2 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: V | Total contact hours: 30 | 1 | 1 | 0 |

**List of Prerequisite Courses**

Physical Chemistry (CHT1405), Process Calculations (CEP1720), Transport Phenomena (CET1105)

**List of Courses where this course will be prerequisite**

Chemical engineering laboratory (CEP1714)

**Description of relevance of this course in the B. Tech. Program**

Chemical Reaction Engineering is concerned with the utilization of chemical reactions on a commercial scale. This course is very relevant but not limited to the following industries: Inorganic chemicals, organic chemicals, petroleum & petrochemicals, Pulp & paper, Pigments & paints, rubber, plastics, synthetic fibres, Foods, Dyes and intermediates, Oils, oleo chemicals, and surfactants, Minerals, clean sing agents, Polymers and textiles, Biochemicals and biotechnology, pharmaceuticals and drugs, Microelectronics, energy from conventional and non-conventional resources, Metals.

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Kinetics of homogeneous reactions, Interpretation of batch reactor data, Single ideal reactors including design aspects | 08 |
| 2 | Multiple reactions, Temperature, and pressure effects | 03 |
| 3 | Introduction to Non ideal flow, RTD measurements, Models to predict conversions | 02 |
| 4 | Homogeneous and Heterogeneous Catalysis, Kinetics of Solid Catalyzed Reactions. Design of gas – solid catalytic reactors | 08 |
| 5 | Introduction to Multiphase reactors | 04 |
| 6 | Mass transfer with chemical Reactions: Regimes of operation and Model contactors | 05 |
| | **Total** | **30** |

**List of Textbooks/ Reference Books**

| | |
|---|---|
| 1 | Elements of Chemical Reaction Engineering – H.Scott Fogler |
| 2 | Heterogeneous Reactions, Vol.I and II –L.K. Doraiswamy, M.M.Sharma |

**Course Outcomes (students will be able to….)**

| | | |
|---|---|---|
| CO1 | Estimate kinetics of chemical reaction based on laboratory data | K3 |
| CO2 | Derive design expressions for ideal reactor systems such as batch, plug flow and continuous stirred tank reactor | K3 |
| CO3 | Estimate conversion, yield and selectivity for different chemical reactions | K3 |
| CO4 | Compare various reactors and select an appropriate reactor for a given situation | K4 |
| CO5 | Select appropriate multiphase reactor based on reaction chemistry, heat and mass transfer aspects | K4 |
| CO6 | Identify rate controlling mechanism of a given reaction system involving mass transfer | K4 |

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating

**Mapping of Course Outcomes (COs) with Programme Outcomes (POs)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 3 | 3 | 3 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 3 |
| CO6 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 1 | 1 | 2 | 1 |
| CO2 | 1 | 0 | 1 | 1 | 2 | 2 |
| CO3 | 2 | 1 | 0 | 1 | 0 | 1 |
| CO4 | 2 | 1 | 1 | 2 | 2 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 2 | 1 |

| **PCC** | **Course Code: CET1807** | **Course Title: Chemical Engineering Operations** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: V** | **Total contact hours:** | **1** | **1** | **0** |

**List of Prerequisite Courses**

Process Calculations (CEP1720), Transport Phenomena (CET1105)

**List of Courses where this course will be prerequisite**

This is a basic course. It is required in many other courses that involve physical processes

**Description of relevance of this course in the B. Tech. Program**

This is a basic Chemical Engineering course. The principles learnt in this course are required in almost all the courses and throughout the professional career of student.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | Distillation: Fundamentals of flash, batch and continuous distillation, distillation columns internals, steam and azeotropic distillation | 10 |
| 2 | Liquid-Liquid Extraction: Solvent selection, construction of ternary diagrams, staged calculations, types of extraction equipment. | 05 |
| 3 | Crystallization: Phase diagram (temp/solubility relationship), evaporative and cooling crystallization, introduction to different types of crystallizers | 05 |
| 4 | Filtration: Mechanism of filtration, basic equation, constant volume, constant pressure filtration, rate expressions with cake and filter cloth resistances, compressible and incompressible cakes, introduction to various types of filters | 05 |
| 5 | Drying: Drying mechanism, drying rate curves, estimation of drying time and types of dryers | 05 |
| | **Total** | **30** |

**List of Textbooks/ Reference Books**


| | |
|---|---|
| 1 | Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., 2002. Chemical engineering: Particle technology and separation processes. Butterworth-Heinemann, Woburn, MA. |
| 2 | Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J. |
| 3 | Svarovsky, L., 2000. Solid-Liquid Separation. Butterworth-Heinemann, Woburn, MA. |
| 4 | McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7 ed. McGraw-Hill Science/Engineering/Math, Boston. |

| | |
|---|---|
| 5 | Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh. |
| 6 | Dutta, B.K., 2007. Principles of Mass Transfer and Separation Process. Prentice-Hall of India Pvt. Ltd, New Delhi. |

| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Understand and compare various unit operations used in the chemical and allied industries | K3 |
| CO2 | Perform preliminary sizing of continuous and batch distillation columns | K3 |
| CO3 | Analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage | K4 |
| CO4 | Construct ternary equilibrium diagram based on laboratory scale experimental data | K3 |
| CO5 | Understand the working principle of various industrial extraction, crystallization, filtration and drying equipment | K2 |
| CO6 | Select and carry out preliminary sizing of various industrial extraction, crystallization, filtration and drying equipment | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 |
| CO2 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 |
| CO6 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 |
| CO3 | 3 | 2 | 2 | 1 | 0 | 1 |
| CO4 | 2 | 2 | 3 | 1 | 1 | 2 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 1 |
| CO6 | 2 | 2 | 3 | 2 | 1 | 2 |

| **PCC** | **Course Code: FDT 1012** | **Course Title: SPL7: Food Additives and Ingredients** | **Credits = 4** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: V** | **Total contact hours: 60** | **3** | **1** | **0** |

| **List of Prerequisite Courses** | |
|---|---|
| Introduction to Food Science and Technology | |
| | |

| **List of Courses where this course will be prerequisite** |
|---|
| Technology of Fruits, Vegetables and Tubers; Technology of Dairy and Animal Products; Technology of Plantation Products; Technology of Cereals, Legumes and Oilseeds. |
| |

| **Description of relevance of this course in the B. Tech. Program** |
|---|

| | | |
|---|---|---|
| This course is designed to understand the classification of food additives and ingredients, significance of different food additives and ingredients in food quality, safety of use of food additives and ingredients. Knowledge of this course will help to understand Maximum Permissible Limit (MPL) of additives and ingredients in foods, effect of different process conditions on stability of food additives and ingredients. | | |
| | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | Additives in food processing and preservation, their functions and safety | 02 |
| 2 | Safety and quality evaluation of additives and ingredients, acute and chronic studies, LD50 | 02 |
| 3 | Analytical methods, chemical and instrumental | 02 |
| 4 | Various additives such as preservatives (4), antioxidants and sequestrants (4), colours and flavours and flavor enhancers (4), emulsifiers (3), humectants (3), hydrocolloids (6), stabilizers and sweeteners (3), acidulants etc (3), with respect to chemistry, food uses and functions in formulations. New emerging additives, regulations as per CODEX and FSSAI | 30 |
| 5 | Indirect food additives | 02 |
| 6 | Colour additives in foods and their stability | 04 |
| 7 | Classification of flavours and the process of preparing including extraction, distillation, fractionation and purification; Stability of flavours | 06 |
| 8 | Ingredients used in food production e. g. sugars, starches, proteins/protein hydrolysates/isolates, fats, prebiotic oligosaccharides, pectin, chitin, and their technology of production and application, unusual protein sources such as insect proteins, mycoproteins | 12 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Food Additives, 2nd and, AL Brannen, PM Davidson, S Salminen, JH Thorngate III, 2002 (eds). Marcel Dekker Inc, New York, pp. 1-9 | |
| 2 | Handbook of Food Additivies, 2nd edn, TE Furia, 1972, (ed) CRC Press, Cleveland, Ohio. | |
| 3 | Functional Foods – Designer Foods, Pharma Foods, Nutraceuticals, Israel Goldberg (Editor) (1994), Chapman and Hall, New York. | |
| 4 | The chemistry of food additives and preservatives, Titus A. M. Msagati, (2012) | |
| 5 | Natural food additives, ingredients, and flavourings, D Baines, R Seal, (2012), Woodhead Publishing Series in Food Science, Technology and Nutrition. | |
| 6 | Indirect Food Additives and Polymers: Migration and Toxicology, Victor O. Sheftel, CRC Press (2000) | |
| 7 | The Role of Alternative and Innovative Food Ingredients and Products in Consumer Wellness, Charis M. Galankis, Academic Press (2019) | |
| 8 | Essential guide to food additives, Mike Saltmarsh, 4 th Edition, Royal Society of Chemistry, UK (2019). | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Describe the various additives and ingredients used in food industries | K2 |
| CO2 | Describe the mechanisms of food additives involved in foods and explain their significance in food quality, preservation, and storage | K2 |
| CO3 | Describe the safety of use of food additives and ingredients | K2 |
| CO4 | Extrapolate the knowledge gained on food additives and ingredients in food industries | K3 |
| CO5 | Describe the process of preparation of food additives and ingredients | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 1 | 1 | 2 | 1 |
| CO2 | 1 | 0 | 1 | 1 | 2 | 2 |
| CO3 | 2 | 1 | 0 | 1 | 0 | 1 |
| CO4 | 2 | 1 | 1 | 2 | 2 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 2 | 1 |

| **PCC** | **Course Code: FDP 1015** | **Course Title: Pr4: Food Chemistry Lab** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: V** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

Technical Analysis Lab I, Food Chemistry

**List of Courses where this course will be prerequisite**

Food Analysis, Analysis of Foods (Chemical), Food Processing and Product Development

**Description of relevance of this course in the B. Tech. Program**

This course is designed to train the students with hands on experience with chemical compositions of foods and assist them for analysing various food constituents, additives present in the food such as nutrients (vitamins), antinutritional factor (tannins, anthocyanins, flavonoids) etc.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Estimation of sulphur dioxide (KMS) | 04 |
| 2 | Estimation of sodium benzoate | 04 |
| 3 | Estimation of sorbic acid and sorbate | 04 |
| 4 | Estimation of Propyl gallate | 04 |
| 5 | Estimation of iodine in iodized salt | 04 |
| 6 | Identification of hydrocolloids | 04 |
| 7 | Estimation of chlorophyll and carotenoids and their separation on column chromatography | 04 |
| 8 | Estimation of tin in canned foods | 04 |
| 9 | Detection of food adulteration | 04 |
| 10 | Demonstration experiments on isolation of starch, proteins and hydrocolloids | 04 |
| 11 | Estimation of lipid oxidation parameters | 04 |
| 12 | Estimation of damaged starch in cereal flour | 04 |
| 13 | Antioxidant Assay (DPPH/FRAP) | 04 |
| 14 | Estimation of anti-nutritional factors | 04 |
| 15 | Sensory analysis of foods | 04 |
| | **Total** | **60** |

**List of Textbooks/ Reference Books**

| | |
|---|---|
| 1 | Handbook of food analysis. Volume I- Nollet, Leo M. L., Toldrá, Fidel. CRC Press: ISBN – 9781482297843 (Third edition - 2005) |
| 2 | Food Analysis- S. Suzanne Nielsen. Springer Food Science Text Series: ISBN – 9783319457741 (5th ed. 2017) |
| 3 | Food Analysis Laboratory Manual- S. Suzanne Nielsen. Springer International Publishing Food Science Text Series: ISBN – 9783319441276 (3rd Ed. 2017) |
| 4 | Methods in Food Analysis- Rui M. S. Cruz, Igor Khmelinskii, Margarida Vieira. CRC Press: ISBN – 9781482231953 (2014) |
| 5 | Handbook of food analysis- Leo M L Nollet. Marcel Dekker-Food science and Technology Series: ISBN – 9780824750381 (2nd Ed 2004) |

| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Understand the principles of different analytical techniques associated with food and demonstrate practical proficiency in a food analysis laboratory | K4+P3 |
| CO2 | Identify the appropriate analytical technique when presented with a practical problem | K3+P3 |
| CO3 | Describe and use principal analytical methods used for quantifying the composition and reactions of food components | K3+P3 |
| CO4 | Interpret and report data derived from chemical experiments/analysis in a meaningful way | K4+P3 |
| CO5 | Apply basic statistical methods to sampling/testing and the analysis of experimental data (e.g., relate this to QC or HACCP) | K3+P3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

**Mapping of Course Outcomes (COs) with Programme Outcomes (POs)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

**Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO5 | 1 | 1 | 1 | 0 | 1 | 3 |

| **PCC** | **Course Code: FDT1037** | **Course Title: Pr5: Technical Analysis II** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: V** | **Total contact hours: 60** | **0** | **0** | **4** |

| **List of Prerequisite Courses** | |
|---|---|
| None | |

| List of Courses where this course will be prerequisite |
|---|
| Food Analysis - I Lab |
| |
| **Description of relevance of this course in the B. Tech. Program** |
| This course is designed to understand the principles behind analytical techniques associated with sugar & water sample, select the appropriate analytical technique when presented with a practical problem. Knowledge of this course will help to demonstrate practical proficiency in a food analysis laboratory, guide the students for usage of different analytical techniques to find out the properties of foods and food waste samples. |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Estimation of Glucose by Lane and Eynon's & Willstatter's Method | 04 |
| 2 | Estimation of Sucrose by Lane and Eynon's Method | 04 |
| 3 | Estimation of Sucrose and Lactose | 04 |
| 4 | Estimation of Reducing Sugar by Bertard's Volumetric Method | 04 |
| 5 | Estimation of Glucose and Maltose by Sichert and Bleyer's Method | 04 |
| 6 | Estimate ∝-Amino Nitrogen by Sorenson's Formal Titration | 04 |
| 7 | Qualitative Analysis of Sugar | 04 |
| 8 | Qualitative Analysis of Fats | 04 |
| 9 | Proximate Analysis of Foods | 04 |
| 10 | Identification of Sugars & amino acids by Paper Chromatography | 04 |
| 11 | Protein Precipitation Reaction | 04 |
| | **Total** | **60** |

| List of Textbooks/ Reference Books | |
|---|---|
| 1 | Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education. |
| 2 | Kirk, S., & Sawyer, R. (1991). *Pearson's composition and analysis of foods* (No. Ed. 9). Longman Group Ltd.. |

| Course Outcomes (students will be able to….) | | |
|---|---|---|
| CO1 | Perform and demonstrate the analytical techniques associated with sugar & water samples | K3 |
| CO2 | Demonstrate the analytical techniques associated with mineral estimation in food samples | K3 |
| CO3 | Select the appropriate analytical technique when presented with a practical problem | K4 |
| CO4 | Demonstrate practical proficiency in a food analysis laboratory | K3 |
| CO5 | Categorize and recommend suitable analytical technique to find out the properties of foods and food waste samples | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 |
| CO3 | 3 | 2 | 2 | 0 | 1 | 1 |
| CO4 | 3 | 2 | 2 | 1 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 0 | 1 |

# THIRD YEAR: SEMESTER – VI

| PCC | Course Code: FDT1014 | Course Title: SPL9: Food Microbiology | Credits = 3 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: VI | Total contact hours: 45 | 2 | 1 | 0 |

| List of Prerequisite Courses | |
|---|---|
| Basics of Microbiology | |

| List of Courses where this course will be prerequisite |
|---|
| Food Biotechnology |

| Description of relevance of this course in the B. Tech. Program |
|---|
| This course is designed to understand the concept of general microbiological ecology and control of food and food-based products. Knowledge of this course will help students to identify the conditions, including sanitation practices, under which the important pathogens and spoilage microorganisms are commonly inactivated, killed or made harmless, understand microbiological concerns in product development, e.g., new formulations, new packaging, new processes. |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Factors affecting spoilage of foods and associated microflora; Intrinsic and extrinsic factors affecting spoilage of foods; biochemical changes caused by microorganisms - putrefaction, lipolysis; Antagonism and synergism in microorganisms | 05 |
| 2 | Microbiological spoilage problems associated with typical food products such as dairy products, fruits and vegetables, grains and oilseeds, meat/fish and poultry, spices, and their control | 09 |
| 3 | Food borne infections and food poisoning, Microbial toxins, Emerging pathogens. | 06 |
| 4 | Detection methods for *E. coli*, *Staphylococci*, *Yersinia*, *Campylobacter*, *B. cereus*, *C. Botulinum* & *Salmonella* from food samples. | 10 |
| 5 | Indicator organisms, microbiological quality assurance systems in food industry, use of the hazard analysis critical control points system to ensure microbiological safety and quality of foods, microbiological food standards | 06 |
| 6 | Rapid methods of microbial analysis; applications of immunological techniques to food industry | 09 |
| | **Total** | **45** |

| List of Textbooks/ Reference Books | |
|---|---|
| 1 | Food Microbiology: Frazier W.C. and Dennis C. Westhoff 5th Edn. Tata McGraw-Hill Publishing Co. Ltd. (2013). |
| 2 | Modern Food Microbiology- Jay, James M., Loessner, Martin J., Golden, David A, Aspen Publishers, Inc, 7th ed. (2004) |
| 3 | Food Microbiology and Fundamentals and Frontiers: Doyle M.P, Beuchat L.R, Montville T.J.2nd Edn. ASM Press, Washington D.C. (2001) |
| 4 | Food Borne Bacterial Pathogens: Doyle, M.P. Marcel Dekker Inc. (1989) Basic Food Microbiology; George J. Banwart, Chapman and Hall (1999) |
| 5 | Food Microbiology (Third Edition). Martin R. Adams and Maurice O. Moss. RSC Publishing. ISBN 978-0-85404-284-5 |

| Course Outcomes (students will be able to….) | | |
|---|---|---|
| CO1 | Describe the different factors associated with microbial spoilage of food and the corresponding biochemical changes in it | K2 |

| | | |
|---|---|---|
| CO2 | Explain the spoilage and methods of controlling the microbial spoilage for specific food products and describing the fundamentals of food fermentation | K2 |
| CO3 | Describe different food borne infections and food poisoning, microbial toxins and functions of newer pathogens | K2 |
| CO4 | describe and apply different detection methods of critical microorganism, rapid methods of microbial analysis, and applications of immunological techniques to food industry | K3 |
| CO5 | Identify the target organism in specific food and design the hazard analysis critical control points system ensuring microbiological safety and quality of foods | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 2 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 2 | 0 | 0 |
| CO4 | 3 | 2 | 2 | 2 | 1 | 0 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 2 |

| **PCC** | **Course Code: FDT1059** | **Course Title: SPL10: Principles of Food Preservation** | **Credits = 3** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VI** | **Total contact hours: 45** | **2** | **1** | **0** |

**List of Prerequisite Courses**

Chemistry of Food Constituents, Microbiology, Biochemistry

**List of Courses where this course will be prerequisite**

Food Engineering, SPL8: Food Process Engineering, Food Processing and Engineering

**Description of relevance of this course in the B. Tech. Program**

This course is designed for providing understanding related to the fundamentals of food preservation through dehydration, high and low temperature processing of food. Knowledge of this course will help students to explain the principles of food preservation by advanced thermal, non-thermal processing of food, fermentation, chemical preservatives, bio- preservatives and hurdle technology.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | **Introduction to food preservation:** Food spoilage; Underlying principles of different modes of food preservation; Preservation methods with emphasis on inactivation, inhibition, and avoiding recontamination. | 04 |

| | | |
|---|---|---|
| 2 | **Dehydration and drying of foods:** Drying curve and drying time calculation; Water activity and moisture absorption isotherms; Psychometric chart; Different types of dryers-Conductive, convective, and combined; IMF foods; osmotic dehydration. | 07 |
| 3 | **Thermal processing of food products:** Sterilization and Pasteurization; Canning of food products; Classifications and structure of cans, corrosion, Lacquering; Spoilage in canned foods (1) Thermal death time (TDT) concept; Process time calculation for canned foods; Retort processing; Aseptic packaging. | 08 |
| 4 | **Newer techniques in thermal processing:** Concept of HTST; UHT; Ohmic, Dielectric, Infra-red Heating; Microwave heating; Frying method. | 06 |
| 5 | **Non-thermal processing of food:** High pressure processing; Pulsed electric field processing; Cold extrusion; Plasma processing; Ionizing Radiations; Ultrasound processing; UV and Pulsed light processing; Membrane Technology. | 10 |
| 6 | **Low temperature storage and preservation:** Chilling and Freezing; Freezing curve and water activity; Properties of frozen foods; Enthalpy change during freezing; Plank's equation for freezing time; Cold storage and Refrigeration load; Refrigeration cycle; Cryogenic freezing and IQF; Freeze concentration and freeze drying. | 05 |
| 7 | **Hurdle technology:** Role of acidity and pH in food preservation; Preservation by fermentation – Curing, Pickling and Smoking; Controlled and modified atmospheric packaging and storage; Chemical and Bio-preservatives; Antimicrobials. | 05 |
| | **Total** | **45** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Toledo, R.T. Fundamentals of Food Process Engineering, Chapman and Hall; 2000, | |
| 2 | Fellows, P.J. Food Processing Technology: Principles and Practice, CBS Publishers; 2005. | |
| 3 | Rahman, M.S. Handbook of food preservation, CRC Press; 2007. | |
| 4 | Cullen, P.J., Brijesh, K.T., Vasilis, Valdramidis, P. Novel Thermal and Non-Thermal Technologies for Fluid Foods, Elsevier Academic Press; 2012. | |
| 5 | Zhang, H.Q., Barbosa-Cánovas, G.V., Balasubramaniam, V.M., Dunne, C.P., Farkas, D.F., Yuan, J.T.C. Non-thermal Processing Technologies for Food, John Wiley & Sons; 2011. | |
| 6 | Shakuntala, N., & Many, O. Food: Facts and Principles, New Age International; 2001. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Apply the principles and develop operations using thermal technologies for food preservation | K4 |
| CO2 | Apply the principle, technology and operations of various non-thermal technologies for food preservation | K3 |
| CO3 | Analyze the concept of various advanced thermal food processing | K4 |
| CO4 | Apply the technique of low temperature in food preservation and analyse the process efficiency | K4 |
| CO5 | Apply the principles of hurdle technology in food preservation | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 2 | 1 | 1 | 3 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 2 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 2 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 2 |
| CO5 | 1 | 1 | 1 | 0 | 1 | 1 |

| **VSEC** | **Course Code: CEP1714** | **Course Title: Chemical Engineering Laboratory** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VI** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

Process Calculations (CEP1720), Transport Phenomena (CET1105), Chemical Reaction Engineering (CET1806) Chemical Engineering Operations (CET1807)

**List of Courses where this course will be prerequisite**

Chemical Engineering Laboratory (CEP1714)

**Description of relevance of this course in the B. Tech. Program**

Chemical Engineering lab provides students the firsthand experience of verifying various theoretical concepts learnt in theory courses. It also exposes them to practical versions of typical chemical engineering equipment's and servers as a bridge between theory and practice. This particular lab focuses on fluid dynamics, distillation, filtration, drying and sedimentation.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | 4 - 6 Experiments on fluid dynamics and heat transfer | 24 |
| 2 | 3 - 5 Experiments on Chemical Engineering Operations | 16 |
| 3 | 2 – 4 Experiments on Reaction Engineering | 12 |
| 4 | 1 – 3 Experiments on process dynamics and control | 08 |
| | **Total** | **60** |

**List of Textbooks/ Reference Books**

| | |
|---|---|
| 1 | McCabe W.L., Smith J.C., and Harriott P. Unit Operations in Chemical Engineering, 2014 |
| 2 | Bird R.B., Stewart W.E., and Lightfoot, E.N. Transport Phenomena, 2007 |
| 3 | Coulson J.M., Richardson J.F., and Sinnott, R.K. Coulson & Richardson's Chemical Engineering: Chemical engineering design, 1996. |
| 4 | Green D. and Perry R. Perry's Chemical Engineers' Handbook, Eighth Edition, 2007. |

**Course Outcomes (students will be able to….)**

| | | |
|---|---|---|
| CO1 | Learn how to experimentally verify various theoretical principles | K3 |
| CO2 | Visualize practical implementation of chemical engineering equipment | K4 |
| CO3 | Perform statistical analysis of experimental data | K4 |
| CO4 | Get hands on experience with various measurement devices | K2 |
| CO5 | Develop empirical correlations based on the experimental data generated | K5 |
| CO6 | Generate meaningful tables and graphs | K3 |

| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating |
|---|

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 1 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 1 | 1 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 3 | 1 | 1 | 3 |
| CO6 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 1 | 3 | 3 | 2 |
| CO2 | 1 | 1 | 1 | 2 | 3 | 1 |
| CO3 | 3 | 1 | 1 | 3 | 3 | 1 |
| CO4 | 3 | 1 | 1 | 2 | 3 | 0 |
| CO5 | 3 | 1 | 1 | 1 | 3 | 1 |
| CO6 | 3 | 1 | 1 | 2 | 3 | 1 |

| **PCC** | **Course Code: FDT 1025** | **Course Title: SPL12: Technology of Dairy and Animal Products** | **Credits =** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VI** | **Total contact hours: 60** | **3** | **1** | **0** |

| **List of Prerequisite Courses** | |
|---|---|
| Introduction to Food Science and Technology; Food Chemistry | |

| **List of Courses where this course will be prerequisite** |
|---|
| Food Processing and Engineering |

| **Description of relevance of this course in the B. Tech. Program** |
|---|
| This course is designed for providing understanding related to the role of chemical constituents on the raw material quality and nutritional, processing, sensory, and storage quality as of a wide range of dairy and animal-based products. Knowledge of this course will help the students to understand the vulnerability of dairy and animal-based products to microbial contamination and steps to mitigate them. As well through this course students will get an idea of the regulatory aspects of dairy and animal-based products. |

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| **Dairy Technology** | | |
| 1 | Milk components, composition and types; raw milk quality and processing (HTST/UHT, homogenization), CIP/COP/distribution/packaging/fermented milks/bulk starter cultures | 04 |
| 2 | Manufacture of milk-based products - condensed and evaporated milk, milk powder, cheese, ice-cream, cream, butter, ghee; their evaluation and quality parameters, defects encountered during production, packaging and storage. | 14 |

| | | |
|---|---|---|
| 3 | Non-dairy milk and milk products; Casein and caseinates, lactose, whey protein concentrates and isolates, milk co-precipitates, and other specialty products | 06 |
| 4 | Traditional dairy products, milk confections such as yoghurt, *dahi*, *khoa*, *burfi*, *kalakand*, *gulab jamun*, *rosogolla*, *shrikhand*, *chhana*, *paneer*, *ghee*, *lassi* etc. Probiotic milk products. | 06 |
| | **Total** | **30** |
| **Animal Products** | | |
| 1 | **Slaughter of food animals:** Plan and layout of slaughterhouse, Religious and scientific methods of Slaughter of Food animals; Principle and Methods of Stunning of Food Animals | 02 |
| 2 | **Handling and Transport of Food Animals:** Animal welfare and pre-slaughter care, handling and transport of meat animals including poultry. Stress and Meat quality (DFD and PSE conditions) | 01 |
| 3 | **AM and PM and Dressing of Food Animals:** Procedures of Ante-mortem and post mortem examination of meat animals, Emergency and casualty slaughter; | 02 |
| 4 | **Structure, Composition and Nutritive Value of Meat, Postmortem changes in meat:** Conversion of muscle to meat, Ageing of meat | 03 |
| 5 | **Meat Quality:** Factors affecting microbial growth, spoilage of meat; Physicochemical parameters of meat, colour, texture, Sensory evaluation of meat and meat products | 02 |
| 6 | **Meat Processing, preservation and packaging**: Meat processing- Basic processing techniques of meat viz. Smoking and Curing, emulsification; Preparation of meat products including fermented meats, Preservation of meat and meat products; Packaging of meat and meat products. | 04 |
| 7 | **Meat plant hygiene:** GMP and HACCP. National and International Laws related to meat | 01 |
| 8 | **Slaughterhouse by products:** By-products from meat industries and their utilization | 02 |
| 9 | **Meat trade:** Statistics of meat industry in India | 01 |
| 10 | **Poultry meat and Egg:** Composition and nutritional value of poultry meat and eggs, Processing of poultry meat and eggs; Preparation of different poultry and egg products, Evaluation of external and internal quality of egg; Egg preservation, Utilization of poultry by products, Microbial Spoilage and control. | 05 |
| 11 | **Fish and Fish Products:** Classification of freshwater fish and marine fish; Commercial handling, storage and transport of raw fish. Average composition of fish; Freshness criteria and quality assessment of fish; Spoilage of fish. Methods of processing and preservation of fish- Canning, Freezing, Drying, Smoking and Curing. Fish products – fish meal, fish protein concentrate, fish liver oil, fish sauce and surimi; Fish processing industries in India. | 04 |
| 12 | **Cultured meats and plant-based alternatives** | 03 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Aneja et al. 2002. Technology of Indian Milk Products. Dairy India Publ. De S.1980. Outlines of Dairy Technology. Oxford Univ. Press | |
| 2 | Rathore,NS et al. 2008.Fundamentals of Dairy Technology- Theory & Practices. Himanshu Publ | |
| 3 | Walstra et al. 2006. Dairy Science and Technology. 2nd Ed. Taylor & Francis. | |
| 4 | Spreer E. Milk and dairy product technology. CRC Press, (2017). | |
| 5 | Sebnem Ozturkoglu Budak and H. Ceren Akal, (Eds). Microbial cultres and enzymes in dairy technology. IGO Global (2018). | |
| 6 | Goyal MR & Chavan RS (Eds). Technological interventions in dairy science: Innovatives approaches to processing, preservation and analysis of milk products, Apple Academic Press (2018). | |
| 7 | Meghwal M, Goyal MR & Chavan RS (Eds). Dairy Engineering: Advanced Technologies and Their Applications, Apple Academic Press (2017). | |

| | |
|---|---|
| 8 | Web BH. et al. 1987. Fundamental of Dairy Chemistry. 3rd Ed. AVI Publ. |
| 9 | Walstra et al. 1999. Dairy Technology. Marcel Dekker. |
| 10 | Sharma BD. Modern Abattoir Practices and Animal by Products Technology, Jaypee Publisher (2003). |
| 11 | Sharma BD. Outlines of Meat Science and Technology, Jaypee Publisher (2011). |
| 12 | Aberele ED, Forrest JC, Gerrard, D. E., & Mills, E. W. Principles of Meat Science, Kendll Hunt (2001). |
| 13 | Warris, PD. Meat Science- An Introductory Text. CABI Publsihing, 2nd Edition (2010) |
| 14 | Kinsman, DM, Kotula DW & Btendstein BC. Muscle Food. destein, Marcel Dekker Inc. (1994) |
| 15 | Ockerman HW & Hansen CL. Animal By-product Processing and Utilization. CRC Press, 1st Edition (1999). |
| 16 | Toldra F. Handbook of Meat Processing, Wiley Blackwell (2010) |
| 17 | Gracey G, Collins DS & Huey R. Meat Hygiene, W.B. Saunders Company Ltd., CRC Press (1999). |
| 18 | Mountney GJ & Parkhurst CR. Poultry Products Technology. Haworth Press, 3rd edition (1995). |
| 19 | Feiner G. Meat Products Handbook, Woodhead Publishing (2006). |
| 20 | Lawrie RA. Lawrie's Meat Science, CRC Press, 8th edition (2017) |
| 21 | Meilgaard, M, Civille GV & Thomas Carr B. Sensory Evaluation Technique, CRC Press (2016) |


| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Explain fundamental knowledge on dairy-based and animal-based products | K2 |
| CO2 | Explain the facts and unit operations/flow sheet of manufacture and technologies involved in the processing/food plant sanitation of different animal products/milk and dairy products | K2 |
| CO3 | Apply techniques suitable for the extraction/isolation of high value compounds from milk/animal products | K3 |
| CO4 | Develop/design/modify new products/processes for value-addition of dairy/animal products | K3 |
| CO5 | Explain the causes related to any aspect of quality/spoilage and processing of dairy/animal based products and do troubleshooting | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| Course | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 0 | 0 | 1 | 0 | 2 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 2 | 0 | 0 | 1 | 0 | 2 |
| CO5 | 2 | 1 | 0 | 1 | 0 | 1 |

| PCC | Course Code: FDP 1018 | Course Title: Pr7: Food Analysis - I | Credits = | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: VI | Total contact hours: 60 | 0 | 0 | 4 |

| List of Prerequisite Courses | |
|---|---|
| PR 3: Technical Analysis, PR 4: Food Chemistry | |

| List of Courses where this course will be prerequisite |
|---|
| Food Analysis-II |

| Description of relevance of this course in the B. Tech. Program |
|---|
| This course is designed to give students hands on training on chemical analysis or food compositions (moisture, fat, protein, fiber, ash and carbohydrate) determinations of wide range of fruit, vegetables, cereal and legume based food products available in the market. Also through this course students can acquire laboratory skills required for performing a range of chemical and physicochemical analyses of food components. |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Analysis of tea and coffee | 04 |
| 2 | Analysis of liquid milk, condensed milk and skim milk powder | 08 |
| 3 | Analysis of honey and golden syrup | 04 |
| 4 | Analysis of wheat flour | 04 |
| 5 | Analysis of beer and wine | 08 |
| 6 | Analysis of jam, jelly and squash | 08 |
| 7 | Analysis of fish | 04 |
| 8 | Analysis of spices | 04 |
| 9 | Analysis of vinegar | 04 |
| 10 | Analysis of ghee and edible oil | 04 |
| 11 | Analysis of bread | 04 |
| 12 | Analysis of Cake, Biscuits | 04 |
| | **Total** | **60** |

| List of Textbooks/ Reference Books | |
|---|---|
| 1 | Sehgal S. (2016). A Laboratory Manual of Food Analysis. I.K. International Publishing House Pvt. Ltd. |
| 2 | Nielsen, S. Suzanne (2017). Food Analysis Laboratory Manual II. (Ed.) 5th edition. Springer, New York |
| 3 | The Food Safety and Standards Act along with Rules and Regulations (2011). Delhi: Commercial Law Publishers (India) Pvt Ltd. |

| Course Outcomes (students will be able to….) | | |
|---|---|---|
| CO1 | Apply the fundamental knowledge in the analysis of plantation crops/animal-based products/dairy based products (K3) | K3+P3 |
| CO2 | Analyse the unit operations involved in the processing of different plantation crops/animal products/milk and dairy products (K4) | K4+P3 |
| CO3 | Select and demonstrate a suitable extraction/isolation technique for high value compounds from plantation crops/milk/animal products (K4) | K4+P3 |
| CO4 | Develop new products and processes for value-addition of plantation crop/dairy/animal products (K4) | K4+P3 |
| CO5 | Develop strategies related to processing of dairy/plantation crops/animal-based products and do troubleshooting (K4) | K4+P3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) |
|---|

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 |
| CO2 | 2 | 0 | 0 | 1 | 0 | 2 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 |
| CO5 | 2 | 0 | 0 | 1 | 0 | 2 |

# FOURTH YEAR: SEMESTER – VII

| PCC | Course Code: FDT 1023 | Course Title: SPL13: Technology of Cereals, Legumes and Oilseeds | Credits = 3 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: VII | Total contact hours: 45 | 2 | 1 | 0 |

| List of Prerequisite Courses | |
|---|---|
| SPL1: Chemistry of Food Constituents **(FDT1011)**, SPL 2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**, SPL6: Food Chemistry **(FDT1032)**, SPL 9: Food Additives and Ingredients **(FDT1012)** | |

| List of Courses where this course will be prerequisite |
|---|
| PR 8: Food Processing and Engineering **(FDP1026)**, Spl 14: Food Safety, Quality and Regulations **(FDT1028)** |

| Description of relevance of this course in the B. Tech. Program |
|---|
| This course is designed to train students in post-harvest handling, storage of cereals, grains, legumes and oilseeds Knowledge of this course will help students to acquaint students with production trends, structure, composition, quality evaluation and processing technologies for product development and value addition of various cereals, pulses and oilseeds. |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | **Cereals and millets:** Morphology: physicochemical properties; chemical composition and nutritional value | 04 |
| 2 | **Wheat:** Milling (chakki, roller) break system, purification system and reduction system; Maida, suji, chakki atta, extraction rate and its effect on flour composition; damaged starch, Quality characteristics of flour and their suitability for baking variety of products | 06 |
| 3 | **Rice:** Paddy processing and rice milling: conventional milling, modern milling operations, milling machines, milling efficiency, byproducts of rice milling. Quality characteristics influencing final milled products. | 05 |
| 4 | **Parboiling**: Parboiling of rice, Rice bran stabilization and its methods; Aging of rice; Enrichment – need, methods; processed foods from rice – breakfast cereals, flakes, puffing, canning and instant rice | 05 |
| 5 | **Corn**: Corn milling – dry and wet milling, starch and gluten separation, milling fractions ad modified starches, corn grits and flakes | 03 |
| 6 | **Barley**: Pearling / milling, Malting process, malt based foods. **Oats**: Processing and oats milling, Flaked oats in breakfast cereals | 02 |
| 7 | **Sorghum**: Milling, Malting, Pearling and industrial utilization | 02 |
| 8 | **Millets**: Importance of Millet, composition, processing of millets for food uses, major and minor millets | 02 |
| 9 | **Bakery Products**: Breads, Cakes, Biscuits, Different types of biscuits, short, hard and fermented Biscuits (02), Advanced bakery products such as croissants, puffs, muffins and filled cookies and muffins, Different functional ingredients used in baking, Gluten free, multigrain products | 08 |
| 10 | **Processing and technology of legumes and oilseeds:** Moong, Channa, Arhar, Urd, whole as well split dal. Technology of oilseeds such as peanut, sesame, sunflower etc, Utilisation in food industry as protein and oil source and their use in Indian diet. | 08 |
| | **Total** | **45** |

| List of Textbooks/ Reference Books |
|---|

| | |
|---|---|
| 1 | The chemistry and technology of cereals as food and feed, Matz S.A., 1991 |
| 2 | Cereal Processing and Technology, Gavin Owens, CRC Press, 2001 |
| 3 | Wheat – Chemistry and Technology, Pomeranz, Y, 1991 |
| 4 | Cereals and Cereal Products: Technology and Chemistry, Dendy, David A.V., Dobraszczyk, Bogdan J., Springer, 2001 |
| 5 | Handbook of Cereal Science and Technology, Karel Kulp, CRC Press, 2000 |
| 6 | Principles of Cereal Science and Technology, Jan A. Delcour, R. Carl Hoseney, 2010 |
| 7 | Food and Feed from Legumes and Oilseeds, J. Smartt, Emmanuel Nwokolo, Chapman & Hall, 1996 |

| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Explain the uniqueness of cereal grain, legume and oilseed and inter-relationships of the key constituents | K2 |
| CO2 | Infer about the quality of finished baked products, ingredient function, product formulation and processing, and molecular mechanisms | K4 |
| CO3 | Apply different processing operations applied to legume and oilseed-based products | K3 |
| CO4 | Describe the processing methods applied for wheat, malt and their products | K2 |
| CO5 | Apply the technology involved in baked, extruded, puffed and fermented cereal, legumes and oilseeds products and Indian traditional products | K3 |

K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 2 | 1 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 1 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 2 |

| **PCC** | **Course Code: FDT 1061** | **Course Title: SPL14: Technology of Plantation Products I** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VII** | **Total contact hours: 30** | **1** | **1** | **0** |

**List of Prerequisite Courses**

Introduction to Food Science and Technology; Food Chemistry

**List of Courses where this course will be prerequisite**

Flavour Science and Technology

**Description of relevance of this course in the B. Tech. Program**

This course is designed for providing understanding related to the process of cocoa fermentation and unit operations involved in extracting cocoa butter and producing cocoa powder, To understand tea/coffee cultivation, composition, processing, products and analysis. Knowdledge of this course will help students to understand role of cocoa butter replacement fats and the method of manufacture of chocolate-based confectionery.

| Course Contents (Topics and subtopics) | | Required Hours |
|---|---|---|
| 1 | Cultivation of cocoa, microbiology/biochemistry of cocoa bean fermentation, development of cocoa flavour precursors, drying, roasting, alkalization (Dutching), NARS process, winnowing, nib grinding, liquor processing, expeller pressing, cocoa cake grinding, cocoa products, analysis of cocoa powder, cocoa butter- chemistry and properties | 06 |
| 2 | Cocoa butter replacement fats (CBS and CBE fats and other fats), antibloom fat, lecithin as emulsifier in chocolate; Chocolate based confectionery-Bulk chocolate manufacture: raw materials, milk chocolate process including milk crumb process, melangeuring, refining, pasting, conching; tempering, moulding, enrobing, panning. | 06 |
| 3 | Tea cultivation, constituents of tea leaf, chemistry and technology of fermentation and black tea manufacture, characteristics and quality of tea beverage, types of tea- black tea, green tea, oolong tea, speciality teas, herbal teas; analysis of tea, iced tea, other tea-based products, kombucha tea.<br>Coffee varieties, cultivation, coffee bean composition, processing of berries (wet and dry process), roasting, grinding, brewing, instant coffee manufacture, decaffeination; analysis of coffee and chicory, green coffee, filter coffee and its packaging, health benefits of coffee | 10 |
| 4 | Varieties of spices/condiments grown and consumed in various countries including India, nomenclature, properties and culinary uses, preservative action, medicinal uses, analysis of spices, post-harvest handling/ storage/ preservation/ processing of spices, spice-based products, major individual spices- turmeric, cardamom, asafoetida, cinnamon, cloves, nutmeg, capsicum, pepper, ginger, saffron, anise, ajwain, coriander, cumin, celery, caraway, dill, fenugreek, fennel etc. | 08 |
| | **Total** | **45** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Chocolate, cocoa and confectionery: Science and Technology – 3rd Edition 1989 Minifie B.W. | |
| 2 | Industrial Chocolate Manufacture and Use, Edited by Stephen Beckett, 4th Edition Publisher Wiley Blackwell, ISBN: 978-1-4051-3949-6 | |
| 3 | Science of Tea Technology by PS Ahuja, A Gulati, RD Singh, RK Sud & RC Boruah. Scientific Publishers (2013). ISBN-13: 978-8172338312 | |
| 4 | Coffee: planting, production and processing by S K Mangal. Gene-Tech Books. 1st Edition (2007). ISBN: 9781441653093 | |
| 5 | Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants, N. Kumar -Oxford and IBH Publishing, (2021) | |
| 6 | Handbook of herbs and spices by KV Peter. Woodhead Publishing Limited. 2nd Edition, Vol II (2012) | |
| 7 | Spices by JW Purseglove, EG Brown, CL Green & SRJ Robbins. Longman Group Ltd. Vol. 2 (1981) (pp. 447-813). | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Describe spices, their chemical constituents and solve the problems related to post-harvest handling and processing | K3 |
| CO2 | Explain the process of cocoa fermentation and unit operations involved in extracting cocoa butter and producing cocoa powder | K2 |
| CO3 | Describe cocoa butter replacement fats and analyse the method of manufacture of chocolate-based confectionery | K4 |
| CO4 | Explain tea cultivation, composition, processing, products and analysis | K2 |
| CO5 | Explain coffee cultivation, composition, processing, products and analysis | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 2 | 1 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 2 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO5 | 3 | 2 | 3 | 2 | 3 | 2 |

| **RM-1** | **Course Code: FDP 1038** | **Course Title: Literature Review (Research Methodology-I)** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VII** | **Total contact hours: 45** | **1** | **0** | **2** |

**List of Prerequisite Courses**

Communication Skills (HUT1110B),

**List of Courses where this course will be prerequisite**

Project-I and Project-II

**Description of relevance of this course in the B. Tech. Program**

The formal exposure to various elements of research methods such as problem formulation, literature search, planning of various activities, documentation, budgeting, purchase, report/thesis compilation, manuscript writing, patent drafting, is critical for polishing the naïve research attitude and aptitude in the PG students of the programme. The course is designed to formally introduce various concepts of research methodology in stepwise manner to the students.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Introduction of Course<br>Academic Honesty Practices<br>General philosophy of science & Arguing About Knowledge<br>Case studies in science history | 03 |
| 2 | Motivation and Background<br>Motivation/Demotivation for Research, Building Background for Research and How to read research papers | 03 |
| 3 | Time Management (Academic and Non-academic time), Effort Management, Plan execution, Energy Management Issue, Role and expectation of research supervisor and student | 04 |
| 4 | Finding and Solving Research Problems<br>What is Research, How to start?, Approaches to find research problems and psychological experiments<br>Literature survey, Textbooks, Review and research papers<br>How to ask Questions<br>What is worthwhile research problem, Analytical and synthetic research approach | 04 |
| 5 | Finding and Solving Research Problems<br>What is Research, How to start?, Approaches to find research problems and psychological experiments | 04 |

| | | |
|---|---|---|
| | Literature survey, Textbooks, Review and research papers, critical review of research papers, how to write literature survey report, How to ask Questions, formulating research questions, | |
| 6 | What is worthwhile research problem, Analytical and synthetic research approaches<br>How to solve research problems, designing work plan, importance of objectives, activity and strategizing research work. Design of timeline for work plan (Gnatt Chart etc), Grant Writing Guidelines | 04 |
| 7 | Experimental Research<br>Inventory Management, Material Management<br>Learning required skills for research, Documentation and lab notebook guidelines,<br>Safety aspects in chemical/biological research | 04 |
| 8 | Methods and Tools used in Research: Qualitative studies; Quantitative studies; Simple data organization; Descriptive data analysis; Limitations and sources of error; Inquiries in form of Questionnaire, Opinionnaire or by interview; Statistical analysis of data including Variance, Standard deviation, Students 't' test and Analysis of variance (ANOVA), Correlation data and its interpretation, Computer data analysis | 06 |
| 9 | Scientific Writing<br>Skeleton of research paper, author guidelines, good writing skills, importance of discussion, Macro-level discussion.<br>Structure of the documents. General issues of presentability. Micro-level discussion.<br>Stylistic issues.<br>Examples of bad and good writings. | 06 |
| 10 | Publishing and Reviewing<br>Publication process, How to publish papers, where to submit, Review process and reacting to a review report<br>Reviewing scientific papers | 04 |
| 11 | Scientific Norms and Conventions<br>Authorship.<br>Plagiarism.<br>Simultaneous submissions. Reviewing norms. Referring to other papers. Use of data.<br>Collaborative Research Work | 03 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Menzel, D.; Writing a Technical Paper; McGraw-Hill, United States (1961). | |
| 2 | Best, J. W., Kahn, J. V., Jha, A. K.; Research in Education; 10th ed.; Pearson, New Delhi, India (2005) | |
| 3 | Davis R. M.; Thesis Projects in Science and Engineering: A Complete Guide from Problem Selection to Final Presentation; St. Martin's Press, (1980). | |
| 4 | Anderson, J., Durston, B. H., Poole, M. E.; Thesis and Assignment Writing; John Wiley, United States (1970). | |
| 5 | Menzel, D.; Writing a Technical Paper; McGraw-Hill, United States (1961). | |
| 6 | Brown, L.; Effective Business Report Writing ; Prentice-Hall, United States (1973). | |
| 7 | WIPO Intellectual Property Handbook; WIPO Publication (2004). | |
| 8 | Carter, M.; Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More; Academic Press, London (2013). | |
| 9 | Ranganathan, S. R.; Documentation : Genesis and Development; Ess Ess Publications, India (2006). | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Understand the basic concepts of research and the components therein, formally | K2 |
| CO2 | Understand and appreciate the significance of statistics in Chemical Technology, Pharmacy and Chemical Engineering | K3 |
| CO3 | Understand and apply importance of literature survey in research design | K4 |
| CO4 | Understand an in-depth knowledge on the documentation in research | K5 |
| CO5 | Evaluate importance of various parts of a research report/paper/thesis in presentation of research results | K4 |

| | | |
|---|---|---|
| CO6 | Prepare and Deliver a model research presentation | K5 |
| CO7 | Understand the significance of various types of IPRs in research | K3 |
| CO8 | Create a model research project | K6 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 |
| CO3 | 2 | 3 | 1 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 |
| CO6 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 3 |
| CO7 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO8 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 1 | 2 | 2 | 2 |
| CO2 | 1 | 2 | 2 | 0 | 2 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 1 | 3 |
| CO4 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 1 | 2 | 0 | 2 | 2 | 3 |
| CO6 | 2 | 2 | 3 | 2 | 2 | 3 |
| CO7 | 2 | 3 | 3 | 1 | 3 | 1 |
| CO8 | 2 | 2 | 3 | 2 | 2 | 3 |

| **RM-2** | **Course Code: FDP 1039** | **Course Title: Design and Analysis of Experiment (Research Methodology-II)** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VII** | **Total contact hours: 45** | **1** | **0** | **2** |

**List of Prerequisite Courses**

Engineering Mathematics (MAT1301), Process Calculations ( CEP1720)

**List of Courses where this course will be prerequisite**

This course is required for graduating engineers to function effectively in Industry, Academia and other professional spheres. This course is in Semester VIII

**Description of relevance of this course in the B. Tech. Program**

Modern day manufacturing activities and R&D activites need decisions taken with a scientific rigour and should be well-supported by ‘statistics’. Chemical Technologist graduates who will serve industry as well as postgraduate research students who will serve industry, R&D organisations, or academic research should have a reasonably good background of statistical decision making. This also involves extraction of meaningful data from well-designed minimal number of experiments at the lowest possible material costs. This course will also help the students in all domains of their life by imparting them a vision for critical appraisal and analysis of data.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Fundamental principles of classical design of experiments<br>Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. | 04 |

| | | |
|---|---|---|
| 2 | Review of Probability and basic statistical inference:<br>Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing. | 03 |
| 3 | Experiments with a Single Factor: The Analysis of Variance<br>Fixed effect model and Random effect model, Model adequacy checking, Contrasts, Orthogonal contrasts, Regression Models and ANOVA, Violation of Normality Assumption: Kruskal-Wallis test.<br>Randomized block designs, Latin square designs, Balanced Incomplete Block Designs | 06 |
| 4 | Factorial designs:<br>Definition, Estimating model parameters, Fitting response curves and surfaces. | 03 |
| 5 | The $2^k$ Factorial Design, Blocking and Confounding in the 2k Factorial Design; Focus of $2^2$ and $2^3$ designs, Blocking and Confounding in the $2^k$ Factorial Design. | 06 |
| 6 | Plackett Burman methods, Central Composite Design (CCD) | 03 |
| 7 | Descriptive Statistics, Probability Distribution and testing of Hypothesis using R | 04 |
| 8 | Regression techniques, diagnostic checks, ANOVA using R and implementation of contrasts. | 04 |
| 9 | Construction of Balanced Incomplete Block Designs and data analysis using R | 04 |
| 10 | Analysis of factorial designs using R, understanding output and interpretation. | 04 |
| 11 | Factorial designs, Data analysis and interpretation. | 04 |
| | **Total** | **45** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Douglas C. Montgomery, Design and Analysis of Experiments, 8th Edition, John Wiley & Sons, Inc. 2013 | |
| 2 | Box, G. E., Hunter, W.G., Hunter, J.S., Hunter, W.G., Statistics for Experimenters: Design, Innovation, and Discovery, 2nd Edition, Wiley, 2005. | |
| 3 | John Lawson, Design and Analysis of Experiments with R, CRC Press, 2015 | |
| 4 | Dieter Rasch, Jürgen Pilz, Rob Verdooren, Albrecht GebhardtOptimal Experimental Designs with R. CRC Press, 2011. | |
| 5 | José Unpingco, Python for Probability, Statistics, and Machine Learning, Springer, 2019 | |
| 6 | Response Surface Methodology: Process and Product Optimization using Designed Experiments: R. H. Myers, D. C. Montgomery. | |
| 7 | Introduction to Statistical Quality Control: D. C. Montgomery. | |
| 8 | Design of Experiments in Chemical Engineering: Živorad R. Lazić. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Understand basic principles of design of experiments. | K2+P4 |
| CO2 | Perform statistical analysis of single experiments and do post hoc analysis. | K3+P4 |
| CO3 | Conduct experiment and analyse the data using statistical methods. | K3+P4 |
| CO4 | Choose an appropriate design given the research problem. | K2+P4 |
| CO5 | Perform statistical analysis of different designs using R and interpret the results. | K5+P4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 1 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 0 | 2 | 3 | 3 | 3 | 2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 3 | 2 | 2 | 0 | 2 | 3 | 3 | 3 | 1 | 3 | 0 | 2 |

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 3 | 2 | 2 | 3 | 3 |
| CO2 | 3 | 1 | 2 | 2 | 3 | 3 |
| CO3 | 2 | 3 | 2 | 1 | 1 | 3 |
| CO4 | 3 | 1 | 2 | 2 | 3 | 0 |
| CO5 | 3 | 3 | 0 | 2 | 3 | 3 |

| **Project** | **Course Code: FDP1040** | **Course Title: Project – I** | **Credits = 8** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VII** | **Total contact hours: 120** | **0** | **0** | **8** |

| **List of Prerequisite Courses** | |
|---|---|
| Communication Skills (HUT1110B) | |
| **List of Courses where this course will be prerequisite** | |
| Project – II | |
| **Description of relevance of this course in the B. Tech. Program** | |
| The course is designed to help students develop a skill-set for solving a research problem related to Pharmaceutical Sciences and Technology. The course presents an opportunity to the students for fine-tuning their scientific communication skills, oral as well as written. | |
| **Course Contents (Topics and subtopics)** | **Required Hours** |
| 1 | The Teachers will communicate various research topics of potential interest to the Pharmaceutical Sciences and Technology field to all the students based on the interest and facilities available. Each student, based on his/her interest and merit, selects the research topic and is allotted a supervisor. The work involves detailed review of the literature, formulation of research project, hypothesis, objectives, methodology, possible expected outcomes, planning for experimentation, experimental trials, data generation and analysis. Finally, the student will compile the report as per the communicated format and then present in front of the Evaluators. 120 |
| | **Total** |
| **List of Textbooks/ Reference Books** | |
| 1 | Relevant research articles, patents, review articles, conference proceeding, book chapters and books |
| **Course Outcomes (students will be able to….)** | |
| CO1 | Develop critical thinking to identify the research gap for the project K5+P4 |
| CO2 | Formulate a scientific question and approach to solve it K6+P4 |
| CO3 | Plan the experimental methodology for the project K5+P4 |
| CO4 | Develop skills to communicate the research plan effectively K6+P4 |
| CO5 | Develop skills for writing a scientific document on the research work K6+P4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 2 |
| CO4 | 2 | 1 | 3 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 2 |
| CO5 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 1 | 2 | 1 | 2 | 2 | 3 |
| CO2 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO4 | 1 | 2 | 2 | 1 | 3 | 2 |
| CO5 | 2 | 2 | 1 | 2 | 2 | 1 |

| **PCC** | **Course Code: FDP 1021** | **Course Title: Pr8: Food Analysis II (Instrumentation)** | **Credits = 4** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VII** | **Total contact hours: 60** | **0** | **0** | **4** |

**List of Prerequisite Courses**

PR3: Technical Analysis Lab **(FDP1011)**, PR4: Food Chemistry Lab **(FDP1015)**, PR6: Food Analysis I **(FDP1018)**

**List of Courses where this course will be prerequisite**

SPL7: Principle of Food Analysis **(FDT1052)**

**Description of relevance of this course in the B. Tech. Program**

This practical course is designed for proving understanding related to significance, purpose and principle of food analysis using instruments (basics and advanced). Through this course students will learn various basics and advanced methods of analysis of major and minor food constituents. Knowledge of this course will help students for selection of correct method based on the precision, accuracy, food system and availability. Also this course will help students to know the principles of thermal analysis, food rheology, colour measurements and their applications in food analysis.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Analysis of food samples for calorific value using bomb calorimeter | 04 |
| 2 | UV-Vis Spectro-photometric analysis of a carotenoid | 04 |
| 3 | Hunter Lab colorimetric studies of food samples. | 04 |
| 4 | Texture analysis of food samples. | 04 |
| 5 | Rheology of food samples | 04 |
| 6 | Sensory evaluation of foods | 04 |
| 7 | Gas chromatographic analysis of food constituents | 04 |
| 8 | Densitometric (HPLTC) assay of food constituents | 04 |
| 9 | HPLC separation of food constituents | 04 |
| 10 | Differential scanning calorimetry (DSC) for food samples | 04 |
| 11 | Polarimetric estimation of sugars | 04 |
| 12 | Conductometric analysis of polyelectrolytes in solution | 04 |
| 13 | Atomic absorption spectroscopic analysis of heavy metals in foods | 04 |
| | **Total** | **60** |

**List of Textbooks/ Reference Books**

| | |
|---|---|
| 1 | Neilsen Suzanne S., Food Analysis, Fourth Edition, Springer; 2010. |

| | | |
|---|---|---|
| 2 | Günzler H. and Williams A., Handbook of Analytical Techniques, Wiley-VCH Verlag GmbH Publishing; 2001 | |
| 3 | Otles S., Handbook of Food Analysis Instruments; 1st ed.; CRC Press; Elsevier; 2008. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Select the appropriate instrumental method when presented with a practical problem | K5+P4 |
| CO2 | Demonstrate practical proficiency in a food analysis laboratory using advanced instruments | K3+P4 |
| CO3 | Evaluate the basic methods of instrumental and subjective sensory evaluation, including when certain methods might be used, the type of data derived, and how that data might be used in decision-making | K5+P4 |
| CO4 | Demonstrate practical proficiency in chromatographic techniques applied in food analysis | K3+P4 |
| CO5 | Choose appropriate techniques for foods and when/how to use them in a food processing environment/situation such as QA&/QC | K5+P4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 2 | 0 | 2 | 1 |
| CO2 | 2 | 2 | 2 | 1 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 2 | 0 |
| CO4 | 2 | 1 | 2 | 0 | 2 | 1 |
| CO5 | 2 | 2 | 2 | 1 | 2 | 2 |

# fFOURTH YEAR: SEMESTER – VIII

| PCC | Course Code: FDT 1017 | Course Title: SPL17: Technology of Fruits, Vegetables and Tubers | Credits = 3 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: VIII | Total contact hours: 45 | 2 | 1 | 0 |

| List of Prerequisite Courses | |
|---|---|
| SPL1: Chemistry of Food Constituents **(FDT1011)**, SPL 2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**, SPL6: Food Chemistry **(FDT1032)**, SPL 9: Food Additives and Ingredients **(FDT1012)** | |

| List of Courses where this course will be prerequisite |
|---|
| PR 5: Food Processing and Product Development Lab **(FDP1034)**, Spl 14: Food Safety, Quality and Regulations **(FDT1028)** |

| Description of relevance of this course in the B. Tech. Program |
|---|
| This course is designed to know overall development and quality of fruits, vegetables and tubers, understand the post-harvest handling, storage and ripening process, different methods/techniques for processing of fruits, vegetables and tubers. Knowledge of this course will help students to know the various by-products from fruit, vegetable and tuber processing industry and provides necessary input for applications of honey, sugar, saccharine in products and soft drink. |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | **Fruits and Vegetables:** Types, Structure and composition, development, maturity indices, Methods, importance and overall quality of fruit and vegetables for harvesting. | 05 |
| 2 | **Post-harvest Processing:** Handling, storage, ripening and control of ripening, chemical changes etc. of fruits and vegetables | 05 |
| 3 | **Fruits:** Processing techniques, juices, juice extraction process, causes of juice spoilage, Methods of juice preservation, concentrates, preserves, Jams/Marmalades, Squashes/cordials, Candied Fruits Fruit Bar, and other traditional products | 12 |
| 4 | **Vegetables:** Processing techniques, vegetable juices, preservation, Ketchup/sauces, Chutneys, Soup powders, pickles, fermented pickles and other traditional products. Dried powders (Onion, garlic, potato, carrot starch), dried Cauliflower and cabbage: Sauerkraut, Pickles, Dried Leafy Vegetables. (Spinach, Fenugreek, Coriander leaves, Curry leaves). Bitter gourd: Pickle, Dried bitter gourd. | 10 |
| 5 | **Tubers:** Processing and products (Potato, Sweet potato, turnips, beetroot, Taro, yam and others) | 06 |
| 6 | Dehydrated and specialty products and by-products of fruits and vegetables | 04 |
| 7 | Honey, Sugars and saccharine products. Soft drinks, fermented pickles. | 03 |
| | **Total** | **45** |

| List of Textbooks/ Reference Books | |
|---|---|
| 1 | Handbook of Fruits Science and Technology: Production, Composition, Storage and Processing by Salunkhe D.K. and Kadam S.S. (1995) CRC press |
| 2 | Handbook of Vegetable Science and Technology: Production, Composition, Storage and Processing, Salunkhe D.K. and Kadam S.S., (1998) CRC press |
| 3 | Preservation of Fruits and Vegetables – Girdhari Lal, Siddhapa and Tondon, ICAR, New Delhi. |
| 4 | Hand Book of Analysis and Quality Control of Fruits and Vegetable Products – S. Ranganna Tata McGraw Hill, New Delhi. |
| 5 | Commercial Vegetable Processing–Wood Roof and Lue. |
| 6 | Commercial Fruit and Vegetable Processing–W.V. Cruses. |
| 7 | Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell & W.K. Nip Handbook of Vegetable Preservation and Processing Marcel Dekker (2003). |

| Course Outcomes (students will be able to….) | | |
|---|---|---|
| CO1 | Explain and develop basics of Fruits and vegetables processing operations | K3 |
| CO2 | Analyse the process protocols of different fruit and vegetable based products and quality | K4 |
| CO3 | Describe the maturity indices, methods, their importance during harvesting and processing | K2 |
| CO4 | Explain the tuber processing, various products process protocol and design the novel food products out of them | K3 |
| CO5 | Analyse the quality characteristics of importance in fresh and processed fruit, vegetable and tuber products in food industry | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 3 | 2 | 1 | 2 | 0 |
| CO2 | 2 | 3 | 2 | 2 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 1 |
| CO4 | 1 | 2 | 2 | 1 | 2 | 0 |
| CO5 | 2 | 3 | 2 | 2 | 2 | 1 |

| PCC | Course Code: FDP1041 | Course Title: Project – II (Experiments) | Credits = 12 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: VIII | Total contact hours: 90 | 0 | 0 | 12 |

| List of Prerequisite Courses | |
|---|---|
| Project – I | |

**List of Courses where this course will be prerequisite**

Professional Career and future academic research

**Description of relevance of this course in the B. Tech. Program**

The course is designed to develop skills necessary for executing and solving a unique research problem in Pharmaceutical Sciences and Technology field. After the laboratory work, the findings of the research are presented in a coherent manner, which may result in a patent, publication and/or presentation.

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | The topic of the research with clearly defined Objectives and Hypotheses should be explored systematically, in a scientifically planned rational set of experiments. Students should have actual experimental data collected on the chosen research topic. | 90 |
| 2 | Oral presentation of the proposed research work with data generated during actual laboratory work along with computational studies, if any, targeted towards fulfilling the objectives. The outcome is submitted in the form of a report. | 30 |
| | **Total** | **120** |

**List of Textbooks/ Reference Books**

| | | |
|---|---|---|
| 1 | Relevant review articles, research papers, patents, book chapter, books, etc. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Perform experiments & troubleshoot to generate reliable data | K5+P5 |
| CO2 | Apply different statistical tools for scientific data analysis | K4+P5 |
| CO3 | Evaluate critically the experimental data and draw meaningful inferences | K5+P5 |
| CO4 | Develop skills to communicate the research outcome effectively | K6+P5 |
| CO5 | Develop skills for writing a complete document on the project work | K6+P5 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

**Mapping of Course Outcomes (COs) with Programme Outcomes (POs)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

**Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 1 | 2 | 0 |
| CO2 | 2 | 3 | 2 | 2 | 2 | 1 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 1 |
| CO4 | 1 | 2 | 2 | 1 | 2 | 0 |
| CO5 | 2 | 3 | 2 | 2 | 2 | 1 |

| **OJT** | **Course Code: FDP1042** | **Course Title: Internship with Industry** | **Credits = 12** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VIII** | **Total Contact Weeks: 12-16** | **0** | **0** | **0** |

**List of Prerequisite Courses**

None

**List of Courses where this course will be prerequisite**

Project – I (PHP1074), Project – II (PHP1075)

**Description of relevance of this course in the B. Tech. Program**

The course is designed to develop a systematic thinking about an industrial problem, skills for communication, networking, personal grooming & professional conduct within an industrial environment. Knowledge of this course will help students to acquire attitude for individual and teamwork.

| | **Course Contents (Topics and subtopics)** | **Required Weeks** |
|---|---|---|
| 1 | Each Student will be involved in R & D/manufacturing (QA/QC/Plant Engineering /Stores and Purchase)/marketing/finance/consultancy/Technical services/ Engineering/Projects, etc., as deemed necessary by the assigned/chosen industry.<br><br>Oral presentation & written report of the in-plant training will be evaluated along with industry feedback. | 12 |
| | **Total** | **12** |

**List of Textbooks/ Reference Books**

| | |
|---|---|
| 1 | Relevant review articles, research papers, patents, book chapter, books, etc. |

| Course Outcomes (students will be able to….) | | |
|---|---|---|
| CO1 | Apply the concept of project & production management in further planning (K3) | K3+P5 |
| CO2 | Develop critical thinking regarding the various operations involved in dyestuff technology and allied industry (K4) | K4+P5 |
| CO3 | Solve certain industrial challenges in dyestuff technology and allied field (K6) | K6+P5 |
| CO4 | Present and communicate an industrial problem effectively (K6) | K6+P5 |
| CO5 | Write a scientific report on the training (K6) | K6+P5 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 2 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 2 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO5 | 1 | 1 | 1 | 0 | 1 | 3 |

## F. Scheme of Evaluation of Internship with Industry (SEMESTER – VIII)

# PROGRAM ELECTIVES

| PEC1 | Course Code: FDT 1022 | Course Title: SPL8: Food Engineering | Credits = 4 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: V | Total contact hours: 60 | 3 | 1 | 0 |

| List of Prerequisite Courses | |
|---|---|
| Principles of Food Preservation | |

| List of Courses where this course will be prerequisite |
|---|
| Food Process Engineering, Food Processing and Engineering Lab |

| Description of relevance of this course in the B. Tech. Program |
|---|
| This course is designed for providing understanding related to concept of material and energy balance in food operations, concept of fluid flow, heat, and mass transfer in food processes. Knowledge of this course will help students to apply basic engineering principles to design mechanical operations in food processing. |

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | **Material and Energy Balance:** Principles of mass, material, and energy balance in food processing operations; Case studies like dehydration, crystallization, and evaporation; Thermodynamics concepts applied to food. | 04 |
| 2 | **Momentum Transport with respect to Foods:** Fluid dynamics; Newtonian and non-Newtonian fluid; Bernoulli's Theorem and friction factor; Flow measuring instruments; Velocity profile in different case studies like pipe, conduits; fluid flow between plates and outside a falling film; Fluid flow through porous media; Fluidization. | 12 |
| 3 | **Heat Transfer in Food Operations:** Steady state heat transfer in food systems; Transient heat transfer; Estimation of thermal conductivity; Dimensional analysis; Overall heat transfer coefficient estimation; Performance analysis of pasteurizer and sterilizer. | 08 |
| 4 | **Freezing and Thawing:** Freezing and Thawing calculations; Application of Plank's equation to specific food system; Refrigeration system and thermodynamic aspects; Concept of cold storage design; Refrigeration load for chilling and freezing process. | 10 |
| 5 | **Mass Transfer in Food Operations:** Basics of mass transfer and diffusion in food systems; Molecular diffusion and Fick's Law; Steady state diffusion; Diffusion through solids, liquids; Mass transfer coefficients and Permeability; Analogies between heat, momentum and mass transfer. | 10 |
| 6 | **Mechanical Operations in Food Processes:** Laws for size reduction; Sieving; Mixing; Homogenization; Centrifugation; Settling; Filtration; Extrusion. | 10 |
| 7 | **Thermal Operations in Food Processes:** Equipment and process for dehydration, evaporation, concentration, pasteurization, and sterilization. | 06 |
| | **Total** | **60** |

| List of Textbooks/ Reference Books | |
|---|---|
| 1 | Das, S.K., & Das, M. Fundamentals and Operations in Food Process Engineering; 1st ed.; CRC Press; 2019. |
| 2 | Varzakas, T., Tzia, C. Food Engineering Handbook; 1st ed.; CRC Press; 2015. |
| 3 | Heldman, D.R. & Singh, R.P. Introduction to Food Engineering; 4th ed.; Academic Press; Elsevier; 2009. |
| 4 | Geankoplis, J. Transport Processes and Separation Process Principles, Pearson Publisher; 4th ed.; 2003. |
| 5 | Das, H. Food Processing Operations Analysis; Asian Books Pvt. Ltd.; 2008. |

| | | |
|---|---|---|
| 6 | Stoecker, W.F. Industrial Refrigeration Handbook, McGraw-Hill Companies, Inc.; 1998. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Apply and analyse the fundamental knowledge of material and energy as a basic tool in food engineering analysis | K4 |
| CO2 | Analyse the performance of heat exchangers applied in food processes | K4 |
| CO3 | Analyse the efficacy of different mass and momentum transfer operations in food processing | K4 |
| CO4 | Design the cold storage and refrigerated vans in food operations | K3 |
| CO5 | Analyse the performance of various mechanical operations applied in food industry | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 2 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO5 | 1 | 1 | 1 | 0 | 1 | 3 |

| **PEC2** | **Course Code: FDT 1060** | **Course Title: SPL11: Food Packaging** | **Credits = 4** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VI** | **Total contact hours: 60** | **3** | **1** | **0** |

| |
|---|
| **List of Prerequisite Courses** |
| Chemistry of Food Constituents, Food Microbiology |
| **List of Courses where this course will be prerequisite** |
| Principles of Food Preservation |
| **Description of relevance of this course in the B. Tech. Program** |
| This course is designed for providing understanding related to the role of food packaging in food preservation, nature of different materials used in food packaging, various food packaging applications with respect to various food commodities, types of package testing methods employed to evaluate quality, performance and safety of food packaging materials. Knowledge of this course will help students to know more about various food-package interactions and environmental issues related to packaging, application of newer food packaging application technologies. |

| **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|

| | | |
|---|---|---|
| 1 | Introduction to food packaging; Causes of food spoilage; Factors affecting food spoilage; Packaging as a method for preservation of foods; Functions of food packaging including new packaging technologies; Levels of packaging; Food labelling | 09 |
| 2 | Different materials used in food packaging such as paper, board, glass, metal containers, aluminium foil, plastics, composites, traditional materials and their physicochemical characteristics, their advantages and limitations, method of manufacture | 09 |
| 3 | Testing of various packaging materials and packages for evaluation of quality, for identification, for evaluation of barrier and strength properties for transport-worthiness, for biodegradability, for migration etc; Criteria for selection of packaging materials; Shelf-life testing of packaged foods | 09 |
| 4 | Food and Packaging material interactions including migration, scalping of flavour; biodegradable packaging; application of nanotechnology in food packaging; environmental concerns and lifecycle assessment<br>Packaging of various food commodities including fresh produce (fruits and vegetables), meat, fish, poultry, milk, cereals and processed foods. | 09 |
| 5 | Newer packaging technologies- CAP/MAP packaging; aseptic processing and packaging; irradiated packaging; retort pouch; microwaveable packaging; packaging for non-thermal processing of foods (pulsed electric field, high pressure processing, irradiation etc.); active packaging; intelligent packaging | 09 |
| 6 | Emerging trends in polymers for food packaging, green packaging materials, nanoparticles in food packaging | 09 |
| 7 | Recycling of food packaging materials and use of recycled materials in food packaging, edible packaging | 06 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Sustainable Food Packaging Technology, Athanassia Athanassiou, John Wiley & Sons, 2021 | |
| 2 | Environmentally compatible Food Packaging, E. Chiellini, Elsevier, 2008 | |
| 3 | Packaging for nonthermal processing of food, Melvin A. Paschall and Jung H. Han, John Wiley & Sons, 2018 | |
| 4 | Edible food packaging: Materials and processing technology, Miquel Angelo Parente Ribeiro Cerqueira, Ricardo Nuno Correia Pereira, Oscar Leandro da Silva Ramos, Jose Antonio Couto Teixeira, Antonio Augusto Vicente, CRC Press, 2017 | |
| 5 | Nanomaterials for food packaging: Materials, processing technologies, and safety issues, Miguel Angelo Parente Ribei Cerqueira, Jose Maria Lagaron, Lorenzo Miguel Pastrana Castro, Antonio Augusto Martins de Oliveira Soares Vicente, Elsevier, 2018 | |
| 6 | Packaging Media by Paine F.A. Publisher: Blackie and son Ltd., Bishop Briggs (1977) | |
| 7 | Food and Packaging Interactions by Risch.S.H. Publisher American chemical society, Washington (1991). | |
| 8 | Handbook of Food Packaging by F.A. Paine and H.Y. Paine Publisher: Blackie and Son Ltd. London. (1983) | |
| 9 | Food Packaging Technology by G Bureau and JL Multon, VCH, New York (Vol.1 & 2) (1996). ISBN: 1560819324, 9781560819325 | |
| 10 | Food Packaging and Shelf Life: A Practical Guide by Gordon L. Robertson. CRC Publication. Edition 1 (2009). ISBN: 9781420078442 | |
| 11 | Food Packaging - Principles and Practice (3rd Edition) by Gordon L. Robertson. Taylor & Francis. Edition 3 (2013). ISBN: 9781628706529 | |
| 12 | Innovations in Food Packaging by Jung H. Han. Academic Press- Food Science and Technology International Series. Edn 1 (2005. ISBN: 9780123116321) | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Discuss and analyze the role of food packaging in food preservation | K4 |

| | | |
|---|---|---|
| CO2 | Describe different food packaging materials, properties, and interactions | K2 |
| CO3 | Apply the concept of packaging with respect to various food commodities | K3 |
| CO4 | Explain and interpret various tests used in evaluating quality and safety of food packaging materials | K2 |
| CO5 | Describe newer food packaging technologies | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO5 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 3 | 2 | 3 | 2 | 0 |
| CO2 | 1 | 2 | 1 | 2 | 1 | 2 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 1 |
| CO4 | 1 | 2 | 1 | 2 | 1 | 3 |
| CO5 | 1 | 2 | 1 | 2 | 1 | 2 |

| PEC3 | Course Code: FDP 1019 | Course Title: Pr6: Food Processing and Product Development | Credits = 2 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: VI | Total contact hours: 60 | 0 | 0 | 4 |

**List of Prerequisite Courses**

Principles of Food Preservation, Food Engineering

**List of Courses where this course will be prerequisite**

Food Process Engineering

**Description of relevance of this course in the B. Tech. Program**

This course is designed for providing understanding related to design and develop the process flow chart for any product development. Knowledge of this course will help students to design the product and process formulations in food industry, evaluate the processing cost of any developed product.

| | Course Contents (Topics and subtopics) | Required Hours |
|---|---|---|
| 1 | Preparation of various degree brix Syrups (rose syrup and almond syrup) | 04 |
| 2 | Preparation, packaging, sensory and evaluation of Jam, jelly marmalade from different fruits | 08 |
| 3 | | |
| 4 | Preparation of Ketchup, Sauces and chutneys | 08 |
| 5 | Preparation of Squashes (lemon squash, orange squash, pineapple squash) | 08 |
| 6 | Preparation of variety of pickles (lemon, mango, chilli, mixed etc) | 08 |
| 7 | Preparation of different types of breads | 08 |

| | | |
|---|---|---|
| 8 | Preparation of different types of cakes | 08 |
| 9 | Preparation of different types of biscuits | 04 |
| | **Total** | **60** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Fuller, G.W. (2011). *New Food Product Development: From Concept to Marketplace*, 3rd ed, CRC Press, UK. | |
| 2 | Theodoros Varzakas, Constantina Tzia. (2015). *Handbook of Food Processing: Food Safety, Quality, and Manufacturing Processes*, CRC Press, UK. | |
| 3 | Giridhari Lal, G.S. Siddappa, G.L. Tandon. (1998). *Preservation of Fruits and Vegetables*, ICAR, New Delhi. | |
| 4 | Khurdia DS. (1995). Preservation of fruits and vegetables. Indian Council of Agriculture Research, New Delhi. | |
| 5 | Ramaswamy H and Marcott M. (2005). Food Processing Principles and Applications. CRC Press. | |
| 6 | The Food Safety and Standards Act along with Rules and Regulations (2011). Delhi: Commercial Law Publishers (India) Pvt Ltd. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Explain and develop basic flow sheet in food processing operations | K3+P3 |
| CO2 | Analyse the major food processing steps applied during various food preparations | K4+P3 |
| CO3 | Describe and design novel food products | K3+P3 |
| CO4 | Use different food processing equipment for product development | K3+P3 |
| CO5 | Analyse the developed food products | K4+P3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

**Mapping of Course Outcomes (COs) with Programme Outcomes (POs)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

**Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO5 | 1 | 1 | 1 | 0 | 1 | 3 |

| **PEC4** | **Course Code: FDT 1051** | **Course Title: Nutraceuticals and Functional Foods** | **Credits = 3** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VII** | **Total contact hours: 45** | **2** | **1** | **0** |
| | | | | | |
| **List of Prerequisite Courses** | | | | | |

| | | |
|---|---|---|
| SPL1: Chemistry of Food Constituents (FDT 1011), SPL4: Nutrition (FDT 1015), Biochemistry (BST 1102), Gut physiology | | |
| | | |
| **List of Courses where this course will be prerequisite** | | |
| None | | |
| | | |
| **Description of relevance of this course in the B. Tech. Program** | | |
| This course is designed for providing understanding related to fundamental knowledge on various nutraceuticals and functional foods and their mechanism of action, basics of nutrigenomics and its relation with nutraceuticals, safety/ toxicity aspects of nutraceuticals and interactions with drugs, basic terminologies and regulatory issues in the field of their applications. Knowledge of this course will help students to know the roles of various nutraceuticals in different physiological/disease conditions, manufacturing of different nutraceuticals and functional foods. | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | Introduction to nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX; nutrigenomics - an introduction and its relation to nutraceuticals | 09 |
| 2 | Clinical testing of nutraceuticals and functional foods; interactions of prescription drugs and nutraceuticals; adverse effects and toxicity/safety of nutraceuticals | 09 |
| 3 | Nutraceuticals/ functional foods for life-style associated diseases such as atherosclerosis, hypertension, heart disease, stroke, obesity, type 2 diabetes, and diseases associated with smoking, alcohol and drug abuse and their mechanisms of action, dosage levels, contraindications if any. | 09 |
| 4 | Nutraceuticals/ functional foods for aging associated diseases such as cancer, arthritis, cataract, osteoporosis, Alzheimer's disease, age related macular degeneration and their mechanisms of action, dosage levels, contraindications if any. | 09 |
| 5 | Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing nutraceuticals, stability, and analytical issues, labelling issues | 09 |
| | **Total** | **45** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Joyce I. Boye, Nutraceuticals and Functional Food Processing Technology, Wiley-Blackwell 2014. | |
| 2 | **Aluko** Rotimi E. Functional Foods and Nutraceuticals, Food Science Text Series, Springer 2012. | |
| 3 | Brian Lockwood, Nutraceuticals: A Guide for Healthcare Professionals, Pharmaceutical Press, 2007 | |
| 4 | Robert E.C. Wildman, Robert Wildman, Taylor C. Wallace Handbook of Nutraceuticals and Functional Foods, Second Edition, CRC Press 2006. | |
| 5 | Geoffrey P. Webb. 2006. Dietary supplements and functional foods. Blackwell Publishing | |
| 6 | Losso, J. N. Angi-angiogenic functional and medicinal foods. CRC Press 2007. | |
| 7 | Shi J.2007. Functional Food Ingredients and Nutraceuticals: Processing Technologies. Taylor & Francis Publ. CRC Press. | |
| 8 | Robert E.C. 2006. Handbook of Nutraceuticals and Functional Foods. 2nd Ed. Wildman. | |
| 9 | Brigelius-Flohé, J and Joost H.G. 2006. Nutritional Genomics: Impact on Health and Disease. Wiley-VCH | |
| 10 | Neeser J.R. and German B.J. Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals. Marcel Dekker, 2004. | |
| 11 | Gibson, GR and William, CM. Functional foods - Concept to Product. Woodhead, 2000. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Describe the fundamental knowledge on various nutraceuticals and functional foods and their mechanism of action and manufacturing aspects | K2 |

| | | |
|---|---|---|
| CO2 | Explain the basics of nutrigenomics and its relation with nutraceuticals | K2 |
| CO3 | Explain the safety/ toxicity aspects of nutraceuticals and interactions with prescribed drugs | K3 |
| CO4 | Describe the basic terminologies and regulatory issues in the field of their applications | K2 |
| CO5 | Explain the roles of various nutraceuticals in different physiological/disease conditions | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO5 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 1 | 0 | 3 | 1 |
| CO2 | 2 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 3 | 2 | 2 | 3 | 2 | 2 |
| CO4 | 2 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 2 | 3 | 1 |

| **PEC5** | **Course Code: FDT 1053** | **Course Title: Waste Management in Food Processing** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VII** | **Total contact hours: 30** | **1** | **1** | **0** |

**List of Prerequisite Courses**

NIL

**List of Courses where this course will be prerequisite**

NIL

**Description of relevance of this course in the B. Tech. Program**

This course is designed for providing understanding related to different terminologies in wastewater treatment, different treatment methods used in wastewater treatment, waste management strategies for food processing industries, recovery of biological from various food wastes. Knowledge of this course will help students to design and develop waste treatment protocol for different food wastes.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Water quality, treatment and recycle. BOD, COD and definitions, Discharge limits for effluents. Primary treatment, secondary and tertiary treatments by physical, chemical and biological methods. | 07 |
| 2 | Effluent and solid waste utilization food processing industry by biological methods – for SCP, biogas and other products | 05 |

| | | |
|---|---|---|
| 3 | Waste management strategies and value-added products from of agri-food processing industry | 08 |
| 4 | Recovery of biological from dairy, meat, fish and poultry processing industry | 05 |
| 5 | Case studies: Cane Sugar waste, molasses for alcohol, bagasse for paper pulp, chemicals, bioethanol, cogeneration. Other processes including vermiculture. | 05 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Wastewater Engineering; Treatment and Reuse, Metcalf & Eddy, Fourth Edition, Tata McGraw-Hill Edition | |
| 2 | Wastewater treatment for pollution Control and Reuse, Soli. J Arceivala & Shyam. R Asolekar Third Edition, Tata McGraw-Hill Edition, 2006. | |
| 3 | Arvanitoyannis I., Waste Management for the Food Industries, 1st Edition, Academic Press, 2007. | |
| 4 | Lawrence K. Wang, Yung-Tse Hung, Howard H. Lo, Constantine Yapijakis, Waste Treatment in Food Processing Industries, Taylor and Francis, 2005. | |
| 5 | Handbook of Waste management and co-product recovery in Food Processing – Vol.1- Keith Waldron, 2009. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Describe and interpret about different terminologies in wastewater treatment | K3 |
| CO2 | Explain and analyse different treatment methods used in wastewater treatment | K4 |
| CO3 | Develop waste management strategies for food processing industries | K4 |
| CO4 | Explain and recommend the strategies for the recovery of biological from various food wastes | K5 |
| CO5 | Design and develop waste treatment protocol for different food wastes | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

**Mapping of Course Outcomes (COs) with Programme Outcomes (POs)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

**Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO2 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO3 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO4 | 1 | 1 | 1 | 0 | 1 | 3 |
| CO5 | 1 | 2 | 1 | 0 | 0 | 2 |

| **PEC6** | **Course Code: FDT1063** | **Course Title: Technology of Plantation Products II** | **Credits = 2** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VIII** | **Total contact hours: 30** | **1** | **1** | **0** |
| | | | | | |
| **List of Prerequisite Courses** | | | | | |

| | | |
|---|---|---|
| Introduction to Food Science and Technology; Food Chemistry | | |
| | | |
| **List of Courses where this course will be prerequisite** | | |
| Flavour Science and Technology | | |
| | | |
| **Description of relevance of this course in the B. Tech. Program** | | |
| This course is designed for providing understanding related to different types of sugar-based, technology of coconut, arecanut, cashew, palmrah, cinchona, medicinal and aromatic plants and their processing to value added products. | | |
| **Course Contents (Topics and subtopics)** | | **Required Hours** |
| 1 | Sugar based confectionery- ingredients used including sugar and alternative sweeteners, description of types of confections like HBC, toffee, fudge, gums and jellies, aerated confectionery, sugar panned confections, chewing gum etc, manufacturing process and equipment, structure of sugar confection, chemical analysis and quality assurance.<br>Indian confectionery- types, description of characteristics, method of preparation | 07 |
| 2 | Cashewnut chemistry, technology, processing and by-products – cashewnut shell liquid, nuts, cashew apple | 03 |
| 3 | Coconut processing in to value added products- coconut water, coconut milk, dessicated coconut, coconut oil, grated coconut and their products; by-product utilization; Other lesser-known nuts such as arecanut, rubber, cinchino and palmyrah | 04 |
| 4 | Commercial floriculture - Production and trade of cut flowers, foliage plants, potted plants, landscape plants, bedding plants, seed production, dried flowers and plant parts, perfumes and essential oils and natural dyes for viable agri-business option, extension of shelf life of flowers, edible flowers and their bioactivities, | 08 |
| 5 | Medicinal plants of commercial importance in nutraceutical formulations, processing, formulations and applications, quality assurance | 08 |
| | **Total** | **30** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Sugar Confectionery and Chocolate Manufacture by R. Lees and E. B. Jackson. Springer US. 1st Edition (1995). ISBN: 9781468414950 | |
| 2 | Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants, N. Kumar, Oxford and IBH Publishing, (2021) | |
| 3 | The Complete Book on Cashew (Cultivation, Processing & By-Products), H. L. Panda, Asia Pacific Business. Press, 2013.Review papers from recent publications | |
| 4 | Postharvest technologies for commercial floriculture, Anil Kumar Verma, New India Publishing Agency, 2012. Review papers from recent publications | |
| 5 | The Complete Book on Coconut & Coconut Products (Cultivation and Processing), Asia Pacific Business Press, 2006 | |
| 6 | Cultivation and Processing of Selected Medicinal Plants, Asia Pacific Busines Press, 2006 | |
| 7 | Sugar Confectionery and Chocolate Manufacture by R. Lees and E. B. Jackson. Springer US. 1st Edition (1995). ISBN: 9781468414950 | |
| 8 | Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants, N. Kumar, Oxford and IBH Publishing, (2021 | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Explain the production and processing of plantation crops of commercial importance such as cashewnut, coconut, their by-product utilization, value added products | K3 |
| CO2 | Explain the techniques used in commercial utilization of flowers for economic gains, post-harvest processing, bioactives from flowers, shelf-life extension of flowers | K3 |

| | | |
|---|---|---|
| CO3 | Describe the medicinal plants that are used commercially for manufacture of nutraceuticals, their processing technologies and formulations, quality assurance | K3 |
| CO4 | Describe different types of sugar-based confections including manufacturing process, equipment used and analysis | K2 |
| CO5 | Explain the production and processing of plantation crops of commercial importance such as cashewnut, coconut, their by-product utilization, value added products | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

**Mapping of Course Outcomes (COs) with Programme Outcomes (POs)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain

**Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | 1 | 1 | 0 |
| CO2 | 3 | 2 | 3 | 2 | 2 | 0 |
| CO3 | 2 | 1 | 2 | 1 | 1 | 1 |
| CO4 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 2 |

# HONORS

| Honors-I | Course Code: FDT 1064 | Course Title: Honors1: Food Biotechnology | Credits = 4 | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| | Semester: V | Total contact hours: 60 | 3 | 1 | 0 |

**List of Prerequisite Courses**

Biochemistry, Microbiology

**List of Courses where this course will be prerequisite**

NIL

**Description of relevance of this course in the B. Tech. Program**

This course is designed to describe the fundamentals of molecular biology, mechanisms of DNA, RNA and protein synthesis, techniques and mechanisms involved in industrial fermentation processes, tissue culture, microalgae, genetically modified foods and nutritional genomics applied in food biotechnology. Knowledge of this course will help to explain the regulations in gene expression and recombinant DNA technology in prokaryotes and eukaryotes and guide the students to explore various industrial applications of enzymes.

| Course Contents (Topics and subtopics) | | Required Hours |
|---|---|---|
| 1 | Introduction to Food of Biotechnology with applications in Industry, Basics of Molecular Biology - Chemistry and Biology of DNA, RNA and proteins, DNA replication, transcription and translation in prokaryotes and eukaryotes | 10 |
| 2 | Regulation of gene expression in prokaryotes and eukaryotes. Recombinant DNA technology with examples | 10 |
| 3 | Introductory aspects of biochemical engineering and bioreactor designs; Application of genetic control mechanisms in industrial fermentation processes; Principles of submerged and solid-state fermentations; Fermentation media and sterilization; Basics of strain improvement techniques. | 10 |
| 4 | Basic concepts of Plant tissue culture and its applications in Biotechnology; Use of microalgae in biotechnology, Animal tissue culture as a tool of biotechnology; Genetically modified foods – plant and animal origin; Nutritional genomics | 10 |
| 5 | Applications of enzymes in food and feed industry | 10 |
| 6 | Fermentative production of food additives and ingredients | 10 |
| | **Total** | **60** |

**List of Textbooks/ Reference Books**


| | |
|---|---|
| 1 | Basic molecular and Cell Biology 3rd edition Ed. David Latchman. BMJ Publishing Group 1997. 1st Indian reprint 2006. |
| 2 | Gene cloning and DNA analysis. An Introduction 4th edition. T.A.Brown. Publishers Blackwell Sciences Ltd. UK 2001. |
| 3 | Introduction to plant biotechnology. H.S. Chawla 2nd edition. Publishers Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi. 2009. |
| 4 | Cell and tissue culture; laboratory procedures in biotechnology. A. Doyle and J.B. Griffiths. John Wiley & Sons, Chichester, UK. 1998. |
| 5 | Fermentation Biotechnology: Principles, Processes and Products, Ward OP, 1989, Prentice-Hall. |


**Course Outcomes (students will be able to….)**

| | | |
|---|---|---|
| CO1 | Describe the fundamentals of molecular biology, chemistry, biology and different mechanisms of DNA, RNA and protein synthesis (K2). | K2 |
| CO2 | Explain the regulations in gene expression in prokaryotes and eukaryotes and recombinant DNA technology (K2) | K2 |
| CO3 | Describe different techniques and mechanisms involved in industrial fermentation processes (K2) | K2 |

| | | |
|---|---|---|
| CO4 | Describe and apply tissue culture and microalgae techniques as a tool of food biotechnology and describe the facts of genetically modified foods and nutritional genomics (K3) | K3 |
| CO5 | Describe various applications of enzymes in industrial processes (K2) | K2 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO2 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO3 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO4 | 1 | 1 | 1 | 0 | 1 | 3 |
| CO5 | 1 | 2 | 1 | 0 | 0 | 2 |

| **Honors-II** | **Course Code: FDT 1027** | **Course Title: Honor2: Food Process Engineering** | **Credits = 4** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VI** | **Total contact hours: 60** | **3** | **1** | **0** |

**List of Prerequisite Courses**

Principles of Food Preservation, Food Engineering

**List of Courses where this course will be prerequisite**

Food Processing and Engineering Lab

**Description of relevance of this course in the B. Tech. Program**

This course is designed to acquaint the students with different thermal and mechanical operations in food processing and its integration to actual process design. Knowledge of this course will help students to design and analyse the performance of food processing equipment such as dryer and evaporators.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | **Product & Process Development:** Important aspects of product and process development. Basic flow sheet development for food processing | 04 |
| 2 | **Boiler & Heat Exchanger:** Thermodynamic properties of steam; Steam as heating medium in Food operations; Fire and water tube boiler; Design of heat exchangers for food operations. | 08 |
| 3 | **Thermal Processing & Equipment:** | 12 |

| | | |
|---|---|---|
| | design and equipment aspects of Thermal processing; Continuous sterilization; Canning and retort processing.<br>Equipment design aspects of pasteurizer, evaporators, and concentrators. Nonthermal processes. | |
| 4 | **Mechanical Operations & Equipment:**<br>Process design aspects of homogenizer, centrifugal separators, extruder, filtration system, Bakery Machines and Equipment: Sheeting, mixing and blending | 10 |
| 5 | **Dryer and their Design Parameters:**<br>Tray dryer, spray dryer, fluidized bed dryer, heat-pump assisted dryer, and freeze dryer | 10 |
| 6 | **Freezing & Cold Storage:**<br>Construction of cold storages and refrigerated vans.<br>Types of freezers and their design parameters – plate contact freezer, air blast freezer, cryogenic freezer. | 10 |
| 7 | **Plant Layout and Costing:**<br>Food processing Plant layout, CGMP, material of construction and corrosion, waste utilization, Process control, optimization and preliminary project costing. | 06 |
| | **Total** | **60** |

| **List of Textbooks/ Reference Books** | |
|---|---|
| 1 | Toledo, R.T. Fundamentals of Food Process Engineering, Chapman and Hall; 2000, |
| 2 | Watson, E.L., & Harper, J.C. Elements of Food Engineering, The Avi Publishing Co.; 1989 |
| 3 | Heldman, D.R. & Singh, R.P. Introduction to Food Engineering; 4th ed.; Academic Press; Elsevier; 2009. |
| 4 | Geankoplis, J. Transport Processes and Separation Process Principles, Pearson Publisher; 4th ed.; 2003. |
| 5 | Das, H. Food Processing Operations Analysis; Asian Books Pvt. Ltd.; 2008. |
| 6 | Meyers, F.E. & Stephens, M.P. Manufacturing Facilities, Design and Material Handling, Pearson Education Inc.; 2013 |

| **Course Outcomes (students will be able to….)** | | |
|---|---|---|
| CO1 | Explain and develop basic flow sheet in food processing operations | K3 |
| CO2 | Analyse the design aspects of different thermal processes and equipment | K4 |
| CO3 | Design different non-thermal processes and bakery equipment | K3 |
| CO4 | Explain the cooling technology in food processing and design the cold storage and refrigerated vans | K3 |
| CO5 | Analyse the critical process control parameters and develop plant layout of a food industry | K4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 2 | 1 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO2 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO5 | 1 | 1 | 1 | 0 | 1 | 3 |

| **Honors-III** | **Course Code: FDP 1041** | **Course Title: Honors3: Food Processing and Engineering Lab** | **Credits = 4** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VII** | **Total contact hours: 120** | **0** | **0** | **4** |

**List of Prerequisite Courses**

SPL2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**, SPL8: Food Process Engineering **(FDT1027)**.

**List of Courses where this course will be prerequisite**

None

**Description of relevance of this course in the B. Tech. Program**

This practical course will help students to evaluate the performance of thermal and mechanical operations in food processes, analyse the integration of experimental design in food processing and formulations.

| | **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|---|
| 1 | Particle size and sieve analysis of cereal and wheat flour | 04 |
| 2 | Efficacy of size reduction process through hammer and ball mill | 04 |
| 3 | Milling of grains: Estimating the milling efficiency | 04 |
| 4 | Milk homogenization: Effect of product and process variables | 08 |
| 5 | Effect of process parameters on viscosity of liquid food | 08 |
| 6 | Rheological study of food slurry, paste and dough | 08 |
| 7 | Estimating the mixing index in a food mixture (solid and liquid) | 04 |
| 8 | Kinetic in thermal process design: Pasteurization of liquid food | 08 |
| 9 | Thermal death time in Canning of fruits and vegetables | 08 |
| 10 | Retort processing of vegetable products | 04 |
| 11 | Effect of process and product parameters on baking of bread | 08 |
| 12 | Effect of process and product parameters on baking of biscuit | 08 |
| 13 | Effect of material and air properties on tray drying of food materials | 08 |
| 14 | Effect of material and air properties on spray drying of food materials | 08 |
| 15 | Freezing of food material (rate and time of freezing) | 08 |
| 16 | Study of extraction of oleoresins from spices using liquid carbon dioxide | 04 |
| 17 | Use of experimental design and sensory evaluation in product formulation: Beverage (fermented and non-fermented); premix | 12 |
| 18 | Non-thermal processing of food | 04 |
| | **Total** | **120** |

**List of Textbooks/ Reference Books**


| | |
|---|---|
| 1 | Ibarz, A., & Barbosa-Canovas, G. V. Unit Operations in Food Engineering. CRC Press, UK; 2002. |
| 2 | Barbosa-Cánovas, G. V., Ma, L., & Barletta, B. J. Food Engineering Laboratory Manual. CRC Press. UK; 1997. |
| 3 | Heldman, D.R. & Singh, R.P. Introduction to Food Engineering; 4th ed.; Academic Press; Elsevier; 2009. |
| 4 | Stoecker, W.F. Industrial Refrigeration Handbook, McGraw-Hill Companies, Inc.; 1998. |
| 5 | Das, H. Food Processing Operations Analysis; Asian Books Pvt. Ltd.; 2008. |
| 6 | Fuller, G.W. New Food Product Development: From Concept to Marketplace, 3rd ed, CRC Press, UK; 2011. |

| Course Outcomes (students will be able to….) | | |
|---|---|---|
| CO1 | Analyse the different unit operations in developing a process specific to food products | K4+P4 |
| CO2 | Analyse different thermal processes for food preservations | K4+P4 |
| CO3 | Analyse and evaluate the effect of different process variables on the quality of food product | K5+P4 |
| CO4 | Analyse and evaluate the effect of compositional variables on quality of food products | K5+P4 |
| CO5 | Develop and optimize the food process and products using the experimental design concept | K5+P4 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |
| P1 – Imitate, P2 – Manipulate, P3 – Perfect, P4 – Articulate, P5 - Embody | | |

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 3 | 2 | 2 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO3 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO5 | 1 | 1 | 1 | 0 | 1 | 3 |

| **Honors-IV** | **Course Code: FDT 1066** | **Course Title: Honors4: Insights in to Traditional Foods** | **Credits = 3** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VIII** | **Total contact hours: 45** | **2** | **1** | **0** |

**List of Prerequisite Courses**

All the previous courses in the program

**List of Courses where this course will be prerequisite**

Project I, Project II and all the subsequent courses of the program

**Description of relevance of this course in the B. Tech. Program**

This course is designed for providing understanding related to the history, philosophy, science and technology of traditional Indian foods, engineering properties and processes related to Indian traditional foods, nutritional and nutraceutical aspects of Indian traditional foods. Knowledge of this course will help students to appropriately use of food additives and ingredients and meet labeling requirements of Indian traditional foods.

| **Course Contents (Topics and subtopics)** | **Required Hours** |
|---|---|

| | | |
|---|---|---|
| 1 | History and Philosophy of Indian traditional foods and food systems: Concept of Annamaykosha; intertwining of food, God and religion; concept of Vasudeva kutumba; concept of fasting; food pairing system; Rasayanas in Indian food systems; main course vs. vyanjanas; biodiversity of Indian food systems | 04 |
| 2 | Chemistry and Technology of traditional Indian foods with respect to commodity technologies (cereals/millets/legumes, dairy, animal foods, plantation foods such as tea/coffee/cocoa/spices/coconut/arecanut etc) and their combinations | 10 |
| 3 | Engineering processes and engineering properties of traditional Indian foods | 04 |
| 4 | Machinery development and scale-up of Indian traditional foods | 05 |
| 5 | Traditional foods for specific population groups such as pregnant and lactating mothers (galactogues), elderly, infants and children | 05 |
| 6 | Traditional foods and food groups as nutraceuticals, Ayurceuticals (traditional adaptogens such as ashwagandha and others listed in FSSAI) | 08 |
| 7 | Geographical indicator (GI) tag and its significance in traditional Indian foods | 03 |
| 8 | Miscellaneous topics such as packaging requirements, mouth fresheners, confectionaries ad savouries in traditional Indian food systems | 06 |
| | **Total** | **45** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Traditional Foods: History, Preparation, Processing and Safety, Mohammed Al-Khusaibi, Nasser Al-Habsi, Mohammad Shafiur Rahman, Springer Nature, 18-Oct-2019. | |
| 2 | Functional Properties of Traditional Foods, Kristberg Kristbergsson, Semih Otles, Springer, 2016 | |
| 3 | Innovations in traditional foods, Edited by Charis M. Galanakis, Elsevier Science, 2019, ISBN: 9780128148877, 012814887X | |
| 4 | Eating traditional food: politics, identity and practices, Brigitte Sebastia, Routledge, 2016. | |
| 5 | Social Ecological Diversity And Traditional Food Systems: Oppurtunities From The Biocultural World, Ranjay K. Singh, New India Publishing Agency, New Delhi, 2014. | |
| 6 | Modernization of Traditional Food Processes and Products, edited by Anna McElhatton, Mustapha Missbah El Idrissi, Springer, 2016 | |
| 7 | Revisiting Indian traditional foods-A critical review of the engineering properties and process operations, S Basak, S Chakraborty, RS Singhal, Food Control, 143, 109286 (2023). | |
| 8 | Regulating Safety of Traditional and Ethnic Foods, edited by V. Prakash, Olga Martin-Belloso, Larry Keener, Siân B. Astley, Susanne Braun, Helena McMahon, Huub L. M. Lelieveld, Academic Press, 2015. | |
| 9 | | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Describe the philosophy, chemistry, technology and nutrition of traditional Indian foods and food systems | K2 |
| CO2 | Describe the engineering properties and processes for commercialization of Indian traditional foods | K2 |
| CO3 | Describe the nutraceutical aspects of traditional Indian foods | K2 |
| CO4 | Describe the significance of GI, regulatory and safety aspects of traditional Indian foods | K2 |
| CO5 | Extrapolate the knowledge gained on commodity technologies in previous courses to traditional Indian foods | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 2 | 2 | 2 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain

| Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs) | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 2 | 1 | 1 | 1 | 0 |
| CO2 | 2 | 2 | 0 | 1 | 1 | 1 |
| CO3 | 2 | 2 | 1 | 1 | 1 | 3 |
| CO4 | 1 | 1 | 1 | 0 | 1 | 3 |
| CO5 | 1 | 2 | 1 | 0 | 0 | 2 |

| **Honors-V** | **Course Code: FDT 1067** | **Course Title: Honors5: Flavour Science and Technology** | **Credits = 3** | | |
|---|---|---|---|---|---|
| | | | **L** | **T** | **P** |
| | **Semester: VIII** | **Total contact hours: 45** | **2** | **1** | **0** |

**List of Prerequisite Courses**

Basics of Organic, Inorganic, Physical and Analytical Chemistry and Chemistry of Food Constituents, Organic Chemistry, Food Additives & Ingredients; Unit operations in Chemical Engineering, Food Chemistry, Food Processing and Product development Lab

**List of Courses where this course will be prerequisite**

Project I, Project II

**Description of relevance of this course in the B. Tech. Program**

This course will provide understanding related to the flavours and flavourings used in food systems, science and technology of extraction and synthesis of various flavours and flavourings, generation of flavours and off flavours in processed food systems, science and technology of microencapsulation of flavours, reaction flavours, WOF in foods; flavours for processed foods such as microwaveable foods, aseptically processed and non-thermal treated foods.

| **Course Contents (Topics and subtopics)** | | **Required Hours** |
|---|---|---|
| 1 | Understanding of terms like Flavour and Flavouring agents. Attributes of flavour, taste, odour, odour stimulation, basic tastes and the human olfactory system, Flavour enhancers, modifiers, precursors, suppressors, major chemicals and raw materials, solvents. | 05 |
| 2 | Flavours and flavourings- classification of flavours; processes of preparing flavours such as extraction, distillation, fractionation and purification-natural and synthetic sources; microbial production of flavours | 05 |
| 3 | Important chemical reactions involved in converting raw materials to flavour chemicals; Synthetic methods for various functional groups; | 06 |
| 4 | Biogenesis of flavours in various commodity food products (eg. fruits and vegetables, fermented products, bakery products etc), reaction flavours, flavours for processed foods such as microwaveable foods; WOF; off flavours and taints in foods | 06 |
| 5 | Isolation, purification of flavour compounds, re-enforcement of top notes in flavour formulation/foods; basics of blending of flavours and flavourings | 05 |

| | | |
|---|---|---|
| 6 | Methods of formulating flavours in liquid, emulsion and solid forms; Flavour encapsulation and stabilization: Principles and techniques of flavour encapsulation, types of encapsulations, factors affecting stabilization of encapsulated flavour and their applications in food industry | 06 |
| 7 | Application in aqueous, oleophilic systems, beverages, bakery products, confectionery products, various commodity products, low-fat, low-sugar, high-protein food products | 06 |
| 8 | Analysis of flavours: Techniques for sensorial evaluation of flavours; psychophysiology of flavours; Instrumental analysis (Absorption Spectroscopy (W/VIS), chromatography, mass spectrometry); legislation of flavours | 06 |
| | **Total** | **45** |
| **List of Textbooks/ Reference Books** | | |
| 1 | Chemistry and technology of flavor fragrances – D. J. Rowe | |
| 2 | Perfumery and Flavoring synthetics – Bedaukian | |
| 3 | Natural food additives, ingredients, and flavourings, D Baines, R Seal, (2012), Woodhead Publishing Series in Food Science, Technology and Nutrition. | |
| 4 | Fuller, G.W. New Food Product Development: From Concept to Marketplace, 3rd ed, CRC Press, UK; 2011. | |
| 5 | Unit processes in organic chemical industries – Desikan P. | |
| **Course Outcomes (students will be able to….)** | | |
| CO1 | Describe the various flavours and flavourings used in food products (K2) | K2 |
| CO2 | Describe the mechanisms of natural and synthetic pathways of flavour generation | K2 |
| CO3 | Describe the techniques of extraction and formulation of flavours and flavourings | K2 |
| CO4 | Describe the forms of use of flavours in different food systems | K2 |
| CO5 | Extrapolate the knowledge gained on flavours and flavourings in food products in food industries | K3 |
| K1 – Remembering, K2 – Understanding, K3 – Applying, K4 – Analyzing, K5 – Evaluating, K6 – Creating | | |

| **Mapping of Course Outcomes (COs) with Programme Outcomes (POs)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain

| **Mapping of Course Outcomes (COs) with Programme Outcomes (PSOs)** | | | | | | |
|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
| CO1 | 2 | 1 | 1 | 1 | 2 | 1 |
| CO2 | 1 | 0 | 1 | 1 | 2 | 2 |
| CO3 | 2 | 1 | 0 | 1 | 0 | 1 |
| CO4 | 2 | 1 | 1 | 2 | 2 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 2 | 1 |