# TABLE OF CONTENTS


| | | | Page Number |
|---|---|---|---|
| **Foreword** | | | xxvii |
| **VFSTR- Vision & Mission** | | | xxviii |
| **Chemical Engineering - Vision & Mission** | | | xxviii |
| **Programme Objectives and Programme Outcomes** | | | xxix |
| **Curriculum Structure** | | | xxx |
| **Course Contents** | | | |
| **I YEAR - I SEMESTER** | | | |
| 19HS104 | - | Engineering Mathematics - I (D) | 3 |
| 19HS114 | - | Engineering Physics (B) | 5 |
| 19EE101 | - | Basics of Electrical & Electronics Engineering | 9 |
| 19ME101 | - | Engineering Graphics & Design | 11 |
| 19CH101 | - | Chemical Engineering Thermodynamics - I | 13 |
| 19PC001 | - | Physical Fitness, Sports & Games - I | |
| **I YEAR - II SEMESTER** | | | |
| 19HS110 | - | Engineering Mathematics - II (D) | 15 |
| 19HS121 | - | Organic Chemistry | 17 |
| 19CS101 | - | Programming for Problem Solving | 21 |
| 19HS122 | - | English Proficiency and Communication Skills | 27 |
| 19HS123 | - | Technical English Communication | 29 |
| 19HS124 | - | Constitution of India | 33 |
| 19ME103 | - | Workshop | 35 |
| 19CH102 | - | Momentum Transfer | 37 |
| 19PC002 | - | Physical Fitness, Sports and Games - II | |
| **II YEAR - I SEMESTER** | | | |
| 19CH201 | - | Chemical Process Calculations | 41 |
| 19CH202 | - | Mechanical Unit Operations | 43 |
| 19CH203 | - | Process Heat Transfer | 45 |
| 19CH204 | - | Chemical Engineering Thermodynamics - II | 47 |
| 19CH205 | - | Mass Transfer Operations - I | 49 |
| 19PC003 | - | Life Skills - I | |
| 19PC004 | - | Technical Seminar - I | |
| 19PC005 | - | Intra-disciplinary Projects - I | 51 |
| 19PC006 | - | Physical fitness, Sports & Games - III | |
| **II YEAR - II SEMESTER** | | | |
| 19CH211 | - | General Pharmacy | 53 |
| 19CH212 | - | Chemical Reaction Engineering - I | 55 |
| 19CH213 | - | Mass Transfer Operations - II | 57 |
| 19HS204 | - | Environmental Studies | 59 |
| 19MS302 | - | Management Science | 61 |
| 19PC007 | - | Life Skills - II | |
| 19PC008 | - | Technical Seminar - II | |
| 19PC009 | - | Intra-disciplinary Projects - II | 63 |
| **III YEAR - I SEMESTER** | | | |
| 19CH301 | - | Pre-formulation Studies | 67 |
| 19CH302 | - | Chemical Reaction Engineering - II | 71 |
| 19CH303 | - | Instrumentation and Process Control | 73 |
| 19EL102 | - | Soft Skills Laboratory | 75 |
| 19PC010 | - | Employability Skills - I | |
| 19HS301 | - | Human Values, Professional Ethics & Gender Equity | 79 |

| | | | |
|---|---|---|---|
| 19PC011 | - | Inter Departmental Project - I | 81 |
| | - | Modular Course | |
| | - | Department Elective - II | |
| | - | Open Elective - II | |

**III YEAR - II SEMESTER**

| | | | |
|---|---|---|---|
| 19CH311 | - | Chemical Engineering Process Design and Economics | 83 |
| 19CH312 | - | Industrial Pharmacy | 85 |
| 19CH313 | - | Safety in Chemical Industries - I | 87 |
| 19EL103 | - | Professional Communications Laboratory | 89 |
| 19PC013 | - | Employability Skills - II | |
| 19PC014 | - | Inter Departmental Project - II | 93 |
| | - | Department Elective - III | |
| | - | Open Elective - III | |

**IV YEAR - I SEMESTER**

| | | | |
|---|---|---|---|
| 19CH401 | - | Quality Control of Pharmaceutical Dosage Forms | 97 |
| 19CH402 | - | Safety in Chemical Industries - II | 99 |
| 19CH403 | - | Industrial Process Technologies - I | 101 |
| 19CH404 | - | Industrial Process Technologies - II | 103 |
| 19PC015 | - | Societal Centric and Industry Related Project | 105 |
| | - | Department Elective - IV | |

**IV YEAR - II SEMESTER**

| | | | |
|---|---|---|---|
| 19PC016 | - | Project work /Internship | |

**DEPARTMENT ELECTIVES**

**ELECTIVE - I**

| | | | |
|---|---|---|---|
| 19CH231 | - | Material Technology | 109 |
| 19CH232 | - | Industrial Effluent Treatment Methods | 111 |
| 19CH233 | - | Energy Management and Auditing | 113 |
| 19CH234 | - | Mineral Process Technology | 115 |
| 19CH235 | - | Polymer Science and Engineering | 117 |
| 19CH236 | - | Petro Chemicals | 119 |
| 19CH237 | - | Fundamentals of Biotechnology | 121 |

**ELECTIVE-II**

| | | | |
|---|---|---|---|
| 19CH331 | - | Process Modelling and Simulation | 123 |
| 19CH332 | - | Solid Waste Management and Treatment | 125 |
| 19CH333 | - | Petroleum Refinery Engineering | 127 |
| 19CH334 | - | Colloidal and Interfacial Science | 129 |
| 19CH335 | - | Fundamentals of Nanotechnology | 131 |
| 19CH336 | - | Membrane Technology | 133 |
| 19CH337 | - | Bio Process Engineering | 135 |

**ELECTIVE- III**

| | | | |
|---|---|---|---|
| 19CH338 | - | Transprot Phenomena | 137 |
| 19CH339 | - | Energy Conservation and Waste Heat Recovery | 139 |
| 19CH340 | - | Non-Conventional Energy Resources | 141 |
| 19CH341 | - | Computational Fluid Dynamics | 143 |
| 19CH342 | - | Introduction to MAT Lab Programming | 145 |

**ELECTIVE- IV**

| | | | |
|---|---|---|---|
| 19CH431 | - | Design and Analysis of Experiments | 147 |
| 19CH432 | - | Matlab Programming for Numerical Computation | 149 |
| 19CH433 | - | Optimization in Chemical Engineering | 151 |
| 19CH434 | - | Chemical Process Equipment Design | 153 |
| 19CH435 | - | Environmental Regulations and Impact Analysis | 155 |


***

# FOREWORD

*Chemical Engineering involves the design and maintenance of chemical plants and the development of chemical processes for converting raw materials and chemicals into valuable products. It combines knowledge of chemistry and engineering for the production of chemicals and related by-products. This branch of engineering is a varied field, covering areas of energy engineering, environmental engineering, mineral processing, pharmaceuticals, polymer engineering, petroleum engineering etc. Chemical Engineers operate chemical plants and improve methods of production and productivity as well.*

*The primary function of chemical engineers is to study raw materials for their consistency/properties, their conversion into products, the process and equipments involved in conversion and safety aspects. Chemical engineering addresses problems in health care, including technology and medicine. It also helps to develop processing systems for waste management and food processing, in a more affordable and healthy fashion. Chemical Engineers also play a major role in national defense with their involvement in the handling, development and disposal of high-tech chemical weapons and ammunition.*

*In the early 21st century, societal demands for better energy conservation and environmentally safe business practices changed the nature of chemical engineering in a larger way.*

*B.Tech. programme of Chemical Engineering is aimed at offering the knowledge and skills of invention, development, design, operation and management of processes in chemical industries. It combines the work of several fields such as chemistry, industrial engineering, materials science as well as mechanical engineering.*

*In the new curriculum of R19, skill-oriented activities are included to enable the students to acquire hands-on experience of technology to make them better suited for industry requirements.*

## R-19 curriculum comprises of:

- *One modular course exclusively offered by industry persons.*
- *Enhanced skill based courses for improving enployment opportunities.*
- *Laboratory sessions embedded into as many courses as possible.*
- *Indrustrial based courses like safety in chemical indrustries, indrustrial pharmacy, quality control of pharmaceutical dosage forms.*

*In R19 curriculum, every care has been taken to accommodate the knowledge and skill reqirements of industry throuth proper activites for practice. While making the graduates industry ready, it also enables them to be successful in competitive examinations like GATE.*

*The focus area fo each unit in every course is clearly defined. The Board of Studies consisiting of eminent personalities along with experienced faculty members of the university have designed the curriculum to offer knowledge and skill of chemical engineering on above mentioned areas. The curriculum includes concedpts with skill based tasks through integrated laboratory and activities combined with theory. The depratment aims to make graduates ready for the industrial needs.*

## *External BoS Members:*

1. Dr.G.Prabhakar, *Professor & Head, Dept. of Chemical Engineering, S V University, Tirupathi.*
2. Dr.K.Krishnaiah, *Dean academics and Professor, Dept. of Chemical Engineering, IIT Tirupati.*
3. Dr.Y Pydi Setty, *Professor, Dept. of Chemical Engineering, NIT Warangal.*
4. Sri R.Banerjee Babu, *General Manager, Production, JOCIL, Dokiparru.*
5. Dr.M.Prasad Babu, *Scientist, Nagarjuna Fertilizers and Chemicals Ltd, Hyderabad.*

*I thank all the BOS Members, Academic Council Members and University authorities for encouraging and supporting us in designing this innovative curriculum for our students.*

**Dr. M. Ramesh Naidu**

HOD, CHEM

VIGNAN'S
Foundation for Science, Technology & Research
(Deemed to be UNIVERSITY)
-Estd. u/s 3 of UGC Act 1956

## VISION

To evolve into a Centre of Excellence in Science & Technology through creative and innovative practices in teaching – learning, towards promoting academic achievement and research excellence to produce internationally accepted, competitive and world class professionals who are psychologically strong & emotionally balanced, imbued with social consciousness & ethical values.

## MISSION

To provide high quality academic programmes, training activities, research facilities and opportunities supported by continuous industry - institute interaction aimed at promoting employability, entrepreneurship, leadership and research aptitude among students and contribute to the economic and technological development of the region, state and nation.

# Department of
# CHEMICAL ENGINEERING

## VISION

To attain global recognition in research and training students for meeting the challenging needs of chemical and allied industries and society.

## MISSION

- Providing high quality undergraduate and graduate education in tune with changing needs of industry.
- Generating knowledge and developing technology through quality research in frontier areas of chemical and interdisciplinary fields.
- Fostering industry-academia relationship for mutual benefit and growth.

# B.Tech. - CHEMICAL ENGINEERING

## Programme Educational Objectives (PEOs)

**PEO1:** Graduates pursue profession in chemical & allied engineering.

**PEO2:** Graduates work in diversified team.

**PEO3:** Graduates will pursue higher education & research.

## Programme Specific Outcomes (PSOs)

**PSO1:** Graduates will be able to separate and purify petrochemicals, pharmaceuticals and health care products.

**PSO2:** Graduates will automate and control processes by applying mathematics, process control, instru mentation, simulation and process modelling.

**PSO3:** Graduates will design equipment for modern science applications.

## Programme Outcomes (POs)

**The graduates of Chemical Engineering will be able to:**

**PO1:** **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamen tals, 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 principle 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 life-long learning in the broadest context of technological change.

B.Tech.

CHE

I YEAR

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## I Year I Semester

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19HS104 | Engineering Mathematics - I (D) | 3 | 1 | 2 | 5 |
| 19HS114 | Engineering Physics (B) | 3 | 0 | 2 | 4 |
| 19EE101 | Basics of Electrical & Electronics Engineering | 3 | 0 | 2 | 4 |
| 19ME101 | Engineering Graphics & Design | 2 | 0 | 2 | 3 |
| 19CH101 | Chemical Engineering Thermodynamics - I | 3 | 1 | 0 | 4 |
| 19PC001 | Physical Fitness, Sports & Games-I | 0 | 0 | 3 | 1 |
| | **Total** | **14** | **1** | **11** | **21** |

## I Year II Semester

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19HS110 | Engineering Mathematics - II (D) | 3 | 1 | 2 | 5 |
| 19HS121 | Organic Chemistry | 3 | 0 | 2 | 4 |
| 19CS101 | Programming for Problem Solving | 2 | 0 | 4 | 4 |
| 19HS122 | English Proficiency and Communication Skills | 0 | 0 | 2 | 1 |
| 19HS123 | Technical English Communication | 2 | 0 | 2 | 3 |
| 19HS124 | Constitution of India | 1 | 0 | 0 | 1 |
| 19ME103 | Workshop | 1 | 0 | 2 | 2 |
| 19CH102 | Momentum Transfer | 3 | 0 | 2 | 4 |
| 19PC002 | Physical Fitness, Sports & Games-II | 0 | 0 | 3 | 1 |
| | **Total** | **15** | **2** | **17** | **25** |

L : Lecture Hours/week ; T : Tutorial Hours/week ;
P : Practical Hours/week ; C : Credits of the Course ;

B.Tech.
CHE
II YEAR

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## II Year I Semester

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH201 | Chemical Process Calculations | 3 | 1 | 0 | 4 |
| 19CH202 | Mechanical Unit Operations | 3 | 0 | 2 | 4 |
| 19CH203 | Process Heat Transfer | 3 | 0 | 2 | 4 |
| 19CH204 | Chemical Engineering Thermodynamics-II | 3 | 1 | 0 | 4 |
| 19CH205 | Mass Transfer Operations-I | 3 | 0 | 2 | 4 |
| 19PC003 | Life Skills-I | 0 | 0 | 2 | 0 |
| 19PC004 | Technical Seminar-I | 0 | 0 | 2 | 1 |
| 19PC005 | Intra-disciplinary Projects-I | 0 | 0 | 3 | 1 |
| 19PC006 | Physical Fitness, Sports & Games-III | 0 | 0 | 2 | 1 |
| | **Total** | **15** | **2** | **15** | **23** |

## II Year II Semester

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH211 | General Pharmacy | 3 | 0 | 2 | 4 |
| 19CH212 | Chemical Reaction Engineering-I | 3 | 1 | 0 | 4 |
| 19CH213 | Mass Transfer Operations-II | 3 | 0 | 2 | 4 |
| 19HS204 | Environmental Studies | 1 | 0 | 0 | 1 |
| 19EL102 | Department Elective-I | 3 | 0 | 0 | 3 |
| 19MS302 | Management Science | 3 | 0 | 0 | 3 |
| 19PC007 | Life Skills-II | 0 | 0 | 2 | 1 |
| 19PC008 | Technical Seminar-II | 0 | 0 | 2 | 1 |
| 19PC009 | Intra Disciplinary Projects-II | 0 | 0 | 2 | 1 |
| | Open Elective-I | 3 | 0 | 0 | 3 |
| | **Total** | **19** | **1** | **10** | **25** |

B.Tech.

CHE

III YEAR

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## III Year I Semester

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH301 | Pre-Formulation Studies | 3 | 0 | 2 | 4 |
| 19CH302 | Chemical Reaction Engineering-II | 3 | 0 | 2 | 4 |
| 19CH303 | Instrumentation and Process Control | 3 | 0 | 2 | 4 |
| 19EL102 | Soft Skills Laboratory | 0 | 0 | 2 | 1 |
| 19PC010 | Employability Skills-I | 0 | 0 | 2 | 0 |
| 19HS301 | Human Values, Professional Ethics & Gender Equity | 2 | 0 | 0 | 2 |
| 19PC011 | Inter Departmental Projects-I | 0 | 0 | 4 | 2 |
| 19PC012 | Modular Course | 0 | 0 | 0 | 1 |
| | Department Elective-II | 3 | 0 | 0 | 3 |
| | Open Elective-II | 3 | 0 | 0 | 3 |
| | **Total** | **18** | **0** | **12** | **24** |

## III Year II Semester

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH311 | Chemical Engineering Process Design and Economics | 3 | 1 | 0 | 4 |
| 19CH312 | Industrial Pharmacy | 3 | 0 | 2 | 4 |
| 19CH313 | Safety in Chemical Industries-I | 3 | 1 | 0 | 3 |
| 19EL103 | Professional Communications Laboratory | 0 | 0 | 2 | 1 |
| 19PC013 | Employability Skills-II | 0 | 0 | 2 | 1 |
| 19PC014 | Inter Departmental Projects-II | 0 | 0 | 4 | 2 |
| | Department Elective-III | 3 | 0 | 0 | 3 |
| | Open Elective-III | 3 | 0 | 0 | 3 |
| | **Total** | **15** | **1** | **10** | **21** |

B.Tech.
CHE
IV YEAR

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## IV Year I Semester

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH401 | Quality Control of Pharmaceutical Dosage Forms | 3 | 0 | 0 | 3 |
| 19CH402 | Safety in Chemical Industries-II | 3 | 0 | 0 | 3 |
| 19CH403 | Industrial Process Technologies-I | 3 | 0 | 0 | 3 |
| 19CH404 | Industrial Process Technologies-II | 3 | 0 | 2 | 4 |
| 19PC015 | Societal Centric and Industry Related Project | 0 | 0 | 6 | 3 |
| | Department Elective-IV | 3 | 0 | 0 | 3 |
| | **Total** | **15** | **1** | **8** | **19** |

## IV Year II Semester

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19PC016 | Project work / Internship (Industry Oriented Projects) | 0 | 0 | 24 | 12 |
| | **Total** | | | **24** | **12** |

In addition to L, T, P, C the following information in hours/semester is also provided for each course.

WA/RA : Writing Assignment / Reading Assignment
SSH/HSH : Self Study Hours / Home Study Hours
CS : Case Study and Example
SA : Skills Activity
S : Seminar
BS : Beyond Syllabus

B.Tech.

CHE

ELECTIVES

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## DEPARTMENT ELECTIVE STREAMS AND COURSES

**ELECTIVE - I**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH231 | Material Technology | 3 | - | - | 3 |
| 19CH232 | Industrial Effluent Treatment Methods | 3 | - | - | 3 |
| 19CH233 | Energy Management and Auditing | 3 | - | - | 3 |
| 19CH234 | Mineral Process Technology | 3 | - | - | 3 |
| 19CH235 | Polymer Science and Engineering | 3 | - | - | 3 |
| 19CH236 | Petro Chemicals | 3 | - | - | 3 |
| 19CH237 | Fudamentals of Biotechnology | 3 | - | - | 3 |

**ELECTIVE - II**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH331 | Process Modelling and Simulation | 3 | - | - | 3 |
| 19CH332 | Solid Waste Management and Treatment | 3 | - | - | 3 |
| 19CH333 | Petroleum Refinery Engineering | 3 | - | - | 3 |
| 19CH334 | Colloidal and Interfacial Science | 3 | - | - | 3 |
| 19CH335 | Fundamentals of Nanotechnoogy | 3 | - | - | 3 |
| 19CH336 | Membrane Technology | 3 | - | - | 3 |
| 19CH337 | Bio Process Engineering | 3 | - | - | 3 |

**ELECTIVE - III**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH338 | Transport Phenomena | 3 | - | - | 3 |
| 19CH339 | Energy Conservation and Waste Heat Recovery | 3 | - | - | 3 |
| 19CH340 | Non Conventional Energy Sources | 3 | - | - | 3 |
| 19CH341 | Computational Fluid Dynamics | 3 | - | - | 3 |
| 19CH342 | Introduction to Matlab Programming | 3 | - | - | 3 |

**ELECTIVE - IV**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CH431 | Design and Analysis of Experiments | 3 | - | - | 3 |
| 19CH432 | Matlab Programming for Numerical Computation | 3 | - | - | 3 |
| 19CH433 | Optimization in Chemical Engineering | 3 | - | - | 3 |
| 19CH434 | Chemical Process Equipment Design | 3 | - | - | 3 |
| 19CH435 | Environmental Regulations and Impact Analysis | 3 | - | - | 3 |

B.Tech.
CHE
ELECTIVES

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## OPEN ELECTIVE COURSES

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19AE521 | Basic Automobile Engineering | 3 | - | - | 3 |
| 19AE531 | On Road and Off-road Vehicles | 3 | - | - | 3 |
| 19AE532 | Safety systems in Automobiles | 3 | - | - | 3 |
| 19AE541 | Vehicle Maintenance and pollution Norms | 3 | - | - | 3 |
| 19BI521 | Community Informatics | 3 | - | - | 3 |
| 19BI531 | Health Informatics | 3 | - | - | 3 |
| 19BI532 | Software Tools for Sustainable Biodiversity | 3 | - | - | 3 |
| 19BM521 | Basic Clinical Sciences | 3 | - | - | 3 |
| 19BM522 | Assist Devices and Implant Technology | 3 | - | - | 3 |
| 19BM531 | Clinical Instrumenatation | 3 | - | - | 3 |
| 19BM532 | Biomaterial and Artificial Organs | 3 | - | - | 3 |
| 19BM533 | Biomedical Equipments | 3 | - | - | 3 |
| 19BM541 | Medical Imaging Techniques | 3 | - | - | 3 |
| 19BM542 | Medical Physics | 3 | - | - | 3 |
| 19BT521 | Elements of Biotechnology | 3 | - | - | 3 |

B.Tech.

CHE

ELECTIVES

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## OPEN ELECTIVE COURSES

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19BT531 | Community Medicine and Public Health | 3 | - | - | 3 |
| 19BT532 | Biodiversity Economics, Trade and Commerce | 3 | - | - | 3 |
| 19BT533 | Bioplastics and Biocomposites Engineering | 3 | - | - | 3 |
| 19CE521 | Environmental Pollution & Control | 3 | - | - | 3 |
| 19CE522 | Building Technology | 3 | - | - | 3 |
| 19CE531 | Disaster Management | 3 | - | - | 3 |
| 19CE532 | Solid Waste Management | 3 | - | - | 3 |
| 19CE533 | Remote Sensing & Geographical Information System | 3 | - | - | 3 |
| 19CE541 | Environmental Impact Assessment | 3 | - | - | 3 |
| 19CS531 | Python Programming | 3 | - | - | 3 |
| 19CS532 | R Programming | 3 | - | - | 3 |
| 19CS533 | Data Structures | 3 | - | - | 3 |
| 19CS534 | Database Management Systems | 3 | - | - | 3 |
| 19CS535 | Operating Systems | 3 | - | - | 3 |

B.Tech.
CHE
ELECTIVES

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## OPEN ELECTIVE COURSES

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19CS541 | Data Mining Techniques | 3 | - | - | 3 |
| 19CS542 | Internet of Things | 3 | - | - | 3 |
| 19EC521 | Embedded Linux | 3 | - | - | 3 |
| 19EC531 | Embedded Systems and RTOS | 3 | - | - | 3 |
| 19EC532 | Microcontrollers for Embedded Systems | 3 | - | - | 3 |
| 19EC541 | Design of IOT Systems (IOT) | 3 | - | - | 3 |
| 19EE521 | Solar PV Technologies-I | 3 | - | - | 3 |
| 19EE531 | Solar PV Technologies-II | 3 | - | - | 3 |
| 19EE532 | Design & Economics of PV plants | 3 | - | - | 3 |
| 19EE541 | Solar Thermal Conversion Systems | 3 | - | - | 3 |
| 19FT521 | Introduction of Food Laws and Regulation | 3 | - | - | 3 |
| 19FT531 | Food Quality and Evaluation | 3 | - | - | 3 |
| 19FT532 | Subjective and Objective Evaluation in Food Products | 3 | - | - | 3 |
| 19FT541 | Food Safety and Public Health | 3 | - | - | 3 |
| 19HS521 | Modern Indian History and Indian Culture | 3 | - | - | 3 |

B.Tech.

CHE

ELECTIVES

# R-19 CURRICULUM

(Applicable for students admitted into First Year from academic year 2019-20 onwards)

## OPEN ELECTIVE COURSES

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 19HS531 | Policy and Governance in India | 2 | - | - | 2 |
| 19HS532 | Economic and Social Development in India | 2 | - | - | 2 |
| 19HS541 | Geography of India | 2 | - | - | 2 |
| 19IT521 | OOPs through JAVA | 3 | - | - | 3 |
| 19IT541 | Data Science using Python | 3 | - | - | 3 |
| 19MS521 | Business Environment and Ethics | 3 | - | - | 3 |
| 19MS522 | Managerial Economics | 3 | - | - | 3 |
| 19MS531 | Marketing and HR Management | 3 | - | - | 3 |
| 19MS532 | Finance for Engineers | 3 | - | - | 3 |
| 19MS541 | Production and Operations Management | 3 | - | - | 3 |
| 19ME521 | Biomechanics & Kinesiology | 3 | - | - | 3 |
| 19ME522 | Basics in Robotics | 3 | - | - | 3 |
| 19ME531 | Advances in Robotics | 3 | - | - | 3 |
| 19ME532 | Reliability Engineering | 3 | - | - | 3 |
| 19ME533 | Field and Service Robots | 3 | - | - | 3 |
| 19ME534 | Energy Audit & Management | 3 | - | - | 3 |
| 19ME535 | Supply Chain Management | 3 | - | - | 3 |
| 19TT531 | Fashion Product Development | 3 | - | - | 3 |
| 19TT532 | Costing of Fashion and Apparel Production | 3 | - | - | 3 |
| 19TT541 | Fashion Marketing and Visual Merchandising | 3 | - | - | 3 |

**Note :** Students should not choose open electives offered by their branch.

I

YEAR

# CHEMICAL ENGINEERING

## B.Tech.

**I SEMESTER**

| | | |
|---|---|---|
| 19HS104 | - | Engineering Mathematics - I (D) |
| 19HS114 | - | Engineering Physics (B) |
| 19EE101 | - | Basics of Electrical and Electronics Engineering |
| 19ME101 | - | Engineering Graphics & Design |
| 19CH101 | - | Chemical Engineering Thermodynamics - I |
| 19PC001 | - | Physical Fitness, Sports & Games - I |

**II SEMESTER**

| | | |
|---|---|---|
| 19HS110 | - | Engineering Mathematics - II (D) |
| 19HS121 | - | Organic Chemistry |
| 19CS101 | - | Introduction to C Progrmming |
| 19HS122 | - | English Proficiency and Communication Skills |
| 19HS123 | - | Technical English Communication |
| 19HS124 | - | Constitution of India |
| 19ME103 | - | Workshop |
| 19CH102 | - | Momentum Transfer |
| 16PC002 | - | Physical Fitness, Sports & Games - II |

**COURSE CONTENTS**

I SEM AND II SEM

# 19HS104 ENGINEERING MATHEMATICS I (D)

LINEAR ALGEBRA & NUMERICAL METHODS

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 2 | 5 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | 15 | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 45 | | 10 | - | 5 |


***SOURCE:***

*https://www.google.co.in/search?q=mathematics+pictures&source=lnms&tbm=isch&sa=&ved=0ahUKEwiQ-837lvXiAhVPVH0KHe56CVEQAUIECgB#imgrc=Fm9KHSsVuOJjM:*

**COURSE DESCRIPTION AND OBJECTIVES:**

To acquaint students with principles of mathematics through matrices, numerical methods, vector calculus that serves as an essential tool in several engineering applications.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Determine rank, Eigen values and Eigen vectors of a matrix and solution of a system of linear equations. | 2 |
| 2 | Appreciate the use of Cayley-Hamilton theorem. | 2 |
| 3 | Demonstrate the techniques of numerical methods. | 2 |
| 4 | Illustrate the concepts of gradient, divergence and curl of a given function. | 2 |
| 5 | Use software tools to obtain and verify the solutions. | 5 |

**SKILLS:**

- ✓ *Find the consistency of system of linear equations with iterative methods.*
- ✓ *Compute the numerical solutions of differential equations and integrate functions using relevant methods.*
- ✓ *Determine the divergence, curl, gradient and directional derivative of vector equations.*

**ACTIVITIES:**

- *Differentiate method to solve the numerical equation.*
- *Compute the numerical solutions of differential equations.*
- *Compare the solutions of differential equations obtained by different methods.*

**UNIT – I** **L-9, T-3**

**MATRICES :** Rank of a matrix; Normal form; Triangular form; Echelon form; Consistency of system of linear equations; Gauss-Jordan method; Gauss elimination method; Gauss-Siedal method.

**UNIT – II** **L-9, T-3**

**EIGEN VALUES AND EIGEN VECTORS :** Eigen values; Eigen vectors; Properties (without proofs); Cayley-Hamilton theorem (with out proof); Power of a matrix; Inverse of a matrix; Diagonalisation of a matrix.

**UNIT – III** **L-9, T-3**

**NUMERICAL METHODS – I**

**Solutions of Algebraic and Transcendental Equations** : Introduction; Bisection method; Regula-Falsi method; Iteration method; Newton-Raphson method.

**Numerical integration** : Trapezoidal rule; Simpson's 1/3 and 3/8 rules; Boole's rule; Weddle's rule.

**UNIT – IV** **L-9, T-3**

**NUMERICAL METHODS – II :** Introduction; Finite differences; Forward differences; Backward differences; Differences of a polynomial; Newton's formulae for interpolation; Gauss forward and backward interpolation formulae; Interpolation with unevenly spaced points; Lagrange's interpolation formula.

**UNIT – V** **L-9, T-3**

**VECTOR DIFFERENTIATION :** Review of Vector Algebra (Not for testing) Vector Function; Differentiation; Scalar and Vector point functions; Gradient; Normal Vector; Directional Derivate, Divergence, Curl, Vector identities.

## . LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

The students must perform any of the following 10 experiments.

1. Mathematical Preliminaries.
2. Algebra of Matrixs.
3. To find Rank,Triangular & Echelon form of a matrix.
4. Solving system of equations using Direct Method.
5. Solving system of equations using Cramer's rule.
6. Solving system of equations using matrix inversion method.
7. Solving system of equations using Gauss-Jordan method, Gauss elimination method.
8. To find Eigen values, Eigen vectors of a Matrix.
9. Cayley-Hamilton Theorem for a square Matrix.
10. Modal Matrix, Diagnolization of a given Matrix.
11. Algebra of Vectors.
12. Gradient, Divergance & Curl of Scalar and Vector functions.

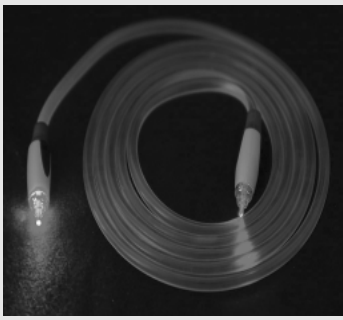
### TEXT BOOKS :

1. H. K. Dass & Er. Rajanish Verma, "Higher Engineering Mathematics", S. Chand & Co., 3rd edition, 2015.
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th edition, 2018.

### REFERENCE BOOKS :

1. John Bird, "Higher Engineering Mathematics", Routledge (Taylor & Francis Group), 2018.
2. Srimanta Pal, Subodh C. Bhunia, "Engineering Mathematics", Oxford Publications, 2015.
3. B. V. Ramana, "Advanced Engineering Mathematics", TMH Publishers, 2008.
4. N. P. Bali, K. L. Sai Prasad, "A Textbook of Engineering Mathematics I, II, III", Universal Science Press, 2018.
5. T. K.V. Iyengar et al., "Engineering Mathematics, I, II, III", S. Chand & Co., 2018.

# 19HS114 ENGINEERING PHYSICS (B)



*Source:*
*https://en.wikipedia.org/wiki/Optical_fiber_cable*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 15 | - | 10 | 2 | 3 |

## COURSE DESCRIPTION AND OBJECTIVES:

This course emphasizes on the wave phenomenon including ultrasonic waves and their applications. It promotes the understanding of mechanical properties of solids and the non-destructive testing of the materials. This enables thorough understanding of fundamentals and applications of Lasers, Optical fiber along with Quantum Mechanics and free electron theory of metals. It also focuses on Nano-materials and experimental techniques for characterizing the materials.

## COURSE OUTCOMES:

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Acquire knowledge on mechanical and sound waves in the perspective of engineering applications. | 1 |
| 2 | Analyze the mechanical properties of materials by the study of stress – strain curve and to adjudge materials from NDT methods. | 5 |
| 3 | Analyze the wavelengths of Laser for suitable applications in the field of industry, medicine and communication and to foster the knowledge on optical fibers to realize fiber optic communication and fiber optic sensors. | 1 |
| 4 | Apply the principles of quantum mechanics to learn the dynamics of free electrons in metals. | 4 |
| 5 | Compute the dimensions of nanoparticles to consolidate the physical aspects of nanomaterials. | 5 |

## SKILLS:

- ✓ *Apply the concepts of waves to unravel the functioning of various physical systems.*
- ✓ *Enunciate the importance of ultrasonics in non-destructive testing of materials.*
- ✓ *Understand the concepts of Lasers and optical fibers in science and engineering.*
- ✓ *Mathematical interpretation of quantum mechanical waves and hence the determination of electrical conductivity of metals.*
- ✓ *Production and characterization of nanomaterials aiming at their applications.*

**ACTIVITIES:**

- *Determination of Ultrasonic impedance of materials.*
- *Estimate ultimate strength of a given material. (Ductile/ brittle)*
- *Evaluate hardness of a material with respect to ambient temperature.*
- *Measurement of height of a room using Laser instrument.*
- *Study the Numerical Aperture of Optical fiber prepared from different materials.*
- *Identification of materials from the determination of acceptance angle of a given fiber.*
- *Measurement of electrical conductivity / resistivity of a given conductor.*

**UNIT - I** **L-7**

**WAVES & OSCILLATIONS:** Simple Harmonic Motion; Free oscillations; Damped oscillations; Forced oscillations; Resonance.

**ULTRASONICS** : Introduction; Properties of ultrasonic waves; Types of ultrasonic waves; Production of ultrasonic waves; Piezoelectric method; Determination of velocity of ultrasonic waves in solids and liquids (Interferometer method).

**UNIT - II** **L-8**

**MECHANICAL PROPERTIES OF SOLIDS**: Introduction; Stress-Strain curve; Elasticity; Poisson's ratio; Creep; Fatigue; Fracture; Factors affecting mechanical properties.

**NON DESTRUCTIVE TESTING OF MATERIALS**: Introduction; Methods of NDT; Visual inspection; Liquid penetrant method; Ultrasonic testing systems; X-ray radiography.

**UNIT - III** **L-12**

**LASERS:** Characteristics of laser light; Spontaneous and stimulated emission of radiation; He-Ne laser; $CO_2$ laser; Semiconductor laser and laser applications; Holography and its applications.

**FIBER OPTICS :** Principle of optical fiber, Acceptance angle, Numerical aperture; Types of fibres; Dispersion and attenuation in optical fibres; Optical fibre communication system; Fibre optic sensors.

**UNIT - IV** **L-9**

**QUANTUM PHYSICS** : Introduction to quantum mechanics; De Broglie's hypothesis; Time independent Schrodinger wave equation; Particle in one dimensional box; Heisenberg's uncertainty principle.

**FREE ELECTRON THEORY**: Elements of classical free electron theory and its limitations; Quantum theory of free electrons; Fermi level; Density of states; Fermi-Dirac distribution and effect of temperature.

**UNIT - V** **L-9**

**NANO MATERIALS:** Introduction to nanoscience and technology; Concept of quantum size effect; Synthesis of nanomaterials - top down and bottom up approaches; Applications of nanotechnology.

**EXPERIMENTAL TECHNIQUES FOR CHARACTERIZATION OF MATERIALS:** X-Ray diffraction-Bragg's law, Powder method of X-ray diffraction; Optical microscope; Scanning electron microscope (SEM); Atomic force microscopy (AFM).

## TEXT BOOKS :


1. M. N. Avadhanulu, P.G. Kshirsagar and T.V.S.Arun Murthy, "A text book of Engineering Physics", 11th edition, S. Chand and Company Ltd., 2019.
2. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", Pearson India Education Services Pvt. Ltd., 2018.


## REFERENCE BOOKS :


1. M. R. Srinivasan, "Engineering Physics", 2nd edition, New Age International Publishers, 2014.
2. William T. Silfvast, "Laser Fundamentals" 2nd edition, Cambridge University Press, 2004.
3. M. R.Srinivasan, "Engineering Physics" New Age International Pulishers, 2006.
4. T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill, 2003.

# LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

Students are expected to perform 10 experiments from the following :

1. Laser - Determination of wavelength using diffraction grating.
2. Optical fiber – Determination of Numerical aperture – Acceptance angle.
3. Determination of Planck's constant.
4. Melde's Experiment - Determination of the frequency of tuning fork.
5. Measurement of Young's modulus by bending beam method.
6. Determination of moment of inertia using torsional pendulum.
7. Determination of velocity of ultrasonic waves velocity in liquid medium using interferometer method.
8. Dye penetrant test method.
9. Seebeck Effect – Determination of Seebeck coefficient.
10. Stewart & Gee's Experiment- Study of magnetic field along the axis of a current carrying coil.
11. Verification of Tangent law.
12. Solar cell – Determination of Fill factor & Efficiency.
13. LED - Study of V-I characteristics.

**LABORATORY MANUAL:**


1. Dr. Ruby Das, C.S. Robinson, Rajesh Kumar and Prasanth Kumar "A text book of Engineering Physics Practical", Sahu University Science press, 1st edition, 2010.
2. Jayaraman, "Engineering Physics Laboratory manual", 1st edition, Pearson education, 2014.

# 19EE101 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

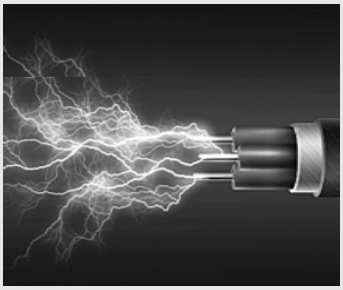
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 5 | 40 | - | 8 | 5 | 5 |



*Source:*

*http://sazehpardazi.ir/wp-content/uploads/2017/01/Mokran-tank.jpghttps://engineeringinterviewquestions.com/wp-content/uploads/2017/07/ELECTRICAL-Engineering-Multiple-Choice-Questions-and-Answers.png*

## COURSE DESCRIPTION AND OBJECTIVES:

This course provides an in-sight into the functioning of basic electrical components like resistor, inductor and capacitor. It deals with the constructional and operational details of both DC & AC machines. It also deals with the basic electronic components like P-N junction diode, Zener diode, Transistor and their characteristics.

## COURSE OUTCOMES:

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Analyze the resistive circuits and solution of resistive circuits with independent sources. | 1, 2, 3 |
| 2 | Solve the AC (single and three phase) and DC circuits using different methods. | 1, 2, 3 |
| 3 | Familiarize the concepts of electro magnetism and it's applications. | 1, 2 |
| 4 | Explain the types of electrical equipment, machines and its applications. | 1, 2 |
| 5 | Acquire the knowledge about the characteristics and working principles of semiconductor diodes, transistor. | 1, 2 |

## SKILLS:

- ✓ *Distinguish between linear and nonlinear elements by looking at VI characteristics.*
- ✓ *Develop a simple loop generator.*
- ✓ *Design a voltage regulator using Zener diode.*
- ✓ *Design a half wave rectifier using PN junction diode.*
- ✓ *Design a full wave rectifier using PN junction diodes.*

**ACTIVITIES:**

- *Decoding the value of resistors.*
- *Design and fabricate a simple loop permanent magnet generator.*
- *Design and fabricate a simple air cored transformer.*
- *Fabricate full and half wave rectifiers using PN junction diodes.*
- *Fabricate a voltage regulator using Zener diode.*

**UNIT – I** **L - 9**

**FUNDAMENTALS OF ELECTRIC CIRCUITS:** Concept of network; Active and passive elements; Voltage and current sources; Concept of linearity and linear network; Unilateral and bilateral elements; R, L and C as linear elements; Ohm's Law; Kirchhoff's Laws - application to simple series, parallel circuits; Mesh and nodal analysis of resistive circuits with DC source (Simple numerical problem).

**UNIT – II** **L - 9**

**FUNDAMENTALS OF AC CIRCUITS:** Generation of AC voltage; Frequency; Average value; R.M.S. value; Form factor; Peak factor for sinusoidal only; Analysis of single-phase ac circuits consisting of R, L, C, RL, RC (series and parallel) (simple numerical problems).

**BALANCED THREE PHASE SYSTEMS**: Relation between phase and line quantities of voltages and currents in star and delta connected systems (Elementary treatment only).

**UNIT – III** **L - 9**

**FUNDAMENTALS OF ELECTROMAGNETISM:** Concepts of Magneto motive force; Reluctance, Flux and flux density; Concept of self inductance and mutual inductance; Coefficient of coupling (only elementary treatment and Simple numerical problems).

**TRANSFORMERS:** Principle of operation of single phase transformer, Constructional features, EMF equation (simple numerical problems).

**UNIT – IV** **L - 9**

**DC MACHINES:** Constructional details of a DC Machine; DC Generator - principle of operation, EMF equation (simple numerical problems); DC Motor - principle of operation; Torque equation (simple numerical problems).

**AC MACHINES:** Principle of operation of three phase induction motor; Slip ring and squirrel cage motors; Torque equation; Constructional details of synchronous machine.

**UNIT – V** **L - 9**

**SEMICONDUCTOR DEVICES:** Classification of semiconductors, P-N junction diode - operation and its characteristics; Half wave rectifier - operation, efficiency; Full wave rectifiers - types, operation, Efficiency; Zener diode and its characteristics; Zener diode as Voltage regulator; Bi polar junction transistor - operation, types (NPN & PNP).

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS-30**

1. Verification of Ohm's law.
2. Verification of Kirchhoff's current law.
3. Verification of Kirchhoff's voltage law.
4. Measurement of Energy in single phase resistive load circuit.
5. Measurement of Power in single phase resistive load circuit.
6. Transformation ratio of a single phase transformer at different loads.
7. Determination of R.M.S. Values of sinusoidal waveform.
8. Determination of impedance in complex AC circuits.
9. Verification of P-N junction diode characteristics under both forward and reverse bias.
10. Verification of Zener diode characteristics under both forward and reverse bias.

**TEXT BOOKS:**

1. V. K. Mehta, "*Principles of Electrical Engineering and Electronics*", 3rd edition, S. Chand Publications, New Delhi, 2010.
2. D. P. Kothari, "*Basic Electrical and Electronics Engineering*", 1st edition., TMH, New Delhi, 2014.

**REFERENCE BOOKS:**

1. Millman & Halkias, "*Integrated Electronics*", Mc Graw Hill, 1979.
2. A. K. Thereja and B.L. Thereja, "*Electrical Technology*", Vol.–II, S. Chand Publications, 2007.
3. U. Bakshi & A. Bakshi, "*Basic Electrical Engineering*", 1st edition, Technical Publications, Pune, 2005.

# 19ME101 ENGINEERING GRAPHICS AND DESIGN

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 2 | - | 2 | 3 |

Total Hours :

| L | T | P |
|---|---|---|
| 30 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 15 | - | - | - | 3 |

*Source: https:// www.gettyimage.in*

## COURSE DESCRIPTION AND OBJECTIVES:

Engineering graphics is the Language of Engineers and is the most effective way of communicating and sharing technical ideas in the form of pictures/drawings. The main objective of this course is to familiarize the students with the conventional concepts of engineering drawing and computer aided drawing.

## COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Communicate the technical ideas in the form of drawings. | 1 |
| 2 | Apply the drawing skills in representing various geometrical features. | 1 |
| 3 | Develop orthographic projections and isometric views of various objects. | 2 |
| 4 | Estimate the lateral surface area of regular geometrical solids. | 2 |
| 5 | Sketch simple objects and their pictorial views using AutoCAD. | 5 |

## SKILLS:

- ✓ *Convert isometric views of objects into orthographic views and vice versa.*
- ✓ *Visualize the shape of the 3D components.*
- ✓ *Create pictorial by using AutoCAD .*
- ✓ *Understand projections by visualization.*

**UNIT- I** **L-6 P-6**

**INTRODUCTION & ENGINEERING CURVES:** Types of lines; Lettering; Dimensioning; Geometric construction of lines; Polygons (Angle, ARC, General and Inscribe in Circle method); Conical curves (General method); Ellipse by oblong method.

**UNIT- II** **L-6 P-6**

**ORTHOGRAPHIC PROJECTIONS OF POINTS & LINES:** Principle of projection; Planes of projections; Projections of points; Projection of straight lines - inclined to one plane, inclined to both planes.

**UNIT- III** **L-6 P-6**

**PROJECTION OF PLANES:** Projections of regular square; Pentagonal; Hexagonal planes inclined to one reference plane.

**PROJECTIONS OF SOLIDS:** Projections of solids (Prisms, Pyramids, Cylinders and Cones) with axis inclined to one reference plane.

**UNIT- IV** **L-6 P-6**

**DEVELOPMENT OF SURFACES:** Development of lateral surfaces of simple solids (Prisms, Pyramids, Cylinder and Cone); Conversion of pictorial views into orthographic views (limited to simple castings only).

**UNIT- V** **L-6 P-6**

**DRAFTING USING COMPUTER PACKAGE:** Introduction to 2D modelling software- Auto CAD, conversion of isometric view into orthographic views of simple castings; Conversion of orthographic views into isometric view of simple solids - prisms, pyramids, cylinders and cones.

## TEXT BOOKS:

1. N D Bhatt, “Engineering Drawing”, 53rd edition, Charotar Publication, 2014.
2. Basant Agrawal, C.M.Agrawal “Engineering Drawing” , 2ndedition., Tata McGraw Hill,2014.

## REFERENCE BOOKS:

1. J Hole, “Engineering Drawing”, 2nd edition, Tata McGraw Hill, 2008.
2. K L Narayana, “Engineering drawing”, 2nd edition, Scitech Publications, 2008.

# 16CH101 CHEMICAL ENGINEERING THERMODYNAMICS-I

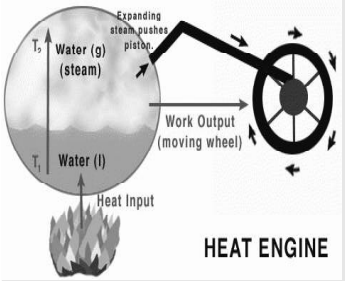
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | - | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | 15 | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |




*Source:*
*https://www.simply.science/images/content/physics/thermal_physics/heat_engines/Concept_map/RealHeat-Engine.html*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with first, second and third laws of thermodynamics, volumetric properties, refrigeration and liquefaction processes. The objective of this course is to provide understanding in the theory and applications of classical thermodynamics, thermodynamic properties and equations of state.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply fundamental concepts of thermodynamics to engineering applications. | 1,2 |
| 2 | Estimate thermodynamic properties of substances in gas and liquid states. | 3 |
| 3 | Derive and discuss the first and second laws of thermodynamics. | 4 |
| 4 | Apply laws of thermodynamics to engineering applications. | 6 |
| 5 | Solve problems using the properties and relationships of thermodynamic fluids. | 3,4 |

**SKILLS:**

- ✓ Estimation of thermodynamic properties.
- ✓ Determination of heat engine and pump efficiency.
- ✓ Identification of reversible and irreversible processes.
- ✓ Selection of refrigeration process and refrigerant.
- ✓ Describe the process in terms of the changes in system properties.

**ACTIVITIES:**

- *Calibration of thermometer.*
- *Conversion of work into heat using Joule's experiment.*
- *Expansion of gas using Joule-Thomson effect*
- *Estimation of heat capacity of liquids*
- *Calibration of dead weight gauge*

**UNIT - I** **L-9, T-3**

**BASIC CONCEPTS :** The scope of thermodynamics; Dimensions and units; Measures of amount or size; Force; Temperature; Pressure; Potential energy; Internal energy; Heat; Work; Zeroth law.

**FIRST LAW OF THERMODYNAMICS :** Joule's experiment; Statement of first law; Energy balance for closed system; Thermodynamic state and state functions; Equilibrium; Phase rule; Reversible processes; Constant-v and constant-p processes; Enthalpy; Heat capacity; First law of thermodynamics for open systems.

**UNIT - II** **L-9, T-3**

**VOLUMETRIC PROPERTIES OF PURE FLUIDS :** PVT behaviour of pure substances; Virial equations of state; Ideal gas; Applications of the virial equations; Cubic equations of state.

**UNIT - III** **L-9, T-3**

**HEAT EFFECTS :** Sensible heat effects; Latent heats of pure substances; Standard heats of reaction, Standard heats of formation; Standard heats of combustion; Temperature dependency of heat of reaction; Heat effects of industrial reactions..

**UNIT - IV** **L-9, T-3**

**SECOND LAW OF THERMODYNAMICS:** Statements of the second law; Heat engines; Thermodynamic temperature scales; Entropy; Mathematical statement of the second law; Maxwell relations.

**PRODUCTION OF POWER FROM HEAT:** Steam power plant, Rankine cycle, Otto engine, Diesel engine.

**UNIT - V** **L-9, T-3**

**REFRIGERATION AND LIQUEFACTION :** The Carnot refrigerator; Vapor compression cycle; Choice of refrigerant; Absorption refrigeration; Liquefaction processes.

## TEXT BOOKS:

1. J. M. Smith, H. C. Vanness and M. M. Abbot, "Introduction to Chemical Engineering Thermodynamics", 6th edition, McGraw-Hill, 2005.
2. Y. V. C. Rao, "Chemical Engineering Thermodynamics", 1st edition, Universities Press, 2004.

## REFERENCE BOOKS:

1. Dodge B. F., "Chemical Engineering Thermodynamics", 1st edition, McGraw-Hill, 1944.
2. Kyle B. G., "Chemical and Process Thermodynamics", 1st edition, Prentice Hall of India, 1999.

# 19HS110 ENGINEERING MATHEMATICS II (D)

DIFFERENTIAL EQUATIONS, LAPLACE TRANSFORMATIONS

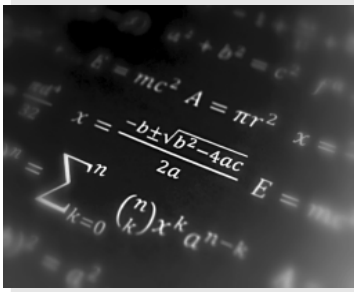
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 2 | 5 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | 15 | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 45 | - | 10 | - | 5 |



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## COURSE DESCRIPTION AND OBJECTIVES:

To provide students with solid foundation in mathematical fundamentals such as numerical methods, differential equations, Laplace transformations required for Engineering applications.

## COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Discuss the Laplace transformation of a function and apply to solve differential equations. | 2 |
| 2 | Apply various analytical methods to solve ordinary differential equations. | 2 |
| 3 | Demonstrate the various numerical methods to solve differential equations. | 2 |
| 4 | Ability to identify the appropriate method to solve a partial differential equation. | 2 |
| 5 | Use software tools to obtain and verify the solutions. | 5 |

## SKILLS:

- ✓ *Solve first order ordinary differential equations by various methods.*
- ✓ *Solve partial differential equations by suitable methods.*
- ✓ *Apply Laplace transformations to solve ordinary differential equations.*

**ACTIVITIES:**

- *Compute the numerical solutions to the partial differential equations.*
- *Solve the given differential equation using suitable method.*

**UNIT - I** **L–9**

**FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS:** Basic definitions; Variables separable; Homogeneous differential equations; Linear differential equations; Bernoulli's differential equations; Exact and non-exact differential equations.

**UNIT - II** **L–9**

**HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS:** Linear differential equations with constant coefficients; Homogeneous differential equations of second and higher order; Methods to find particular integral when RHS is of the form - $e^{ax}$ , sinax, cos ax and $x^n$ .

**UNIT - III** **L–9**

**PARTIAL DIFFERENTIAL EQUATIONS:** Introduction; Partial differential equations; Order and degree; Formation of partial differential equations; Lagrange's linear equations; Method of multipliers;

Classification of second order PDE; Method of seperation of variables; Examples - one dimensional wave equation, heat equation and Laplace's equation.

**UNIT - IV** **L–9**

**NUMERICAL METHODS – III:** Taylor series method; Picard's method; Euler's and modified Euler's method; Runge-Kutta method.

**UNIT - V** **L–9**

**LAPLACE TRANSFORMATIONS:** Introduction; Laplace transformation; Properties; Change of scale property; Shifting theorems; Laplace transformation of derivative; Laplace transformation of integral; Multiplication by t; Initial and final value theorems; Convolution theorem.

Inverse Laplace transformation - multiplication by s, division by s; Shifting properties; Inverse Laplace transformation of derivatives; Applications - solutions of ordinary differential equations.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS-30**

The students must perform any of the following 10 experiments.

1. Differentiation of functions of one or two variables.
2. Integration of functions of one or two variables.
3. Definite Integration functions of one variable.
4. Trapezoidal rule for numerical integrations.
5. Simpson's rule for numerical integrations.
6. Boole's rule, Weddle's rules for numerical integrations.
7. Lagrange Interpolation for given data.
8. Solving ordinary Differential Equations.
9. Euler's method for first order differential equation.
10. Runge-Kutta method for first order differential equation.
11. Plotting of graphs for functions one variable.

### TEXT BOOKS:


1. H. K. Dass & Er. Rajanish Verma, "Higher Engineering Mathematics", S. Chand & Co., 3rd edition, 2015
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th edition, 2018.


### REFERENCE BOOKS:


1. John Bird, "Higher Engineering Mathematics", Routledge (Taylor & Francis Group), 2018.
2. Srimanta Pal, Subodh C. Bhunia, "Engineering Mathematics", Oxford Publications, 2015.
3. B. V. Ramana, "Advanced Engineering Mathematics", TMH Publishers, 2008.
4. N. P. Bali, K. L. Sai Prasad, "A Textbook of Engineering Mathematics I, II, III", Universal Science Press, 2018.
5. T. K.V. Iyengar et al., "Engineering Mathematics, I, II, III", S. Chand & Co., 2018.

# 19HS121 ORGANIC CHEMISTRY

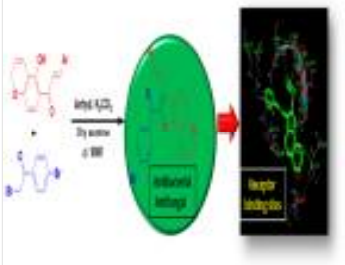
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 10 | - | 10 | - | 5 |



Source: Koya Prabhakara Rao. et al., *Journal of Heterocyclic Chemistry*, ***2019***, *56 (1), 73-80*

**COURSE DESCRIPTION AND OBJECTIVES:**

The course is aimed at offering fundamental concepts towards the synthetic methods of common organic compounds including polymers and pharmaceuticals. This course enlightens the students about the fundamentals of bonding, reaction intermediates and stereo-chemical aspects. It enables students understand advanced level mechanistic aspects of synthesis and characterization techniques for future prospects.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes.

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply various types of reaction intermediates for a variety of organic reactions. | 1,2 |
| 2 | Evaluate the relationship between stereochemistry and biological activity of the optically active compounds. | 1,2,3 |
| 3 | Analyze various synthetic methods with feasible mechanisms for preparing drug molecules. | 1,2,3 |
| 4 | Apply the concept of 'Green chemistry" using organic and bio-catalysis for the synthesis of organic compounds. | 1,2,3 |
| 5 | Apply various instrumental techniques for determining the structures of organic compounds. | 3,4,5 |

**SKILLS:**

- ✓ Analyze the reactivity of substrates.
- ✓ Write a plausible reaction mechanism for different reactions.
- ✓ Differentiate optically active and optically inactive compounds.
- ✓ Characterize organic compounds by various structural elucidation techniques.

**UNIT - I** **L-9**

**CHEMICAL BONDING :** Introduction to VBT and VSEPR theory; Molecular orbital theory of diatomic molecules ($O_2$ and CO); Molecular orbital energy diagram of ethylene; 1, 3-butadiene and benzene.

**REACTION INTERMEDIATES :** Bond fissions; Formation and reactivity of carbon ions; Formation and reactivity of carbenium ions; Formation and reactivity of free radicals; Formation and reactivity carbenes.

**UNIT - II** **L-9**

**STEREOCHEMISTRY:** Representations of 3 - dimensional structures; Structural isomers and stereo isomers; Symmetry and chirality; Optical isomerism - enantiomers, diastereomers (lactic acid and tartaric acid); Absolute configurations and conformational analysis – ethane and cyclohexane; Relevance of stereochemistry in biology Ex. Thalidomide; Resolution and asymmetric synthesis.

**UNIT - III** **L-9**

**ORGANIC REACTIONS AND SYNTHESIS OF A DRUG MOLECULES:** Introduction to reactions involving - substitution, addition, elimination; C-C bond formation; Oxidation- jones reagent; Reduction- $NaBH_4$ and LAH; Synthesis of aspirin.

**ORGANOMETALIC CHEMISTRY** - Introduction; Grignard & cross coupling reactions.

**UNIT - IV** **L-9**

**GREEN CHEMISTRY :** 12 Principles of green chemistry; Catalysis including transition metal catalysis (catalytic hydrogenation and wilkinson's catalyst); Organocatalysis and bio-catalysis.

**UNIT - V** **L-9**

**STRUCTURAL ELUCIDATION OF ORGANIC COMPOUNDS:** IR Spectroscopy - principle, identification of functional groups; NMR spectroscopy - principle, chemical shift, $^1$H-NMR- ethyl alcohol, *cis-trans* isomers; Mass spectroscopy - principle, fragmentation (nitrogen rule); Introduction to XRD.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

The students must perform any of the following 10 experiments.

1. Determination of melting point of organic compounds.
2. Determination of boiling point of organic compounds.

   Analysis of functional groups of organic compounds (5 functional groups, listed below).
3. Carboxylic Acids.
4. Phenols.
5. Aldehydes.
6. Ketones.
7. Amines.
8. Preparation and characterization of aspirin.

9. Separation of organic compounds by thin layer chromatography (TLC).
10. Preparation of paracetamol.
11. Synthesis of organic compounds by solvent free methods.
12. Henry (Nitro Aldol) reaction of benzaldehyde and nitromethane.
13. Reduction of aldehydes using sodium borohydride ($NaBH_4$).
14. Oxidation using potassium permanaganate ($KMnO_4$).

**ACTIVITIES:**

- *Synthesis, purification and Characterization of drugs.*
- *Freidal-Crafts Acylation and Alkylation reactions.*
- *Synthesis of Organic compounds by catalytic Method eg. Proline.*

## TEXT BOOKS:


1. Arun Bahl and B. S. Bahl, "Text Book to Organic Chemistry", 8th edition, S.Chand & Co, 2009.
2. R. T. Morrison and R. M. Boyd, "Organic Chemistry", 6th edition, Pearson Publications, 2008.
3. Graham Patrick, "A Very Short Introduction to Organic Chemistry", Oxford Publishers, 2017.


## REFERENCE BOOKS:


1. Silverstein, Robert M Bassler, G. Clayton Morrill, Terence C, "Spectroscopic Identification of Organic Compounds", Wiley publishers, 1981.
2. O. P. Agarwal, "Reactions and Reagents", 46th edition, Goel Publications, 2005.

3 I. L. Finar, "Organic Chemistry", Vol – I, 6th edition, Longman Scientific Publications, 2006.

4. Jerry March,"Advanced Organic Chemistry", 4th edition, Wiley India Pvt. Ltd, 2007.
5. J. David Rawn, Robert Ouellette, "Organic Chemistry: Structure, Mechanism, Synthesis", 2nd edition, Academic Press, 2018.


## LABORATORY MANUAL:


1. J. Mendham, R. C. Denney, J. D. Bares, M. Thomas and B. Siva Sankar, "Vogel's Text book of Qualitative Chemical Analysis", Pearson Publications - Volume I, 2009.
2. Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell "Vogel's text book of Practical Organic Chemistry", 5th edition, Longman Scientific & Technical, 1989.

# 19CS101 PROGRAMMING FOR PROBLEM SOLVING

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 5 | 30 | 5 | 20 | 5 | 5 |

## COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed to impart knowledge on basic concepts of C programming language and problem solving through programming. It covers basic structure of C program, data types, operators, decision making statements, loops, functions, static and dynamic data structures. At the end of this course, students will be able to design, implement, test and debug modular C programs.

## COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Understanding of how to write simple, but complete, C programs. | - |
| 2 | Identification of suitable data type operands and design of expressions having right precedence. | 2 |
| 3 | Application of decision making and iterative features of C Programming language effectively. | 1 |
| 4 | Design and development of non-recursive and recursive functions and their usage to build large modular programs. | 3 |
| 5 | Selection of problem specific static/dynamic data structures and suitable accessing methods. | 2 |
| 6 | Development of C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt. | 3 |

## SKILLS:

- ✓ *Analysis of a given problem to be solved.*
- ✓ *Design of algorithm/solution for a given problem.*
- ✓ *Identification of suitable data types for operands.*
- ✓ *Application of suitable control statements for decision making.*
- ✓ *Design of non-recursive and recursive functions to perform different tasks.*
- ✓ *Selection of static or dynamic data structures for a given problem and manipulation of data items.*

**ACTIVITIES:**

- *Analysis of a given problem.*
- *Design of algorithm/ solution.*
- *System testing*
- *Implementation (coding and unit testing) of algorithm.*

✓ *IDevelopment of C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.*

**UNIT - I** **L - 9**

**INTRODUCTION TO C:** Structure of a C program; pre-processor statement, inline comments, Variable declaration statement, Executable statement; C Tokens: C Character Set, Identifiers and Keywords, Type Qualifiers and Type Modifiers, Variables and Constants, Punctuations, and Operators.

**Data Types:** Basic data types; Storage classes; scope of a variable; Formatted I/O; Reading and writing characters;

**UNIT - II** **L - 9**

**OPERATORS AND CONTROL STATEMENTS:** Operators**:** Assignment, Arithmetic, Relational, Logical, Bitwise, Ternary, Address, Indirection, Sizeof, Dot, Arrow, Parentheses operators; Expressions: Operator precedence, Associative rules; Control statements - Category of statements, Selection, Iteration, Jump, Label, Expression and Block.

**UNIT - III** **L - 9**

**ARRAYS AND FUNCTIONS:** Array - Declaration, Initialization, Reading, Writing, Accessing and passing as a parameter to functions, 2D-arrays, Multidimensional arrays; Function - Declaration, Prototype, Definition, Calling by value and call by address, Standard library functions and Recursive functions.

**UNIT - IV** **L - 9**

**STRINGS AND POINTERS:** Strings - Declaration, String library functions, Array of strings, Command line arguments; Pointers - Declaration, Initializing pointers, Multiple indirection, Relationship between arrays and pointers; Dynamic memory allocation functions.

**UNIT - V** **L - 9**

**STRUCTURES AND UNIONS:** Structures - Defining a Structure, Declaration of a structure objects, Operations on structures; Pointers to a structure; Array of structures; Nested Structures; Unions; Bit – Fields.

**Experiment 2:**

(a) For the given Basic salary, compute DA, HRA and PF using the following criteria and find out the Net Salary of an Employee by deducting PF and IT.

DA = (Basic salary *25)/1000

HRA= (Basic salary * 15)/100

Gross salary = Basic salary + DA + HRA

PF = Gross salary * 10/100

IT= Gross salary * 10/100

Net Salary = Basic Salary + DA + HRA – (PF + IT)

(b) Write a C program to swap the two integers with and without using additional variable.

**Example**: Before swapping values of a =4, and b = 5 and after swapping a = 5, and b = 4.

**Experiment 3:**

(a) Write a C program to check whether a given character is a vowel or consonant.

**Hint**: Read input from the user, and check whether it is an alphabet or not. If it is an alphabet, then check whether it is a vowel or a consonant. Otherwise display it is not an alphabet.

(b) The marks obtained by a student in '*n*' different subjects are given as an input by the user. Write a program that calculates the average marks of given 'n subjects and display the grade. The student gets a grade as per the following rules:

**Experiment 4:**

(a) Write a C Program to print Floyd triangle for the user given number of rows.

**Example:** If the user entered 4 rows, then the output is as follows:

```
1
2 3
4 5 6
7 8 9 10
```

(b) Write a C Program to print the * for the given number of times in a rows to form a diamond shape.

**Example:** If the user input is 5, then the output is as follows:

```
  *
 ***
*****
 ***
  *
```

| Average | Grade |
|---|---|
| 90-100 | O |
| 80-89 | E |
| 70-79 | A |
| 60-69 | B |
| 50-59 | C |
| <50 | F |

**Experiment 5:**

(a) Write a C Program to check whether the given number is a palindrome or not.

**Hint**: To check whether a number is a palindrome or not, reverse the given number and compare the reversed number with the given number, if both are same then the number is palindrome otherwise not.

**Example**: Given Number = 121, Reversed number = 121.

(b) Write a C Program to calculate sum of the individual digits of the given number.

**Hint**: To find the sum of the digits of given number, use modulus operator (%) to extract individual digits of a number and keep on adding them.

**Example**: Given number is 9875. Sum of the digits of given number "9875" is
9+8+7+5 = 29

**Experiment 6:**

(a) Write a program to search for a given number in the given set of numbers.

**Example**: Read set of numbers *L*={2,4,6,1}. Search whether 4 is present in the set or not.

(b) Write a program to perform the following operations on a given list of elements.

i. Insert the given element at the beginning of the list and at the end of the list.

**Example**: The given list is *L*={1,2,3,8}. Insert '0' at the beginning of the list and at the end of the list. Hence the resultant list is *L*={0,1,2,3,8,0}

ii. Delete an element at the beginning of the list and at the end of the list.

**Example**: The given list is *L*={1,2,3,8}. Delete an element at the beginning of the list and at the end of the list. Hence the resultant list is *L*={2,3}

**Experiment 7:**

Write a C program to perform the following operations on a list.

(a) Find the maximum or the largest element in a given list.

(b) Find the minimum or the smallest element in a given list.

**Hint:** Choose one dimensional array to store the given list of data items.

**Experiment 8:**

Write a C program to perform addition, subtraction, multiplication operations on the two given matrices using functions.

**Experiment 9:**

(a) Write a C program to compute the factorial of a given number using recursion.

**Hint:** Factorial is represented using '!' and it is calculated as n! = n*(n-1)*(n-2)*…*3*2*1.*As a function factorial(n)=n*factorial(n-1). Note: 0!=1.*

(b) Write a C program to swap two numbers using call by value and call by reference.

**Experiment 10:**

(a) Write a C program to read string using gets() function and use puts() function to print the contents of the string.

(b) Write a C program to copy a given string into another string without using standard string handling library function **strcpy()**.

**Hint**: Read one string as an input and then with the help of loop copy the content of given string into the new string. If the storage space allocated to the new string is less than the given string, entire string will not be copied into the new string.

**Example**: consider storage space allocated to new string is 20 and given string length is 30. In this case, your program can only copy 20 characters from given string into the new string.

**Experiment 11:**

(a) Write a C program to reverse a string without using standard string handling library function. Do not use another array to store the reversed string.

**Hint**: If a user enters a string “hello”, then on reversing it will be displayed as “olleh”.

(b) Write a C program to find whether the given two strings are same or not.

**Hint**: User need to enter two strings *s1 and s2* and check whether the two strings are same or not. For example: s1=hello, s2=hello output: YES

**Experiment 12:**

Write a C program for the following:

Given a string S, consisting of uppercase and lowercase letters, change the case of each alphabet in the string. That is, all the uppercase letters should be converted to lowercase and all the lowercase letters should be converted to uppercase.

**Input:** Vignan University

**Output:** vlGNANuNIVERSITY

**Experiment 13:**

(a) Write a C program to access the integer elements of the array using pointers.

Hint: Declare a pointer variable and assign the base address of the array to it and print the values of an array using pointer variable.

(b) Declare a character array to hold the input string and declare a character pointer variable. Assign the character array base address to the pointer and then display the every element of the character array.

**Hint**: Increment the pointer in loop.

**Experiment 14:**

Write a C program to count the number of vowels and consonants in a string using pointers.

**Hint**: Use pointers to read the content of the string.

**Experiment 15:**

Create a jagged array [array of variable length lists] with no of rows and no of columns in each row as specified by the user

**Hint**: Use Dynamic memory allocation (malloc() or calloc())

**Input:**

Enter no of rows: 3

Enter no of columns in Row 1: 3

Enter no of columns in Row 2: 5

Enter no of columns in Row 3: 2

Enter the elements row wise:

8 6 5

8 4 6 9 7

9 2

**Output:**

8 6 5

8 4 6 9 7

9 2

**Experiment 16:**

Write a C program for the following:

Customer billing system is a structure, having customers_name, street_address, city, state, account_number, payment_status(paid/ not_paid), payment_date(current date/ due_date), and amount as members. In this example, payment_date is also structure includes month, day and year as members. So, every customer record can be considered as nested structure. Display the payment_status of each customer.

**Hint**: Use nested structure concept.

**Experiment 17:**

Write a C program for the following: Define a structure named 'Complex' consisting of two floating point members called "real and imaginary". Let c1 and c2 are two Complex variables; compute the sum of two variables.

## TEXT BOOKS:

1. Behrouz A. Forouzan, Richard F.Gilberg, "Programming for Problem Solving", 1st edition, Cengage, 2019.
2. Ajay Mittal, "Programming in C - A practical Approach", 1st edition, Pearson Education, India, 2010.

## REFERENCE BOOKS:

1. ReemaThareja, "Introduction to C Programming", 2nd edition, Oxford University Press India, 2015.
2. Herbert Schildt, "C: The Complete Reference", 4th edition, Tata McGraw-Hill, 2017.
3. Byron S Gottfried, "Programming with C", 4th edition, Tata McGraw-Hill, 2018.

# 19HS122 ENGLISH PROFICIENCY AND COMMUNICATION SKILLS

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| - | - | 2 | 1 |

Total Hours :

| L | T | P |
|---|---|---|
| - | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 15 | 15 | - | 10 | - | - |


*Source:*
*https://www.google.com/search?q=english+proficiency&client*

## COURSE DESCRIPTION AND OBJECTIVES:

The course will provide students an exposure on a wide range of language used in everyday situations. They will read, analyze, and interpret material from a variety of general topics and practice reading, writing, listening and speaking skills in English, to use it confidently in their professional and social contexts.

## COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Ability to read and grasp the content and significance of news, articles and reports on a wide range of general topics connected with their interests. | 9,10 |
| 2 | Apply suitable strategies to achieve comprehension, like listening for main points; checking comprehension by using contextual clues etc. | 9,10 |
| 3 | Ability to follow lectures or talks on topics within their own field, and well structured presentations outside their field. | 9,10 |
| 4 | Apply their knowledge of functional English to communicate effectively in real life situations and demonstrate good presentation skills in classroom situations. | 9,10 |

## SKILLS:

- ✓ *Reading strategies for global meaning and for specific details.*
- ✓ *Writing with a purpose.*
- ✓ *Listening for drawing inferences.*
- ✓ *Speaking fluently with appropriate stress and intonation.*

**UNIT - I** **P-6**

**INTRODUCING SELF / OTHERS (SWOT ANALYSIS), EXPRESSING NEEDS/FEELINGS/OPINIONS:**

**Skill Focus**:

- Reading – Understanding factual information.
- Writing – Understanding word order and sentence formation.
- Listening – Decoding for meaning following elements of stress, intonation and accent.
- Speaking – Articulating individual sounds/syllables clearly, speaking fluently with intelligibility.
- Vocabulary – Discerning use of right word suiting the context, Preliminary English Test (PET) word list.
- Grammar – Spellings, Use of Nouns, Adjectives, Verbs, Prepositions.

**Practice**: Units 1 – 6 in the Text Book, *Objective PET.*

**UNIT - II** **P-6**

**DESCRIBING PEOPLE AND THINGS:**

**Skill Focus:**

- Reading – Drawing inferences from sentences and short messages(True/False statements).
- Writing – Rewording, Sentence transformation, Convincing.
- Listening –Understanding short messages and conversations.
- Speaking – Role-plays, Short conversations.
- Vocabulary / Grammar – Use of Adjectives/Adverbs, Comparatives and Superlatives.

**Practice**: Units 7 – 12 in the Text Book, *Objective PET.*

**UNIT - III** **P-6**

**DESCRIBING PLACES AND PROCESSES, SPATIAL AND TEMPORAL ASPECTS, GIVING DIRECTIONS/ INSTRUCTIONS:**

**Skill Focus:**

- Reading – Reading between the lines, Drawing inferences, True/False.
- Writing –Developing hints, Writing short messages/paragraphs.
- Listening – Searching for factual information, Gap filling.
- Speaking – Snap Talks, JAM, Elocution.
- Vocabulary / Grammar – Prepositions, Phrasal Verbs, PET word list.

**Practice**: Units 13 – 18 in the Text Book, *Objective PET.*

**UNIT - IV** **P-6**

**NARRATING, PREDICTING, NEGOTIATING, PLANNING:**

**Skill Focus**:

- Reading – Reading for comprehension, evaluation and appreciation.
- Writing – Letters, E-mails, 7 C's.
- Listening – Following long conversations / Interviews.
- Speaking – Participating in Group Discussions, Debates, Mini-presentations.
- Vocabulary / Grammar – Modals, Conditionals, Verb forms (Time and Tense).

**Practice**: Units 19 – 24 in the Text Book, *Objective PET.*

**UNIT - V** **P-6**

**REQUESTING, DENYING, SUGGESTING, PERSUADING:**

**Skill Focus**:

- Reading – Understanding factual information.
- Writing – Short stories, Explanatory paragraphs.
- Listening – Inferring information from long speeches/conversations.
- Speaking – Making announcements, Presentations.
- Vocabulary / Grammar - Punctuation, Cloze tests.

**Practice**: Units 25 – 30 in the Text Book, *Objective PET.*

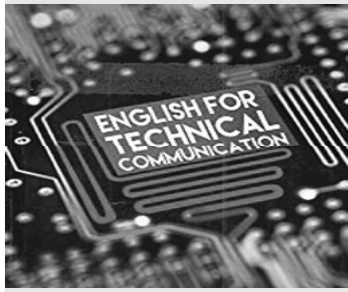
## TEXT BOOK:

1. Louise Hashemi and Barbara Thomas, "Objective PET", Student's Book with answers, 2nd edition, Cambridge University Press, 2015.

## REFERENCE BOOK:

1. Annette Capel and Rosemary Nixon, "Introduction to PET", Oxford University Press, 2009.

# 19HS123 TECHNICAL ENGLISH COMMUNICATION




*Source: www.google.com*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 2 | - | 2 | 3 |

Total Hours :

| L | T | P |
|---|---|---|
| 30 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 13 | 15 | - | 13 | - | 6 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The course will introduce students to the specific use of English for technical communication. In this course students will read, analyze, and interpret material from general and technical fields, and will practice reading, writing, listening and speaking skills on a variety of contemporary topics

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Understand and interpret a wide range of materials on technology. | 9,10 |
| 2 | Apply a variety of strategies to achieve comprehension, including listening for main points; checking comprehension using contextual clues etc. | 9,10 |
| 3 | Apply functional/academic language and grammar to express clearly while speaking and make short presentations on general/technical topics. | 9,10 |
| 4 | Apply functional/academic language and grammar to write clearly on topics related to technology and writing in the workplace. | 9,10 |

**SKILLS:**

- ✓ *Oral communication skills to make presentations.*
- ✓ *Paraphrasing and summarizing skills.*
- ✓ *Etiquette in interpersonal communication.*
- ✓ *Language competence to work in international environments.*

**UNIT - I** **L-6**

**ENVIRONMENTAL CONSCIOUSNESS:**

**Reading:** Reading for comprehension (general/technical articles); Reading subskills - predicting, skimming, scanning, reading for inference; Reading and note making (**Reading Texts:** 1) Is a global agreement the only way to tackle climate change? 2) How to regain green cover 3) Solution to plastic pollution).

**Writing:** Precis writing; Paraphrasing; Functional grammar [articles, prepositions of time, place, direction and movement, verb, tense, subject, verb agreement]; Glossary of 25 words from the texts studied.

**Listening:** Anupam Mishra; TED talk on water harvesting (LC); Answering comprehension based Qs; Listening to improve pronunciation.

**Speaking:** Functional English(LC); Introducing oneself; Speaking of likes & dislikes/hobbies; Speaking of daily/weekly routine; Speaking of past and present habits/ activities/events; Speaking of future plans.

**UNIT - II** **L-6**

**SPACE TREK:**

**Reading:** Reading for global understanding; Reading for specific information; Guessing meanings from context; Inter-textual (extrapolative) reading;
**Reading Texts:** 1) The Hubble telescope 2) Genesis of ISRO 3) A Home in the sky
**Writing:** Writing formal and informal letters; Functional grammar; Modals [Receptive practice of modals like can, could, will, would, shall, should, may, might, must, ought to, used to; Receptive practice of modals for habit, advice, ability, permission, obligation and possibility]; Framing questions - open ended & close ended.

**Listening:** Listening to a debate on “Colonising the Moon” (LC); Listening subskills; Listening for global understanding; Listening for specific information; Note Making.

**Speaking:** (LC) Making mini presentations on general topics; Sharing information about ISRO / NASA/ Elon Musk.

**UNIT - III** **L-6**

**TRAVEL AND TOURISM:**

**Reading:** Reading for specific information; Reading with a focus to learn new words; Reading critically for the narrative tone; 50 most commonly used collocations; **(Reading Texts:** 1) Ten reasons why travel is a waste of time 2) Southern Splendour 3) Tourism in India - role in conflict and peace).

**Writing:** Paragraph writing [writing a topic sentence, supporting sentences, effective introductions & conclusions, cohesive devices]; Stages of writing - planning/organising/writing/editing/rewriting; Functional grammar [relative pronouns, comparative adjectives, adverbs of time, frequency, place & manner, speaking of the future/ simple future using *will* and *am/is/are + going to*].

**Listening:** (LC) Listening to a Song; Listening for global meaning; Listening for getting at the nuances and the mood of the singer.

**Speaking:** (LC) Telephonic Skills; Participating in an interactive video or telephone talk.

**UNIT - IV** **L-6**

**ENERGY:**

**Reading:** Reading for factual information; Reading for extrapolation; Reading for understanding author’s stance; **(Reading Texts:** 1) In search of our energy solution 2) Wind energy 3) How pertinent is the nuclear option).

**Writing :** Current modes of communication; Writing an E-mail; Fax texting; SMS texting for Mobile.

**Speaking:** Group Discussion (LC) – language functions, initiating a discussion, expressing one's opinion, leading a discussion; Agreeing/ disagreeing to someone's view; Cutting into a speech; **(G.D Topics:** Dumping of nuclear wastes, Exploring eco-friendly energy options, Lifting subsidies on petrol, diesel, LPG, etc).

**Listening:** Listening to an Interview (LC) related to the text ; Listening critically for understanding the attitude/tone of the speaker.

**UNIT – V** **L-6**

**MEDIA MATTERS:**

**Reading:** Reading for factual understanding; Reading for specific information; Reading for inferring words/phrases from context; Reading for summarizing the main ideas/points in a diagrammatical form; Reading for extrapolation; **Reading Texts**: 1) The evolution of media 2) The top ten developments in journalism in the 2000s 3) Criminal cases and the media.

**Writing:** Drafting a report/proposal (LC); Using graphic tools [tables, pie & bar charts; Writing an abstract; Leveraging ICT for communication; Preparing a PPT (LC).

**Speaking:** Making short presentations [individual/team] with the aid of PPT (LC); Physical appearance, body language & voice modulation; Making impromptu presentations.

**Listening:** Listening to a radio program (LC); Watching a movie scene (LC); Subskills - listening to understand one's viewpoint, listening to understand speaker's intention, listening for local understanding.

## LABORATORY EXPERIMENTS

**LIST OF LAB ACTIVITIES** **TOTAL HOURS: 30**

1. Note making while reading a technical/general article.
2. Paraphrasing.
3. Paragraph writing.
4. Note taking while listening to a technical/general talk.
5. Precis writing/Summarising.
6. Preparing an outline for developing a report.
7. Writing a short report.
8. Making a PPT and mini presentations with the aid of a PPT.
9. Using language functions suiting the context.
10. Team presentations/group discussion.
11. Using collocations.
12. Speaking face to face / on the telephone with appropriate stress and intonation.

**TEXT BOOKS:**

1. Elango, K et.al., "Mindscapes: English for Technologists and Engineers", Orient Blackswan, 2014.

**REFERENCE BOOKS:**

1. M. Balasubrmanyam, "Business Communication" Vani Educational Books, 1985.
2. T. Balasubramanian, "A Text book of Phonetics for Indian Students", Orient Longman, 1989.
3. N. Krishnaswamy and Sriraman, T., "Current English for Colleges", Macmillan India Ltd. 1995.
4. Mohan Krishna and Meera Banerjee, "Developing Communication Skills", Macmillan India Ltd.,1990.
5. V.R.Narayanaswamy, "Strengthen your Writing", Orient Longman, 1979.
6. B. Jean Naterop and Rod Revell., "Telephoning in English", Cambridge University Press, 1997.

# 19HS124 CONSTITUTION OF INDIA


*Source: www.livemint.com*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 12 | - | - | 1 |

Total Hours :

| L | T | P |
|---|---|---|
| 12 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 2 | 12 | 1 | 2 | - | - |

**COURSE DESCRIPTION AND OBJECTIVES:**

To provide students with a basic understanding of Indian Policy and Constitution and make them understand the functioning of government at the centre and state besides local self government, in order to equip them with knowledge on fundamental rights and duties of a citizen in democracy.

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Analyze the major articles and provisions of Indian constitution. | 6,8 |
| 2 | Understand the constitution and its role in safeguarding individual rights. | 6,8 |
| 3 | Understand the functioning of organs of the State in a democracy. | 6,8 |
| 4 | Understand the relationship between rights and duties of citizens. | 6,8 |

**SKILLS**

- ✓ Understanding of the basics of Indian constitution.
- ✓ Awareness on fundamental rights, duties and DPSP.
- ✓ Knowledge of the functioning of various institutions in democracy.

**UNIT - I** **L - 7**

Meaning of the constitution law and constitutionalism; Historical perspective of the constitution of India; Salient features and characteristics of the constitution of India.

Scheme of the fundamental rights; Scheme of the fundamental right to equality; Scheme of the fundamental right to certain freedom under article 19; Scope of the right to life and personal liberty under article 21; The scheme of the fundamental duties and its legal status; The directive principles of state policy; Its importance and implementation.

**UNIT - II** **L - 8**

Federal structure and distribution of legislative and financial powers between the union and the states; Parliamentary form of Government in India; The constitution powers and status of the President of India; Emergency provisions: National emergency, President rule, Financial emergency.

Amendment of the constitutional powers and procedure; The historical perspectives of the constitutional amendments in India; Local self-government; Constitutional scheme in India.

**TEXT BOOK:**

1. P.M.Bhakshi, “Constitution of India”, 15th edition, Universal Law Publishing, 2018.

**REFERENCE BOOK:**

1. Subhash Kashyap, “Our Constitution”, 2nd edition, National Book Trust, India, 2011.

# 19ME103 WORKSHOP

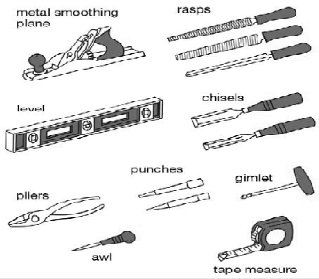
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 1 | - | 2 | 2 |

Total Hours :

| L | T | P |
|---|---|---|
| 15 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 10 | 20 | - | - | - | - |




***SOURCE:***
*http://woodtech.weebly.com/lesson-1—hand-tools.html*

## COURSE DESCRIPTION AND OBJECTIVES:

This course deals with different workshop trades and tools and also introduction of CNC machines. The objective of this course is to provide hands on experience in carpentry, fitting, tinsmith, black smithy, house wiring and welding.

## COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Identify various tools connected to the carpentry, fitting, tinsmith, black smithy, house wiring and welding. | 1 |
| 2 | Fabricate different models using workshop trades. | 2 |
| 3 | Develop methodology as per specifications of the product. | 2 |
| 4 | Understand various advance machine tools and its components. | 1,3 |

## SKILLS:

- ✓ *Understand the concepts of making various wooden joints for house hold purpose.*
- ✓ *Design and develop various sheet metal products.*
- ✓ *Fabricate various agriculture tools by using forging technique.*
- ✓ *Create products by using different trades for Industrial applications.*

**ACTIVITIES:**

- *To make wooden joints like Mortise and Tenon joint, T-lap Joint which are used to prepare a wooden furniture.*
- *To prepare metal joints and metal sheet products like V-Joint and trays by using mild steel flats and Galvonised iron sheets.*
- *Trials on electrical circuit connections.*

**UNIT- I** **L-3 P-6**

**ENGINEERING MATERIALS:** Introduction; Classification; Ferrous & non ferrous metals and alloys; Physical; Electrical; Optical & mechanical properties.

**UNIT- II** **L-3 P-6**

**CARPENTRY:** Introduction; Classification of wood; Marking tools; Measuring tools; Holding tools; Cutting tools & supporting tools; Classification of joints; Safety precautions.

**UNIT- III** **L-3 P-6**

**FITTING:** Introduction; Vices; Try square; Files; Hacksaw.

**TIN SMITHY:** Introduction; Metals used in sheet metal work; Classification of tools.

**UNIT- IV** **L-3 P-6**

**FORGING:** Introduction; Tools and equipment used in forging; Smith's forge or hearth.

**HOUSE WIRING:** Concepts of basic electricity; Single phase and three phase circuits; Knowledge of different electrical wirings - residential, offices, hospitals, godowns.

**UNIT- V** **L-3 P-6**

**WELDING:** Concepts of welding; Arc welding; Gas welding; Soldering and Brazing.

**CNC:** Introduction; Components of CNC; Types of CNC systems.

## LABORATORY EXPERIMENT

**LIST OF EXPERIMENTS:** **TOTAL HOURS: 30**

1. Fabrication of Mortise and Tenon joint using carpentry tools.
2. Fabrication of T-lap joint using carpentry tools.
3. Fabrication of V-fit using fitting tools.
4. Fabrication of U-fit using fitting tools.
5. Fabrication of truncated cylinder using tin smith tools.
6. Fabrication of square tray using tin smith tools.
7. Forging of S shape using black smith technique.
8. Forging of square to round cross section using black smith technique.
9. Peformance of 1 lamp controlled by one way switch using house wiring.
10. Performance of 2 lamp controlled by one way switch using house wiring.
11. Demonstration of CNC and welding operations.

**TEXT BOOKS:**

1. S.K Hazra Choudhury, "Elements of Work Shop Technology", 11th edition, Media Promoters, 1997.
2. Venkatachalapathy, V.S, "First year Engineering Workshop Practice", Ramalinga Publications, 2014.

**REFERENCE BOOKS:**

1. T.V.Gopal, T.Kumar and G. Murali, "A first Course on Workshop Practice: Theory, Practice and Work Book", Suma Publication, 2005.
2. K.V.N.Pakirappa, "Workshop Technology", 5th edition, Radiant Publishing House, 2011.

# 19CH102 MOMENTUM TRANSFER

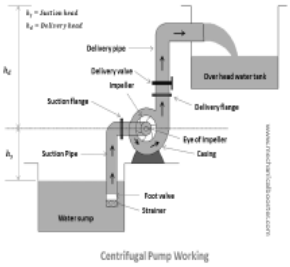
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |



Centrifugal Pump Working

***Source:***

*https://2.bp.blogspot.com/-Gs8IpwInty0/WWYXXNqS2xI/AAAAAAAAIVA/s7k-P0qNjj4IIVeYxfu-smZBkMGWl4bNgCLcBGAs/s1600/centrifugal%2Bpump%2Bworking.png*

## COURSE DESCRIPTION AND OBJECTIVES:

This course deals with fundamentals of fluid flow and its application to chemical process industries including pipe flow, fluid machinery. The objective of this course is to familiarize students with basic concepts of fluid statics, fluid dynamics, compressible and incompressible fluids, fluidization, transportation and metering of fluids.

## COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes.

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Formulate dimensionless groups by dimensional analysis. | 2 |
| 2 | Design solutions for manometers and decanters using the principles of fluid statics. | 3 |
| 3 | Develop solutions for problems related to pipe size / flow rate / power requirements under laminar and turbulent flow conditions. | 3 |
| 4 | Identify suitable machinery for fluid transportation. | 2 |
| 5 | Interpretation of flow rate data for the fluid passing through closed channels. | 4 |

## SKILLS:

- ✓ *Application of fluid mechanics concepts to solve real life problems.*
- ✓ *Estimate physical properties of fluids in motion and at rest.*
- ✓ *Measurement of flowing fluids.*
- ✓ *Selection of pumps for engineering applications.*

**UNIT - I** **L-9**

**DEFINITIONS AND PRINCIPLES:** Unit operations; Unit systems; Dimensional analysis; Basic concepts; Fluid statics: Nature of fluids; Hydrostatic equilibrium; Manometers.

**UNIT - II** **L-9**

**BASIC EQUATIONS OF FLUID FLOW:** Mass balance; Mass velocity; Momentum balance; Bernoulli equation; Mechanical energy balance equation; Correction factors; Pump work.

**UNIT - III** **L-9**

**FLOW OF INCOMPRESSIBLE FLUIDS :** Shear stress distribution in pipes; Relation between skin friction parameters; Laminar flow in pipes; Hagen-poiseuille equation; Laminar flow of non-Newtonian liquids; Velocity distribution for turbulent flow; Friction factor chart.

**FLOW OF COMPRESSIBLE FLUIDS** : Mach number; Basic equations.

**UNIT - IV** **L-9**

**FLOW PAST IMMERSED BODIES :** Drag; Drag Coefficient; Stagnation Point; Friction in flow through beds of solids; Motion of particles through fluids; Terminal velocity; Motion of spherical particles; Fluidization- conditions for fluidization, minimum fluidization velocity.

**UNIT - V** **L-9**

**TRANSPORTATION AND METERING OF FLUIDS :** Pipes; Fittings, Valves; Joints; Pumps; Developed head and power requirement in pumps; Suction lift and cavitation; Positive displacement pumps; Centrifugal pumps; Measurement of flowing fluids- classification of measuring devices, venturi meter, orifice meter, rotameter.

## LABORATORY EXPERIMENT

**LIST OF EXPERIMENTS:** **TOTAL HOURS: 30**

1. Classification of flows using Reynolds number.
2. Verification of Bernoulli's theorem.
3. Determination of coefficient of discharge of venturi meter.
4. Determination of head and power loss due to sudden expansion.
5. Determination of coefficient of discharge of V-notch.
6. Determination of coefficient of discharge of orifice meter.
7. Determination of friction loss in pipes.
8. Determination of head and power loss due to sudden contraction.
9. Determination of pressure drop in packed bed.
10. Determination of pressure drop in fluidized bed.
11. Characteristics of centrifugal pump.
12. Characteristics of reciprocating pump.
13. Flow through helical coil.
14. Local velocity measurement using pitot tube.
15. Viscosity measurement using Cannon-Fenske viscometer.

### TEXT BOOKS:

1. W. L. McCabe, J. C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", 7th edition, McGraw-Hill, 2005.
2. Chattopadhyay. P., "Unit Operations of Chemical Engineering Vol-1", 1st edition, Khanna publishers, 2012.

### REFERENCE BOOKS:

1. C. J. Geankoplis, "Transport Processes and Unit Operations", 3rd edition, Prentice Hall of India, 1993.
2. A. S. Foust, "Principles of Unit Operations", 2nd edition, John Wiley & Sons, 1981.

II

YEAR

# CHEMICAL ENGINEERING

## B.Tech.

**I SEMESTER**

| | | |
|---|---|---|
| 19CH201 | - | Chemical Process Calculations |
| 19CH202 | - | Mechanical Unit Operations |
| 19CH203 | - | Process Heat Transfer |
| 19CH204 | - | Chemical Engineering Thermodynamics - II |
| 19CH205 | - | Mass Transfer Operations - I |
| 19PC003 | - | Life Skills - I |
| 19PC004 | - | Technical Seminar - I |
| 19PC005 | - | Intra Disciplinary Projects - I |
| 19PC006 | - | Physical Fitness, Sports & Games - III |

**II SEMESTER**

| | | |
|---|---|---|
| 19CH211 | - | General Pharmacy |
| 19CH212 | - | Chemical Reaction Engineering - I |
| 19CH213 | - | Mass Transfer Operations - II |
| 19HS204 | - | Environmental Studies |
| 19MS302 | - | Management Science |
| 19PC007 | - | Life Skills - II |
| 19PC008 | - | Technical Seminar - II |
| 19PC009 | - | Intra Disciplinary Projects - II |
| | - | Department Elective - I |
| | - | Open Elective - I |

## COURSE CONTENTS

I SEM AND II SEM

# 19CH201 CHEMICAL PROCESS CALCULATIONS

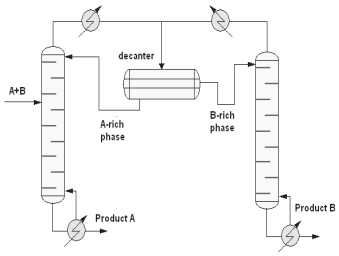
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | - | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | 15 | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 55 | - | - | 5 | 5 |




***Source:***

*https://www.google.com/search?q=chemical+process+calculations&safe=strict&tbm=isch&tbs=rimg*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with the fundamentals of material and energy balance involved in chemical processes. The objective of this course is to develop basic understanding pertaining to principles of chemical engineering processes and calculations.

**COURSE OUTCOMES :**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Design of flow sheet for a chemical Process. | 3 |
| 2 | Estimate of properties of gases using ideal gas mixtures. | 2 |
| 3 | Evaluate material and energy balance for any chemical plant. | 3 |
| 4 | Estimate the heat capacity. | 2 |
| 5 | Estimate the heat of reaction & adiabatic flame temperature. | 2 |

**SKILLS:**

- ✓ Material balance for different chemical processes.
- ✓ Energy balance for any chemical plant.

**UNIT – I** **L-9, T-3**

**BASIC CONCEPTS :** Units & dimensions; Graphical integration and differentiation; Use of log-log, semi-log and triangular graphs; Conversion of units.

**STOICHIOMETRIC AND COMPOSITION RELATIONS :** Stoichiometric relation; Basis of calculation; Method of expressing composition of mixture and solutions; Density and specific gravity.

**BEHAVIOR OF IDEAL GASES :** Ideal gas law and it's applications; Gaseous mixtures; Gases in chemical reactions.

**UNIT - II** **L-9, T-3**

**MATERIAL BALANCE WITHOUT CHEMICAL REACTION :** Formulation; Material balance calculations of unit operations- distillation, absorption, extraction, crystallization (single solute systems), drying, evaporation.

**UNIT - III** **L-9, T-3**

**MATERIAL BALANCE WITH CHEMICAL REACTION :** Material balance calculations- processes with chemical reactions, processes involving recycle, purge and bypass.

**UNIT- IV** **L-9, T-3**

**VAPOR PRESSURE :** Concept of vapor pressure; Liquefaction and liquid state; Vaporization; Boiling point; Effect of temperature on vapor pressure; Vapor pressure plots; Vapor pressure of solutions and immiscible liquids; Raoult's law and it's limitations.

**HUMIDITY AND SATURATION :** Relative saturation; Percent saturation; Dew point; Wet bulb and dry bulb temperatures; Humidity charts.

**UNIT- V** **L-9, T-3**

**THERMOPHYSICS :** Concept of energy; Energy balance equation; Heat capacity- gases, liquids and mixtures, Kopp's rule; Latent heat- heat of fusion, heat of vaporization, Trouton's ratio, Kistyakowski equation.

**THERMOCHEMISTRY :** Heat of formation; Heat of combustion; Heat of reaction; Hess law; Heat of reaction from heat of formation/combustion; Effect of temperature and pressure on heat of reaction; Adiabatic reaction temperature; Fuel & combustion- heating value, theoretical and actual flame temperature.

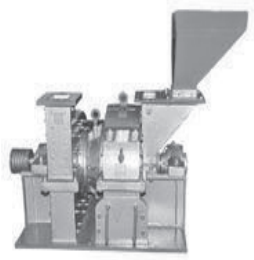
## TEXT BOOKS:

1. Hougen O. A., Watson K. M. and Ragatz. R. A., "Chemical Process Principles Part – I: Material and Energy Balance", 2nd edition, CBS Publishers & Distributors, 2004.
2. Bhatt B. I., and Vora S. M., "Stoichiometry", 4th edition, Tata McGraw Hill, New Delhi, 2004.

## REFERENCE BOOKS:

1. Himmelblau D.M. and Rigges J. B., "Basic Principles and Calculations in Chemical Engineering", 8th edition, Prentice Hall of India, 2011.
2. Richard M. F. and Ronald W. R., "Elementary Principles of Chemical Processes", 3rd edition, John Wiley, 2004.

# 19CH202 MECHANICAL UNIT OPERATIONS



***Source:***
*https://www.indiamart.com/singhasini/size-reduction-equipments.html*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

This course provides knowledge in the basics of unit operations employed in chemical process industries. The objective of this course is to familiarize student on the principles and practices involved in transporting, separating and storing of solids and associated unit operations.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the basic methods of characterization to determine the properties of solid particles. | 1 |
| 2 | Formulate the solution for complex unit operations by using the principles of engineering mathematics. | 2 |
| 3 | Design of various unit operation devices to meet the desired specifications. | 3 |
| 4 | Investigate the problems encountered during working of equipments related to unit operations. | 4 |
| 5 | Conduct experiments of various unit operations for a given industry problem using modern tools. | 5 |

**SKILLS:**

- ✓ *Perform cumulative and differential particle size analysis.*
- ✓ *Identify the suitable mixer required for mixing cohesive and non cohesive solids.*
- ✓ *Recognize the required specifications of the size reduction equipment for a given feed.*
- ✓ *Identify the filtration equipment required for a specific application.*
- ✓ *Compare the efficiency of separation equipment.*

**UNIT- I** **L-9**

**PROPERTIES AND CHARACTERIZATION OF SOLIDS :** Properties of particulate masses; Characterization of solid particles- particle shape, particle size, mixed particle size and size analysis; Screen analysis; Standard screen series; Pressures in masses of particles; Storage of solids; Pressures in bins and silos; Flow out of bins.

**UNIT- II** **L-9**

**MIXING OF SOLIDS :** Mixing of solids; Types of mixers; Mixers for cohesive solids; Criteria of mixing; Effectiveness; Mixers for free flowing solids; Mixing index- mixing index for blending granular solids, mixing index at zero time; Rate of mixing.

**CONVEYING OF SOLIDS :** Belt conveyor; Screw conveyor; Pneumatic conveyor; Bucket elevator; Hydraulic conveying.

**UNIT- III** **L-9**

**PRINCIPLES OF COMMINUTION :** Criteria for comminution; Characteristics of comminuted products; Energy and power requirements in comminution; Empirical relationships; Size reduction equipment- crushers, grinders, ultrafine grinders, cutting machines.

**PARTICLE SIZE ANALYSIS :** Screening; Screening equipment; Screen effectiveness.

**UNIT- IV** **L-9**

**FILTRATION :** Introduction to filtration; Types of filters- pressure filters, vacuum filters, centrifugal filters, filter media, filter aids; Principles of cake filtration; Pressure drop through filter cake; Continuous filtration; Numericals on filtration.

**UNIT-V** **L-9**

**PARTICLE SEPARATION TECHNIQUES :** Separations based on motion of particles through fluids; Gravity settling processes- gravity classifiers, sorting classifiers, clarifiers and thickeners, flocculation, batch sedimentation, clarifier and thickener design; Centrifugal settling processes; Electrostatic precipitators; Cyclones and hydroclones; Crystalization- introduction, crystal geometry, nucleation, origin of crystals in crystallizers.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Determination of particle size using screen analysis.
2. Determination of the effectiveness of a screen.
3. Verification of size reduction laws using jaw crusher.
4. Verification of size reduction laws using ball mill.
5. Verification of size reduction laws and finding efficiency using roll crusher.
6. Determination of compressibility coefficient using sedimentation process.
7. Determination of filter medium resistance and cake resistance using plate and frame filter press.
8. Determination of percent recovery of coal from coal-sand mixture using froth flotation cell.
9. Determination of the dehusking efficiency of rubber roll sheller.
10. Determination of the collection efficiency of a cyclone separator.
11. Determination of the size using ICI sedimentation.
12. Determination of the rate of filtration in a leaf filter.
13. Determination of size reduction ratio and power consumption in Hammer mill.
14. Determination of filter medium resistance and cake resistance using Rotary vacuum filter.

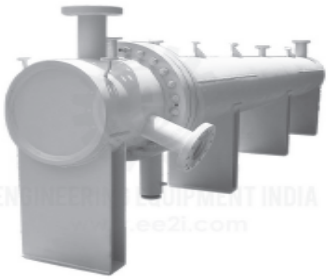
**TEXT BOOKS:**

1. McCabe, W. L., Smith J. C. and Peter Harriot, “Unit Operations of Chemical Engineering”, 7th edition, McGraw-Hill, 2005.
2. Foust A. S., Wenzel L. A., Clump C. W., Maus L. and Anderson L. B., “Principles of Unit Operations”, 2nd edition, Wiley, New York, 2004.

**REFERENCE BOOK:**

1. Perry R. H. and Green D. W., “Chemical Engineer’s Hand book”, 8th edition, McGraw-Hill, New York, 2007.

# 19CH203 PROCESS HEAT TRANSFER



*https://www.engineeringequipmentindia.com/shell-and-tube-heat-exchanger/*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 55 | 1 | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with the phenomena of heat transfer. The objective of this course is to provide theoretical and practical knowledge in various modes of heat transfer and its application for designing of process equipments.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Determine critical radius of insulation for any given system. | 2 |
| 2 | Determine heat transfer coefficient for a given system. | 2 |
| 3 | Design heat exchange equipment. | 3 |
| 4 | Identify the suitable evaporators. | 3 |

**SKILLS:**

- ✓ *Estimate the rate of heat flow.*
- ✓ *Calculate the insulation thickness for a specified heat loss target.*
- ✓ *Determine heat transfer coefficient in simple geometries for forced and natural convection.*
- ✓ *Estimate area of heat exchanger required for specified conditions.*
- ✓ *Design of heat exchanger.*
- ✓ *Determine the emissivity of a given body.*

**UNIT- I** **L-10**

**HEAT TRANSFER BY CONDUCTION :** Nature of heat flow; Modes of heat transfer- conduction, convection, radiation; Conduction- Fourier's law, concept of electrical analogy, one dimensional heat flow through slab/cylinder/sphere, thermal resistance, heat flow through composite wall/cylinder and sphere, thermal contact resistance.

**UNIT- II** **L-9**

**HEAT TRANSFER TO FLUIDS WITHOUT PHASE CHANGE :** Principles of heat flow in fluids; Heat exchange equipment; Counter current & parallel current flows; Energy balances; Rate of heat transfer; LMTD; Individual heat transfer coefficients; Overall heat transfer coefficient**;** Regimes of heat transfer; Thermal boundary layer; Dimensional analysis- Buckinghum pi theorem, dimensionless groups in natural and forced convection, significance of dimensionless groups; Forced convection: heat transfer in laminar flow, heat transfer in turbulent flow, analogy between transfer of momentum and heat, Reynolds analogy, Colburn analogy; Natural convection- heat transfer by natural convection from vertical and horizontal shapes.

**UNIT- III** **L-8**

**HEAT TRANSFER TO FLUIDS WITH PHASE CHANGE :** Boiling heat transfer; Types of boiling; Critical heat flux concept; Pool boiling of saturated liquids; Film boiling; Condensation heat transfer-drop wise and film type condensation.

**RADIATION :** Radiation; Emissivity; Absorptivity; Transmissivity; Laws of black body and grey body radiation; Radiation between black surfaces; Radiation between grey surfaces; Shape factors; Combined heat transfer by conduction; Convection and radiation.

**UNIT- IV** **L-8**

**HEAT EXCHANGE EQUIPMENT :** Types of heat exchange equipment- double pipe, shell and tube, extended surface and plate type; General design of heat exchange equipment; Bell Delaware method, ; Kern method; Condensers; Boilers- water tube boilers, fired tube boilers.

**UNIT- V** **L-10**

**EVAPORATION :** Liquid characteristics; Types of evaporators- falling film, climbing film, forced circulation and agitated film type evaporators; Performance of single effect evaporators- material and energy balance, capacity and economy; Multiple effect evaporators; Methods of feeding.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of metal rod.
3. Determination of thermal conductivity of a liquid.
4. Determination of overall resistance in composite wall.
5. Determination of heat transfer coefficients of double pipe heat exchanger.
6. Estimation of heat transfer coefficient in forced convection.
7. Estimation of natural convection heat transfer coefficient.
8. Determination of overall heat transfer coefficient of a given coil.
9. Determination of critical heat flux of nichrome wire.
10. Verification of Stefan-Boltzmann's law of radiation.
11. Estimation of emissivity of a test plate.
12. Determination of heat transfer coefficient in Shell and Tube Heat Exchanger.
13. Determination of temperature distribution and effectiveness of the fin.
14. Determination of overall heat transfer coefficient in vertical condenser.
15. Determination of steam economy and the overall heat transfer coefficient for evaporator.

**TEXT BOOKS:**

1. W. L. McCabe, J. C. Smith and P. Harriott,"Unit Operations of Chemical Engineering", 7th edition, McGraw-Hill, Inc., 2005.
2. D. Q. Kern, "Process Heat Transfer", 1st edition, Tata McGraw-Hill, 2002.

**REFERENCE BOOKS:**

1. J. P. Holman, "Heat Transfer", 8th edition, McGraw-Hill, New York, 1997.
2. Y. V. C. Rao, "Heat Transfer", 1st edition, University Press, 2001.
3. D. Pitts, E. Leighton and Sissom, " Schaum's Outline of Heat Transfer", 2nd edition, McGraw-Hill publications, 1998.
4. J. M. Coulson and J. F. Richardson," Chemical Engineering, Vol -1", Oxford, Pergamon Press,1968.

# 19CH204 CHEMICAL ENGINEERING THERMODYNAMICS-II

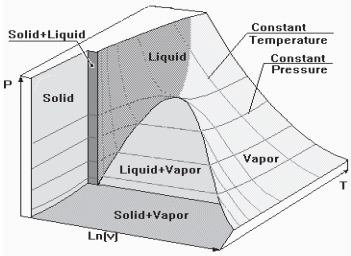
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | - | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | 15 | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 30 | 60 | - | - | 5 | 5 |




***Source:***
*https://www.google.com/search?q=chemical+engineering+thermodynamics&safe*

**PRE-REQUISITE COURSES :** Chemical Engineering Thermodynamics -I

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with the theory and applications of solution thermodynamics. The objective of this course is to familiarize student with solution thermodynamics, thermodynamic properties, equations of state and methods used to describe and predict the vapor liquid equilibrium and chemical reaction equilibrium.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Familiarize with the theory of solution themodynamics. | 1 |
| 2 | Analyze bubble and dew point calculations for ideal and non ideal solutions using VLE data. | 2 |
| 3 | Model the vapor liquid equilibria. | 3 |
| 4 | Estimate the equilibrium conversions for different chemical reactions. | 3 |

**SKILLS:**

- ✓ *Estimation of solution thermodynamic properties.*
- ✓ *Modelling of vapor liquid equilibrium.*
- ✓ *Estimation of equilibrium conversions.*

**UNIT - I** **L-9, T-3**

**SOLUTION THERMODYNAMICS THEORY :** Review of first and second law of thermodynamics; Fundamental property relation; Chemical potential; Partial molar properties; Ideal gas mixtures; Fugacity and fugacity coefficient- pure species, species in solution; Generalized correlations; Ideal solution; Excess properties.

**UNIT - II** **L-9, T-3**

**SOLUTION THERMODYNAMICS APPLICATIONS :** Liquid phase properties from VLE data- fugacity, activity coefficient, excess Gibbs free energy, thermodynamic consistency; Models for excess Gibbs free energy- Van Laar equations, Margules equations, NRTL model, UNIFAC and UNIQUAC models; Property changes of mixing.

**UNIT - III** **L-9, T-3**

**VAPOR - LIQUID EQUILIBRIUM :** Nature of equilibrium; Phase rule; Duhems theorem; VLE qualitative behavior; Simple models for VLE- Raoult's law, Henry's law; Dew point and bubble point calculations with Raoult's law; VLE by modified Raoults law; Dew point and bubble point calculations with modified Raoult's law.

**UNIT - IV** **L-9, T-3**

**TOPICS IN PHASE EQUILIBRIA :** Liquid-Liquid equilibria; Vapor-Liquid equilibria; Solid-Liquid equilibria; Solid-Vapor equilibria.

**UNIT - V** **L-9, T-3**

**CHEMICAL REACTION EQUILIBRIA :** Reaction cordinate; Equilibrium criterion; Standard Gibbs free enrgy change and equilibrium constant; Effect of temperature on equilibrium; Evaluation of equilibrium constant at different temperatures; Relation of equilibrium constant to composition; Equilibrium conversion of single reactions; Phase rule for reacting systems; Multi reaction equilibria.

## TEXT BOOK:

1. J. M. Smith, H.C. Van Ness and M. M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 6th edition, Tata McGraw-Hill, 2003.

## REFERENCE BOOKS:

1. Dodge B. F., "Chemical Engineering Thermodynamics", 1st edition, Tata McGraw-Hill, 1960.
2. Sandler S. I., "Chemical and Engineering Thermodynamics", 4th edition, John Wiley & Sons, 2006.
3. Kyle B. G., "Chemical and Process Thermodynamics", 2nd edition, Prentice Hall of India,1990.

# 19CH205 MASS TRANSFER OPERATIONS - I

***Source:***
*-http://www.hitekengineers.com/absorption-system.html*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 60 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The course deals with mass transfer phenomena and its usage for engineering application. The general objectives of this course are to discuss the fundamental concepts of mass transfer principles such as diffusion phenomena, absorption, stripping, humidification, drying and design of various mass transfer equipments and to apply those concepts towards real problems in process industry.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Articulate equation to estimate diffusivities in fluids & solids using the principles of engineering sciences along with the estimation of mass transfer coefficients for gas –liquid contacting systems. | 1,2 |
| 2 | Apply mass transfer fundamentals and correlate their theoretical knowledge to determine rates of mass transfer and design the system components for various operations. | 3 |
| 3 | Apply of the principles of novel separation process to evaluate societal, health and safety by subsequent responsibilities. | 2 |
| 4 | Conduct experiments in teams related to various mass transfer operations and design various prototype or pilot plant setup for mass transfer. | 3,9 |
| 5 | Interpret experimental data to estimate mass transfer co-efficient and provide valid conclusions on suitability of the process. | 4 |

**SKILLS:**

- ✓ *Estimate the diffusion coefficients for binary and ternary mixture.*
- ✓ *Specification and design of various mass transfer equipment.*
- ✓ *Estimate the correlation of mass transfer coefficients in packed and fluidized bed absorption column.*
- ✓ *Design specifications of cooling tower.*
- ✓ *Design calculation of rotary dryer.*

**UNIT - I** **L-9**

**DIFFUSION AND MASS TRANSFER :** Mass transfer operations; Molecular diffusion in fluids and in binary solutions; Fick's Law; Steady state equimolar counter current diffusion; Application of molecular diffusion; Theories of mass transfer; Diffusion in fluids; Mass transfer coefficients in laminar and turbulent flow; Diffusion through solids; Dimensionless groups in mass transfer; Mass transfer coefficients in wetted wall column.

**UNIT - II** **L-9**

**INTERPHASE MASS TRANSFER :** Concept of equilibrium; Diffusion between phases; Material balance in- steady state, co–current and counter current stage processes; Sparged vessels; Agitated vessels; Venturi scrubbers; Sieve tray design for absorption tray tower verses packed tower; Loading and flooding in a packed column.

**UNIT - III** **L-9**

**ABSORPTION AND STRIPPING :** Introduction; Counter and co–current absorption; Isothermal absorption and stripping of single component; Operating lines; Minimum flow rate; Determination of number of transfer units and height of continuous absorber; Determination of number of plates; Absorption factor; Kremser-Brown equations.

**UNIT - IV** **L-9**

**HUMIDIFICATION :** Introduction; Vapor pressure curve; Definitions; Psychometric charts; Enthalpy of vapor gas mixtures; Humidification and dehumidification; Cooling towers.

**UNIT - V** **L-9**

**DRYING :** Introduction; Definitions of various moisture contents; Drying conditions; Rate of batch drying under constant drying conditions; Mechanism of batch drying; Drying time through circulation drying; Batch and continuous drying.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Estimation of diffusivity in gas phase.
2. Estimation of diffusivity in liquid phase.
3. Determination of batch drying characteristics using tray dryer.
4. Determination of batch drying characteristics using vacuum dryer.
5. Determine the pressure drop and flooding characteristics in a packed column.
6. Determination of hydrodynamic characteristics of a packed column.
7. Verification of Himus equation through surface evaporation.
8. Estimation of solid diffusion coefficient.
9. Estimation of distribution coefficient.
10. Determination of solubility of a ternary system.
11. Oil extraction by soxhelet apparatus.
12. Determination of the mass transfer coefficient for absorption of $CO_2$ in NaOH solution in packed Column.
13. Estimate the drying characteristics curve under constant drying condition in the rotary dryer.
14. Study the design and operating principles of spray dryer.
15. Study the characteristics of cooling tower experiment.

### TEXT BOOKS:

1. Treybal R. E., "Mass Transfer Operations", 3rd edition, McGraw-Hill, 2005.
2. Binay. K. Dutta, "Principles of Mass Transfer and Separation Processes", 2nd edition, Prentice Hall of India, New Delhi, 2009.

### REFERENCE BOOKS:

1. Christie J. Geankoplis., "Transport Processes and Separation Process Principles", 4th edition, Prentice Hall India Pvt. Ltd., 2003.
2. Judson King C., "Separation Processes", 2nd edition, McGraw-Hill, 2005.
3. J. D. Seader, Ernest J. Henley and D. Keith Roper, "Separation Process Principles-chemical and Biochemical Operations", 3rd edition, John Wiley& Sons, Inc, 2011.

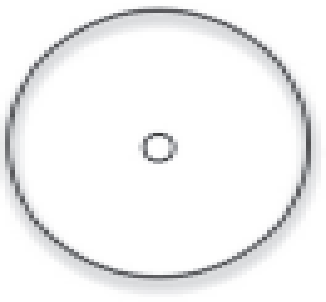
# 19PC005 INTRA-DISCIPLINARY PROJECTS-I

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| - | - | 2 | 1 |

Total Hours :

| L | T | P |
|---|---|---|
| - | - | 30 |



***Source:***

*https://www.google.com/search?q=3.+Intra-disciplinary+project+I&rlz=1C1GCEB_enIN833IN833&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi7h8GZ9qTjAhUjSo8KHVTwCigQ_AUIESgC&biw=1366&bih=625#imgrc=ZTT9dcMpa_wxlM:*

**DESCRIPTION AND OBJECTIVES:**

These projects arise from a combination of courses. The major objective of these projects is to enable students understand the relationship between the courses.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Ability to map different courses to gain the knowledge of intra-disciplinary engineering. | 1 |
| 2 | Function effectively as an individual and as a member or leader in diverse teams. | 9 |
| 3 | Comprehend and write effective reports and make effective presentations. | 10 |

## LIST OF INTRA - DISCIPLINARY PROJECTS

- Manufacturing of sulphuric acid: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of phosphoric acid: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Production of Hydrogen: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Production of Urea: Material and energy balance, design of heat exchanger .(Chemical Process Calculations, Process Heat Transfer)
- Production of Ammonium phospate: Material and energy balance, design of heat exchanger and dryer.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Soda ash: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)

- Manufacturing of Caustic soda: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Production of Chlorine: Material and energy balance, design of heat exchanger.(Chemical Process Calculations, Process Heat Transfer)
- Production of soaps: Material and energy balance, design of heat exchanger.(Chemical Process Calculations, Process Heat Transfer)
- Manufacturing of Paper: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Cement: Material and energy balance, design of heat exchanger and dryer.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Formaldehyde: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Chloromethanes: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Ethylene: Material and energy balance, design of heat exchanger and evaporator.(Chemical Process Calculations, Process Heat Transfer)
- Manufacturing of Ethylene-dichloride: Material and energy balance, design of heat exchanger and scrubber.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of iso-Propanol: Material and energy balance, design of heat exchanger and stripper.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Acetaldehyde: Material and energy balance, design of heat exchanger and stripper.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Portland cement: Material and energy balance, design of heat exchanger. (Chemical Process Calculations, Process Heat Transfer)
- Manufacturing of Phenol: Material and energy balance, design of heat exchanger and stripper.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Nitric acid: Material and energy balance, design of heat exchanger and absorber.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of sugar: Material and energy balance, design of heat exchanger and Evaporator.(Chemical Process Calculations, Process Heat Transfer)
- Manufacturing of Acetic acid: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)
- Manufacturing of Ethyleneoxide: Material and energy balance, design of heat exchanger and absorption column.(Chemical Process Calculations, Process Heat Transfer, Mass Transfer Operations-I)

**NOTE:** The afore - mentioned list is not exhaustive and the objective is to provide an idea of some of the projects that can be executed by students arising from a combination of courses. Students are given full flexibility to choose any projects of their choice under the supervision of faculty Mentors.

# 19CH211 GENERAL PHARMACY

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The main objective of this course is to deal with a fundamental knowledge on the art and science of formulations available, formulation requirements for formulating different types of dosage forms. This course deals with the fundamental knowledge on differrent mono phasic and biphasic liquid preparations available, formulation aspects of biphasic liquid preparations. This course imparts different extraction processes used for the preparation of surgical aids, galenicals and incompatibilities.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Formuilation and the preperation of different mouthgels, ear drops and nasal spray. | 2 |
| 3 | Identiffy the diifferent additives for oral and external use. | 2 |
| 2 | Apply the different formulation techniques required for dosage form. | 2 |
| 3 | Formulate and prepare diffrent semi solids dosage form like ointments, creams. | 3 |
| 4 | Design and calculation of extraction equipment for spirits and tincture preparation. | 3 |

**SKILLS:**

- ✓ Carry out the different formulation using colouring agents, preservetives, sweetening agents.
- ✓ Use the latest formulation technologies, processes and methods to develop new additives.
- ✓ Evaluate the preparation methods of various mono phasic and biphasic liquids.
- ✓ Analyze formulation development towards ointments, creams, spirits, tinctures etc.

**UNIT – I** **L-9**

**INTRODUCTION TO DOSAGE FORMS:** Classification – types with examples; Definitions and essential characteristics of different dosage forms – formulation and its purpose.

**FORMULATION ADDITIVES:** Solvents; Vehicles for Liquids; Antioxidants; Preservatives; Colouring agents; Sweetening and flavouring agents in Liquid dosage forms.

**UNIT – II** **L-9**

**MONOPHASIC LIQUIDS:** Liquid oral dosage forms; Definitions; General formulation; Methods of preparation; Uses of officials and other products in common usage of the following solutions - aromatic waters, spirits, syrups, elixirs, dry syrups, mixtures.

**MONOPHASIC LIQUIDS FOR EXTERNAL AND OTHER USES :** Definitions; General formulation; Methods of preparation; Uses of official and other products in common usage of the following lotions - liniments, throat paints, gargles, mouthwashes, glycerins, collodions, ear drops, nasal drops and sprays, douches, preparations.

**UNIT – III** **L-9**

**BIPHASIC LIQUID DOSAGE FORMS:** Suspensions; Definitions; Types; Ideal requirements; Formulation additives; Typical examples for oral and external use; Methods of preparation.

**EMULSIONS:** Definition; Types; Ideal requirements; Formulation additives; Typical examples for oral and external use; Methods of preparation.

**UNIT – IV** **L-9**

**SEMI SOLID DOSAGE FORMS:** Definition; Anatomy and physiology of skin; Penetration mechanisms; Semi solids classification; Formulation additives for commonly used semisolid dosage forms like – ointments, creams, pastes, jellies.

**SUPPOSITORIES AND PESSARIES:** Ideal requirements; Different bases; Preparation methods; Typical examples; Calculations involving displacement value.

**UNIT – V** **L-9**

**SURGICAL AIDS:** Surgical dressings; Absorbable gelatin sponge; Sutures; Ligatures and medicated bandages.

**GALENICALS:** Definition; Extraction types and processes like – infusion, decoction, maceration and percolation, methods for preparation of spirits, tinctures, extracts.

**INCOMPATIBILITY:** Introduction; Classification; Methods to overcome incompatibilities.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Preparation of Syrups [Eg: Simple syrup I.P., Orange syrup, Ferrous phosphate syrup I.P. etc.).
2. Preparation of Elixir [Piperizine citrate elixir BP, Cascara elixir BP etc] and throat paint [1].
3. Preparation of Mouth washes [Any 1], Gargle [1].
4. Preparation of Lotion [Calamine lotion, Aloevera lotion].
5. Preparation of Aromatic waters [rose water, chloroform water].
6. Preparation of Mixtures [ magnesium hydroxide mixture etc].
7. Preparation of Liniments [turpentine liniment, camphor liniment].
8. Preparation of Solutions [cresol with soap solution, Iodine solution(strong, weak, aqueous).
9. Preparation of flocculated and deflocculated suspensions [magnesium trisilicate or magnesium carbonate suspension].
10. Formulation of o/w and w/o emulsions [castor oil or liquid paraffin emulsions].
11. Formulation of Multiple emulsions [o/w/o or w/o/w].
12. Formulation of Ointments [atropine sulphate ointment, sulphur ointment].
13. Preparation of Creams [cold cream, vanishing cream].
14. Preparation of Gels [Diclofenac sodium gel].
15. Calculation of selected base displacement value and preparation of suppositories [boric acid suppositories].

**Note:** Practice labeling for all the preparations.

**TEXT BOOKS:**

1. Introduction to Pharmaceutical Dosage forms by H.C. Ansel, 9th edition.
2. Dispensing for pharmaceutical students by Cooper & Gunn's 12th edition.

**REFERENCE BOOKS:**

1. Pharmaceutical Science, Remington's 21st edition.
2. Text book of professional pharmacy, N.K.Jain & S.N.Sharma, 5th edition.

# 19CH212 CHEMICAL REACTION ENGINEERING-I

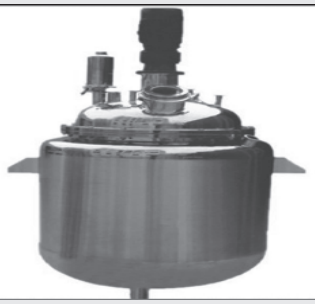
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | - | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | 15 | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |



***Source:***
*http://reactor.co.in/chemical-reactor.html*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course encompasses methodologies to design chemical reactors and also to solve related problems in process industries. The objective of this course is to train students to apply knowledge from calculus, differential equations, thermodynamics, chemistry and process calculations for designing chemical reactors.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Develop rate laws for homogeneous reactions. | 1 |
| 2 | Conduct experiments for kinetic studies and interpretation of kinetic data to estimate the kinetic parameters. | 2 |
| 3 | Design ideal reactors to meet the desired conversion. | 3 |
| 4 | Design of right contact pattern for multiple reactions. | 3 |
| 5 | Identify the non idealities of the reactor from residence time distribution studies. | 2 |
| 6 | Model the non ideal reactors and estimate conversion of non ideal reactors. | 5 |

**SKILLS:**

- ✓ *Carry out the experiments to obtain the kinetic data.*
- ✓ *Determine the kinetic parameters.*
- ✓ *Estimate the temperature and concentration dependency of rate of reaction.*
- ✓ *Identification best reactor and sizing of the reactor for the given reaction.*
- ✓ *Optimizing the selectivity in case of multiple reactions.*
- ✓ *Identify the non idealities of reactor.*
- ✓ *Modeling of non ideal reactors.*

**UNIT - I** **L-9, T-3**

**KINETICS OF HOMOGENEOUS REACTIONS :** Stoichiometry- limiting reactant, extent of reaction, conversion, selectivity; Rate of reaction; Dependency of rate of reaction; Concentration dependency of rate equation- elementary and non elementary reactions, kinetic models for elementary reactions, testing of models; Temperature dependency of rate equation- Arrhenius law**,** activation energy, temperature dependency of rate constant, numericals on temperature dependency.

**UNIT - II** **L-9, T-3**

**INTERPRETATION OF BATCH REACTOR DATA :** Constant volume batch reactor; Analysis of pressure data; Integral method of analysis; Differential method of analysis; Integral method of analysis- irreversible zero order reactions, first order reactions, second order reactions, $n^{th}$ order reactions, reversible first and second order reactions.

**VARIABLE VOLUME BATCH REACTOR :** Analysis of pressure data; Integral method of analysis- zero, first, second order reactions.

**UNIT - III** **L-9, T-3**

**IDEAL REACTORS :** Performance of ideal reactors- batch reactor, steady state mixed flow reactors, steady state plug flow reactor.

**DESIGN FOR SINGLE REACTIONS :** Size comparison of mixed flow versus plug flow reactors; Multiple reactor systems- plug flow reactors in series, mixed flow reactors in series, reactors of different types in series.

**UNIT - IV** **L-9, T-3**

**DESIGN FOR PARALLEL REACTIONS :** Parallel reactions; Conversion; Selectivity; Yield; Contacting patterns for maximize the productivity of the desired product; Quantitative treatment of product distribution and reactor size.

**DESIGN FOR SERIES REACTIONS :** Optimizing the productivity of desired product- irreversible first order reactions in series, first order reaction followed by zero order reaction, zero order reaction followed by first order reaction conversion.

**UNIT - V** **L-9, T-3**

**RESIDENCE TIME DISTRIBUTION STUDIES :** Non idealities in ideal reactors; Importance of residence time distribution studies; Different input methods of tracer- E, F, C curves; RTD curves from experimental data; RTD curves for Ideal CSTR & PFR.

**CALCULATION OF CONVERSIONS :** RTD information; Macro fluid; Micro fluid; Tanks in series model; Axial dispersion model.

## TEXT BOOK:

1. Octave Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley & Sons, 2016.

## REFERENCE BOOKS:

1. Fogler H. S., “Elements of Chemical Reaction Engineering”, 3rd edition, PHS Publishers, 2014.
2. Simth J. M., “Chemical Engineering Kinetics’, 3rd edition, McGraw-Hill, 2014.

# 19CH213 MASS TRANSFER OPERATIONS-II

***Source:***
*http://www.hitekengineers.com/distillation-column.html*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 60 | - | - | 5 | 5 |

**PRE-REQUISITE COURSES :** Mass Transfer Operations-I

**COURSE DESCRIPTION AND OBJECTIVES:**

The course deals with mass transfer phenomena and its usage for engineering application. The general objectives of this course are to explain various separation mechanisms and fundamental concepts involved in separation operations such as distillation, extraction, leaching, adsorption and other modern separation techniques such as membrane separation and ion exchange. To educate the design aspects of various mass transfer operation equipment widely used in industry along with determination of number of equilibrium stages required for a desired separation.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Design several mass transfer equipment that encounters the specific prerequisites with approximate concern of economics, public health and safety. | 3 |
| 2 | Recognize and differentiate mass transfer process to analyze and interpret experimental and theoretical data along with their application in various process industries. | 3,4 |
| 3 | Apply and correlate their theoretical knowledge of mass transfer in multiphase contact processes to understand the impact of engineering solutions in environmental perspectives and society. | 1,7 |
| 4 | Conduct experiments in teams related to various mass transfer operations and design various prototype or pilot plant setup for mass transfer. | 4,9 |
| 5 | Interpret experimental data to estimate and deliver effectiveness. | 4,12 |

**SKILLS:**

- ✓ *Estimation of vapor liquid equilibrium data.*
- ✓ *Assessment of working condition of fractionating column with varying reflux ratio.*
- ✓ *Design specification and equilibrium stage calculation of distillation column.*
- ✓ *Model development of multistage co-current and counter current extractor.*
- ✓ *Design of adsorption and leaching equipments.*

**UNIT - I** **L-9**

**DISTILLATION I :** Introduction; Fields of application; VLE -miscible liquids, Immiscible liquids, VLE phase diagrams, tie lines, mixture rules; Flash vaporization; Differential distillation-binary, multi-component mixtures.

**UNIT - II** **L-9**

**DISTILLATION II :** Continuous fractionation of binary mixtures; McCabe -Thiele method & Ponchon – Savarit method - determination of no of ideal plates for binary mixtures, optimum reflux ratio, plate efficiencies, condenser and reboiler duties; Principles of azeotropic and extractive distillation.

**UNIT - III** **L-9**

**LIQUID-LIQUID EXTRACTION :** Fields of application of ternary liquid systems; Triangular and solvent free coordinate systems; Choice of solvent and selectivity; Extraction with insoluble and partially soluble systems; Single stage extraction; Multi-stage extraction; Cross and counter current extraction with reflux; Equipment for liquid – liquid extraction.

**UNIT - IV** **L-9**

**SOLID-LIQUID EXTRACTION :** Introduction; Fields of application; Preparation of solid for leaching;Types of leaching; Leaching equilibria; Constant under flow conditions; Equipment for leaching operation.

**MEMBRANE SEPARATION :** Introduction; Types of membranes; Principles and applications; Membrane characterization; Membrane module; Microfiltration; Ultrafiltration; Osmosis; Reverse osmosis; Nanofiltration.

**UNIT - V** **L-9**

**ADSORPTION AND ION-EXCHANGE :** Principles and applications; Types of adsorption; Use of adsorbents; Adsorption equilibria; Adsorption isotherms for vapor and dilute solutions; Break through curve; Fixed bed adsorber; Ion exchange; Isotherm and separation factors in ion exchange.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Verification of Rayleigh's equation using batch distillation.
2. Determination of steam distillation temperature, percentage recovery and vaporizing efficiency.
3. Estimation of capacity coefficient of packing in a packed bed distillation column under total reflux condition.
4. Determination of solubility characteristics of given ternary system.
5. Determination of VLE data for a binary mixture.
6. Determination of percentage adsorption of ternary system.
7. Estimation of number of equilibrium trays in distillation.
8. Estimation of NTU, HTU & height of packed column.
9. Adsorption studies on a binary mixture.
10. Leaching studies on a ternary mixture.
11. Plate column distillation- to study the performance of a rectification column.
12. Estimation of overall efficiency for a three-stage counter-current and cross current system.
13. Determination of the rate of distillation by steam distillation.
14. Estimation of the number of heat transfer units (HTU) & height equivalent to the theoretical plate (HETP) of the packed distillation column.
15. Study of adsorption of acetic acid on activated charcoal -To verify adsorption isotherms.

**TEXT BOOKS:**

1. Treybal R. E., "Mass Transfer Operations", 3rd edition, McGraw-Hill, 2005.
2. Binay. K. Dutta, "Principles of Mass Transfer and Separation Processes", 2nd edition, Prentice Hall of India, New Delhi, 2012.

**REFERENCE BOOKS:**

1. Christie J. Geankoplis., "Transport Processes and Separation Process Principles", 4th edition, Prentice Hall India Pvt. Ltd., 2003.
2. Judson King C., "Separation Processes", 2nd edition, McGraw-Hill, 2005.
3. Seader J. D., Henley E. J. and Keith Roper D., "Seperation Process Principles- Chemical and Biochemical Operations" 3rd edition, John Wiley & Sons, Inc, 2011.

# 19HS204 ENVIRONMENTAL STUDIES

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 1 | - | - | 1 |

Total Hours :

| L | T | P |
|---|---|---|
| 15 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 10 | 15 | 5 | - | - | 5 |


*Soource:*
*https://stock.adobe.com/uk/images/sustainable-development-logo*

**COURSE DESCRIPTION AND OBJECTIVES:**

This is a multidisciplinary course which deals with different aspects using a holistic approach. The major objective of the course is to plan appropriate strategies for addressing environmental issues. The course also brings awareness of nature and judicious use of natural resources for long term sustenance of life on this planet. The course also enables the students to understand their responsibility required to react effectively to natural, man-made and technological disasters.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Understand the importance of environment and natural resources. | 6,7 |
| 2 | Gain the concept on protection of biodiversity and maintain healthy environment. | 7,8 |
| 3 | Analyze the sources of pollutants and their effects on atmosphere. | 4,8 |
| 4 | Identify the evidence of global warming, ozone depletion and acid rain. | 7 |
| 5 | Develop a basic understanding of prevention, mitigation, preparedness, response and recovery. | 7,8 |

**SKILLS:**

- ✓ *Acquire fieldwork techniques to study, observe and prepare documents, charts, PPTs, Models etc.*
- ✓ *Understand how natural resources should be used judiciously, to protect biodiversity and maintain ecosystem.*

**ACTIVITIES:**

- *Painting contests on environmental issues and themes.*
- *Models of energy resources, Pollution and Solid Waste Management-3R strategy.*

**UNIT - I** **L-3**

**INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES :** Multidisciplinary nature of environmental studies- definition, scope and its importance; Concept of sustainability and sustainable development; Natural resources- deforestation, causes and impacts; Water resources- use and over exploitation of surface and ground water, conflicts over water; Heating of earth and circulation of air; Air mass formation and precipitation; Energy resources-renewable and non-renewable energy sources; Land resources- soil erosion and desertification.

**UNIT - II** **L-3**

**ECOSYSTEMS AND BIODIVERSITY**

**Ecosystem:** Structure and functions of an ecosystem; Energy flow- food chains, food webs and ecological succession; Forest; Grassland; Desert and aquatic ecosystems (ponds, rivers, lakes, streams, ocean, estuary).

**Biodiversity:** Genetic; Species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity; India as a mega diversity; Endangered and endemic species of India; Hotspots of biodiversity; Threats to biodiversity; Conservation of biodiversity.

**UNIT - III** **L-3**

**ENVIRONMENTAL POLLUTION**

**Pollution:** Air, Water, Soil, Chemical and Noise pollution; Nuclear hazards and human health risks; Solid waste Management - control measures of urban and industrial wastes; Pollution case studies.

**UNIT - IV** **L-3**

**ENVIRONMENTAL POLICIES AND PRACTICES:** Climate change, Global warming, Acid rain, Ozone layer depletion and impacts on human communities and agriculture; Environmental laws- Wildlife Protection Act, Water (pollution prevention and control) Act, Forest Conservation Act, Air (pollution prevention and control) Act, Environmental Protection Act; Tribal populations and rights; EIA - introduction, definition of EIA; EIS- scope and objectives.

**UNIT - V** **L-3**

**HUMAN COMMUNITIES AND THE ENVIRONMENT**

**Human population growth:** Impacts on environment; Human health and welfare; Resettlement and rehabilitation of project affected persons- case Studies; Disaster management- floods, earthquake, landslides and cyclones; Environmental communication and public awareness- case studies (C.N.G Vehicles in Delhi).

**Field work/Environmental Visit:** Visit to a local area to document environmental assets – river/ forest / grassland / hill /mountain; Visit to a local polluted site; Study of local environment - common plants, insects, birds; Study of simple ecosystems – pond, river, hill slopes; Visit to industries/water treatment plants/effluent treatment plants.

## TEXT BOOKS:


1. A. Kaushik and C. P. Kaushik, “Perspectives in Environmental Studies”, 5th edition, New Age International Publishers, 2016.
2. Y. Anjaneyulu, “Introduction to Environmental Science”, B. S. Publications, 2015.
3. B. Joseph, “Environmental Studies”, 2nd edition, Mc Graw Hill Education, 2015.
4. S. Subash Chandra, “Environmental Science”, New Central Book Agency, 2011.


## REFERENCE BOOKS:


1. Mahua Basu & S.Xavier, “Fundamentals of Environmental Studies”, Cambridge University Press, 2016.
2. K. Mukkanti, “A Textbook of Environmental Studies”, S. Chand Company Ltd., 2009.
3. M. Anji Reddy, “A Textbook of Environmental Science and Technology”, B. S. Publications, 2008.
4. K. Joseph and R. Nagendram, “Essentials of Environmental Studies”, Pearson Education Pvt. Ltd., 2007.
5. M. Chandrasekhar, “A Textbook of Environmental Studies”, Hi-tech Publications, 2006.
6. C. S. Rao, “Environmental Pollution Control Engineering”, New Age International Publishers, 2001.

# 19MS302 MANAGEMENT SCIENCE

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| - | - | - | - | 5 | 5 |


***SOURCE:***

*http://www.baffledbee.co.uk/uploads/1/5/3/2/15321380/functional-areasbetter_orig.png.*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course offers the framework for improving managerial skills and leadership qualities The objective of the course is to provide skills related to making decisions, organization structure, production operations, marketing, human resource management, product management and other management strategies.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Able to apply the concepts & principles of management in real life industry. | 1,9 |
| 2 | Able to demonstrate right type of leadership for achieving good results out of people. | 2,9 |
| 3 | Able to apply Work-study principles in real life industry. | 1,3 |
| 4 | Able to maintain Materials departments by using stores records, & Determine EOQ. | 1,5 |
| 5 | Able to identify Marketing Mix Strategies for an enterprise. | 1,12 |
| 6 | Able to apply the concepts of HRM in Recruitment, Selection, Training & Development, performance appraisal, promotions, transfers and separation. | 1,12 |

**SKILLS:**

- ✓ *Improve productivity and marketing through production, sales and time management techniques.*
- ✓ *Create better ambience in the shop floor using better Interpersonal relationship.*
- ✓ *Conduct / organize meetings, seminars and conferences in a professional manner.*
- ✓ *Effective management of human resources.*

**UNIT - I** **L-9**

**INTRODUCTION TO MANAGEMENT :** Concepts of management and organization; Nature; Importance and functions of management; Systems approach to management; Taylor's scientific management identify various theory; Fayol's principles of management; Mayo's Hawthorne experiments; Maslow's theory of human operational needs; Douglas McGregor's theory X and theory Y; Herzberg's two-factor theory of motivation, functions of management using case studies; Leadership styles; Social responsibilities of management.

**UNIT - II** **L-9**

**OPERATIONS MANAGEMENT :** Principles and types of plant layout; Methods of production (Job, batch and mass production); Work study; Basic procedure Involved In method study and work measurement.

**UNIT - III** **L-9**

**MATERIAL MANAGEMENT AND STATISTICAL QUALITY CONTROL :** Objectives- need for inventory control, EOQ, ABC analysis, purchase procedure; Stores management and stores records; Satistical quality control; Control charts for variables and attributes (simple problems); Acceptance sampling.

**UNIT - IV** **L-9**

**HUMAN RESOURCE MANAGEMENT :** Concept of HRM; Basic functions of HR manager; Manpower planning; Recruitment; Sources of recruitment; Selection, selection procedure; Training; Methods of training; Performance appraisal; Methods of performance appraisal; Promotion- types of promotion, basis for promotion; Transfer; Reasons for transfer; Separation; Grievance handling; Grievance handling procedure.

**UNIT - V** **L-9**

**MARKETING MANAGEMENT :** Evolution of marketing; Functions of marketing; Selling vs marketing; Product mix and product line; Product life cycle; Channels of distribution; Pricing; Objectives of pricing; Methods of pricing; Promotion tools; Advertising; Advertising process; Sales promotion; Personal selling; Direct marketing; Publicity; Public relations.

## TEXT BOOKS:

1. P. V. Kumar, N. A. Rao, and A . Chnalill, "Introduction to Management Science", Cengage Learnlng India, 2012.
2. A. R. Aryasri, "Management science", 4th edition, McGraw Hill Education , India, 2008.

## REFERENCE BOOK :

1. K. Philip Kotler and K. K. Lane, "Marketing Management" 12th edition, PHI, 2015.

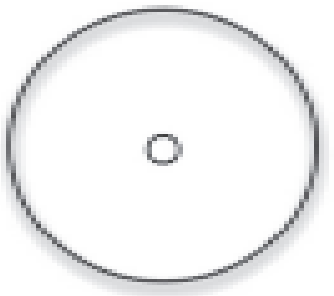
# 19PC009 INTRA-DISCIPLINARY PROJECTS-II

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| - | - | 2 | 1 |

Total Hours :

| L | T | P |
|---|---|---|
| - | - | 30 |



***Source:***

*https://www.google.com/search?q=3.+Intra-disciplinary+project+I&rlz=1C1GCEB_enIN833IN833&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi7h8GZ9qTjAhUjSo8KHVTwCigQ_AUIESgC&biw=1366&bih=625#imgrc=ZTT9dcMpa_wxIM:*

**COURSE DESCRIPTION AND OBJECTIVES:**

These projects arise from a combination of courses. The major objective of these projects is to enable students understand the relationship between the courses.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Ability to map different courses to gain the knowledge of intra-disciplinary Engineering. | 1 |
| 2 | Function effectively as an individual and as a member or leader in diverse teams. | 9 |
| 3 | Comprehend and write effective reports and make effective presentations. | 10 |

## LIST OF INTRA - DISCIPLINARY PROJECTS

- Hydrogenation of oil: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Ethylenedichloride: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Methanol: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Acetone Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Ethylene oxide: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Benzene: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Ethanol-amines: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)

- Production of Cumene: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Acetic anhydride: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Butanol: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Propanol: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Ethanol: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Phenol: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Acetic acid: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Butadiene: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Chloro methane: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Maleic anhydride: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Acrylonitrile: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Benzene: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Isoprene: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Vinyl chloride: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Ethylene glycol: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Styrene: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)
- Production of Hydrogen peroxide: Design of reactor and distillation column.
  (Chemical Reaction Engineering-I, Mass Transfer Operations-II)

**NOTE:** The afore - mentioned list is not exhaustive and the objective is to provide an idea of some of the projects that can be executed by students arising from a combination of courses. Students are given full flexibility to choose any projects of their choice under the supervision of faculty Mentors.

III

YEAR

# CHEMICAL ENGINEERING

## B.Tech.

**I SEMESTER**

| | | |
|---|---|---|
| 19CH301 | - | Pre-formulation Studies |
| 19CH302 | - | Chemical Reaction Engineering - II |
| 19CH303 | - | Instrumentation and Process Control |
| 19EL102 | - | Soft Skills Laboratory |
| 19PC010 | - | Empolyability Skills - I |
| 19HS301 | - | Human Values, Professional Ethics and Gender Equity |
| 19PC011 | - | Inter Departmental Projects - I |
| 19PC012 | - | Modular Course |
| | - | Department Elective - II |
| | - | Open Elective - II |

**II SEMESTER**

| | | |
|---|---|---|
| 19CH311 | - | Chemical Engg. Plant Design and Economics |
| 19CH312 | - | Industrial Pharmacy |
| 19CH313 | - | Safety in Chemical Industries - I |
| 19EL103 | - | Professional Communication Laboratory |
| 19PC013 | - | Empolyability Skills - II |
| 19PC014 | - | Inter Departmental Projects - II |
| | - | Department Elective - III |
| | - | Open Elective - III |

## COURSE CONTENTS

I SEM AND II SEM

# 19CH301 PRE-FORMULATION STUDIES

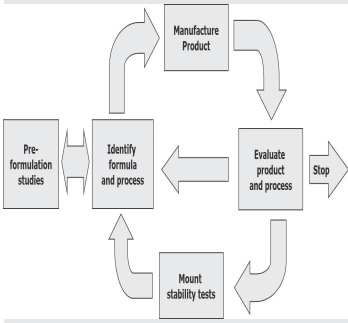
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |




***Source:***

*https://www.google.com/search?rlz=1C1GIWA_enIN770IN770&biw=1366&bih=608&tbm=isch&sa=1&ei=DMYqXaf0LdKUwgOtxaz4Cg&q=images+of+stability+testing+of+new+drug+substance+and+formulations&oq=images+of+stability+testing+of+new+drug+substance+and+formulations&gs_l=|img.3...872313.876381..877980...0.0..1.426.1602.0j10j4-1.....0....1j2..gws-wiz-img.....0j35i39j0i67.hAiNyRMWLAE#imgrc=S5vgDT256ul9xM:*

**COURSE DESCRIPTION AND OBJECTIVES:**

The main objective of this course deals with studies involved in the assessment of rate and extent of drug that reaches into systematic circulation and biopharmaceutical considerations in the development of dosage form. This course also deals with sources of quality variations, control of quality variations, and good manufacturing practices in the pharmaceutical industry along with pre-formulation studies towards new drug design.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Develop solutions to carry pre-formulation studies for the successful development of dosage form. | 3 |
| 2 | Identify and characterize the various factors influencing the absorption for the successful development of dosage form and able to evaluate drug release by dissolution studies. | 2 |
| 3 | Apply the knowledge of engineering fundamentals to the solution of bioavailability studies and methods for assessment of bioavailability. | 1,3 |
| 4 | Interpret experimental data to estimate and deliver effective conclusions which encourages to recognize the requirement to engage in independent and lifelong learning. | 4,12 |

**SKILLS:**

- ✓ Carry out the experiment towards drug solubility and absorption.
- ✓ Identyfy and analyze the factors and kinetics involved in drug absorption.
- ✓ Evaluate and design the drug transport mechanism.
- ✓ Analyze the stability testing of solid drugs, self life calculation.

**UNIT – I** **L-9**

**PREFORMULATION STUDIES**: Introduction to preformulation studies; Objectives of preformulation studies; Multidisciplanary development of a drug candidate; Principle areas of preformulation research; Essential information helpful in designing the preformulation; Evaluation of new drug.

**UNIT – II** **L-9**

**DRUG SOLUBILITY & ABSORPTION:** Solubility; Factors affecting on solubility; Methods for enhancement of solubility; Drug absorption; Significance in product; Formulation and development; Drug transport mechanisms; Factors and kinetics involved - physico-chemical and biological factors involved in drug absorptions; Formulation and dosage form considerations in drug absorption.

**DRUG DISSOLUTION:** Mechanisms; Factors and kinetics of dissolution; Dissolution rate; Significance; Methods for enhancement of dissolution rate; Evaluation - official methods.

**UNIT – III** **L-9**

**BIOAVAILABILITY :** Bioavailability; Concept; Definition; Objectives of bioavailability study; Measurement of bioavailability as per ICH guide lines.

**BIOEQUIVALENCE:** Concept; Definitions; Study designs for bioequivalence studies; Study protocol and analysis of data as per ICH Guide lines.

**UNIT – IV** **L-9**

**STABILITY TESTING:** Stability testing solid state drug stability; Dosage form stability; Accelerated stability testing; Shelf life calculations; Strategies for prolonging shelf life; Effect of packaging materials on dosage form stability; Basic principles of ICH; Stability testing of new drug substance and formulations.

**PHOTO STABILITY TESTING:** Photostability testing and oxidative stability; Role of containers in stability testing ICH stability guidelines.

**UNIT – V** **L-9**

**SPECIFICATIONS OF QA & QC:** Different test procedures and acceptance criteria for new drug substance and new drug products; Sources of quality variations; Control of quality variations; Statistical quality control.

**GOOD MANUFACTURING PRACTICES:** Layout of buildings; Services; Equipment and their maintenance; Material management; Handling and transportation; Inventory management and control; Production and planning control; Industrial and personal relationship; Safety and health in pharmaceutical industry.

# LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Determination of flow properties of given powder samples.
2. Determination of moisture content and particle size of given sample.
3. Study of effect of particle size on flow properties, dissolution and compatibility.
4. Determination of solubility and partition coefficient of given sample.
5. Determination of pKa of a drug using spectrophotometry or potentiometric titration.
6. Study of the effect of pH on solubility of drugs.
7. Study of the effect of surfactants to improve the solubility of drugs.
8. Accelerated stability study of a drug in solution dosage form.
9. Compatibility evaluation of drugs and excipients using spectrophotometry.
10. Comparision of dissolution of 3 different marketed brands of a drug.
11. Study of diffusion of drugs through various polymeric membranes.
12. Study of effect of pH on rheological properties of carbopol gel using Brookfield viscometer.
13. Dissolution of drugs in different pH media for comparision of test drug performance with innovator or reference product.
14. Evaluation of marketed aerosols using flame test, leakage test etc.
15. Designing of plant layouts for tablets, liquid orals and paren.

## TEXT BOOKS:


1. Libermann & Lachman, “Industrial pharmacy”, 4th edition.
2. M. E. Aulton, “Pharmaceuties The Science of Dosage Form Design”, 2nd edition.
3. D.M.Bramankar and Sunil B. Jaiswal, “BioPharmaceutics and Pharmacokinetics”, 3rd edition.


## REFERENCE BOOKS:


1. Remington’s, “The Science and Practice of Pharmacy, 21st edition”, Lippincott Williams & Wilkins, 2005.
2. Banker & Rhodes, “Modern pharmaceutics”, 12th edition.

# 19CH302 CHEMICAL REACTION ENGINEERING-II

***Source:***
*http://ecourseonline.iisc.ac.in/course/view.php?id=29*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

**PRE-REQUISITE COURSES :** Chemical Reaction Engineering-I & Mass Transfer Operations-I

**COURSE DESCRIPTION AND OBJECTIVES :**

This course encompasses methodologies to design chemical reactors and also to solve related problems in process industries. The objective of this course is to train the student to design of reactor for heterogeneous catalytic and non catalytic reactions.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Develop rate laws for fluid particle reactions. | 1 |
| 2 | Apply appropriate techniques for characterizing the heterogeneous catalyst. | 5 |
| 3 | Analyze and interpret the experimental data to estimate the kinetics of catalytic reactions. | 3 |
| 4 | Analyze the mass transfer effects in porous catalyst. | 3 |

**SKILLS:**

- ✓ How to model the fluid particle reactions.
- ✓ Determine the rate controlling step.
- ✓ Find the characteristics of catalyst.
- ✓ Know the importance of mass transfer effects.

**UNIT - I** **L-9**

**FLUID-PARTICLE REACTIONS AND KINETICS :** Rate equation; Fluid particle reactions; Selection of a model; Shrinking core model for spherical particles of unchanging size- diffusion through gas film controls, diffusion through ash layer controls, chemical reaction controls; Rate of reaction for shrinking spherical particles- diffusion through gas film controls, chemical reaction controls; Determination of rate controlling step.

**UNIT - II** **L-9**

**HETEROGENEOUS PROCESSES, CATALYSIS AND ADSORPTION :** Heterogeneous processes- global rates of reaction, types of heterogeneous reactions; Catalysis- the nature of catalytic reactions, the mechanism of catalytic reactions; Adsorption- physical adsorption and chemical adsorption, adsorption isotherms, rate of adsorption; Solid catalysis- determination of physical properties, surface area, void volume, solid density, pore volume distribution, classification of catalysts, catalyst preparation, promoters and inhibitors, catalyst deactivation.

**UNIT - III** **L-9**

**SOLID – CATALYZED REACTIONS :** The rate equation- adsorption, desorption, surface reaction; Rate equation in terms of fluid phase concentrations at the catalyst surface; Film resistance controls; Surface phenomenon controls; Qualitative analysis of rate equation; Qualitative predictions from active - site theory; Quantitative interpretation of kinetic data; Pore diffusion resistance importantance; Diffusion in single cylindrical pores; Diffusion in porous catalysts; Heat effects during reaction; Combination of resistances for isothermal particles; Experimental methods for finding rates; Comparison of experimental reactors; Determination of controlling resistances and the rate equation.

**UNIT - IV** **L-9**

**DEACTIVATION OF CATALYSTS :** Mechanisms of catalyst deactivation; Rate and performance equations- rate equation from experiment, batch solid-batch fluid, batch solid-mixed flow of fluid, batch solid- plug flow of fluid.

**UNIT - V** **L-9**

**FLUID- FLUID REACTIONS :** The rate equation; Kinetic regimes for mass transfer and reaction; Rate equations for- instantaneous fast, slow, intermediate and infinitely slow reactions; Hatta number and enhancement factor for first order reactions; Tower reactor design.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Kinetic studies in batch reactor with equimolar feed.
2. Kinetic studies in batch reactor with non equimolar feed.
3. Kinetic studies in flow reactors.
4. Estimation of activation energy and frequency factor.
5. Kinetic studies in adiabatic reactor.
6. RTD studies in tubular reactor.
7. RTD studies in continuous stirred tank reactor.
8. RTD Studies in combined reactor.
9. RTD studies in mixed flow reactors in series.
10. RTD studied in packed bed reactor.
11. RTD studies in fluidized bed reactor.
12. Kinetic studies of heterogeneous catalyst.
13. Kinetic studies of homogeneous catalyst.
14. Simulation of product distribution in series & parallel reactions.
15. Estimation of effect of mass transfer on reaction.

**TEXT BOOKS:**

1. Octave Levenspiel, “Chemical Reaction Engineering”, 3rd edition, JohnWiley & Sons, 2016.
2. Fogler H. S.,”Elements of Chemical Reaction Engineering”, 3rd edition, PHS Publishers, 2014.

**REFERENCE BOOK:**

1. Simth J. M.,”Chemical Engineering Kinetics’, 3rd edition, McGraw-Hill, 2014.

# 19CH303 INSTRUMENTATION AND PROCESS CONTROL

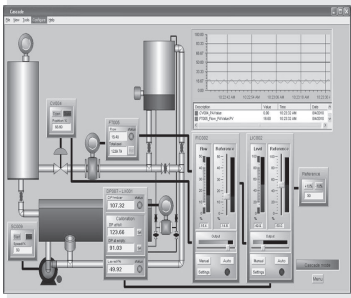
Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |



*Source:*
*https://www.google.com/search?safe=strict&rlz=1C1GIWA_enIN770IN770&biw=1366&bih=608&tbm=isch&sa=1&ei=-iUwXez2C87hz7sP1qKzAU&q=instrumentation+and+process+control&oq=instrumentation+and+proces&gs_l=img.1.1.0l3j0i24l7.10130.20527..22875...0.0..1.466.4129.0j25j4-1.....0....1..gws-wiz-img.....35i39j0i67._KzBDW0NjAU#imgrc=LPivk-Ie1G60GM:*

**COURSE DESCRIPTION AND OBJECTIVES :**

This course deals with fundamental concepts in process control and its industrial application. The objective of this course is to provide knowledge on various control mechanisms and strategies used in chemical process industries and to familiarize student with the working principles of standard measurement devices used in engineering applications.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Estimation of time constant of dynamic system. | 2 |
| 2 | Design of controller for any chemical process. | 3 |
| 3 | Developemnt of block diagram for any control system. | 3 |
| 4 | Estimate the concentration of a mixture. | 2 |

**SKILLS:**

- ✓ Solve ODE using laplace transforms.
- ✓ Analyze dynamic behavior of physical systems.
- ✓ Select and design a suitable controller for a given application.
- ✓ Flow measurement with different devices.
- ✓ Select a suitable measurement device for a given application.

**UNIT - I** **L-9**

**FIRST AND SECOND ORDER SYSTEM :** Laplace transforms; Initial value and final value theorem**;** Response of first order systems; Physical examples of first order systems; Response of first order systems in series; Second order systems and transportation lag.

**UNIT - II** **L-9**

**CONTROL SYSTEM :** Developement of block diagram; Controllers; Closed loop transfer functions; Transient response of control sytem to servo and regulatory problem; Offset.

**UNIT - III** **L-9**

**STABILITY CRITERIA :** Stability; Routh array; Root locus.

**FREQUENCY RESPONSE ANALYSIS :** Introduction to frequency response; Control systems design by frequency response; Bode diagrams.

**UNIT - IV** **L-9**

**QUALITIES OF MEASUREMENT & COMPOSITION ANALYSIS :** Elements of Instruments; Static and dynamic characteristics; Photoelectric and optical pyrometers; Spectroscopic analysis; Chromatography (GC, HPLC, GCMS/LCMS); Color measurement spectrometers.

**UNIT - V** **L-9**

**MEASUREMENT OF HEAD AND LEVEL :** Head, Density and specific gravity measurement; Direct measurement of liquid level; Pressure measurement in open vessels measurement of interface level; Open channel meters; Recording; Indicating and signaling Instruments; PI Diagrams; Control center.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS: 30**

1. Dynamics of 1st order systems [Thermometer].
2. Response of 2nd order system [Manometer].
3. Response of single tank system.
4. Response of non-interacting system for step input.
5. Response of interacting system for step input.
6. Response of interacting & non-interacting system for pulse input.
7. Calibration of RTD.
8. Calibration of thermocouple.
9. Level measurement using air purge method.
10. Determination of pressure by using dead weight pressure gauge.
11. Determination color measurement using spectrophotometer.
12. Composition analysis using HPLC.
13. Level control trainer.
14. Pressure control trainer.
15. Flow control trainer.
16. Temperature control trainer.
17. Composition measurement using gas chromatography.

### TEXT BOOKS:

1. Donald R. Coughanowr and Steven E. LeBlanc, “Process System Analysis and Control”, 3rd edition, McGraw-Hill, 2017.
2. Donald P. Eckman, “Industrial Instrumentation”, 1st edition, Wiley Eastern, 2004.

### REFERENCE BOOKS:

1. Norman Anderson, “Instrumentation for Process Measurement and Control”, 3rd edition, CRC Press, 1997.
2. W.Gaikwad, S.A.Misal “Process Dynamics and Control”,1st edition, Central Techno publications, 2004.

# 19EL102 SOFT SKILLS LABORATORY


*Source: https//5.imimg.com*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| - | - | 2 | 1 |

Total Hours :

| L | T | P |
|---|---|---|
| - | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | - | - | 20 | - | 2 |

**COURSE DESCRIPTION AND OBJECTIVES:**

To impart students employability skills like resume preparation and facing interviews. To enable trainees to develop interpersonal and leadership skills. To train them on work place skills like making presentations, participating in group discussions etc.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Ability to introspect on individual strengths and weaknesses, and emerge as a balanced personality with improved self-awareness and self-worth for their future. | 12 |
| 2 | Ability to prepare a resume and gain the confidence to communicate effectively. | 10 |
| 3 | Possess the interpersonal skills to conduct himself/herself effectively in everyday professional and social contexts. | 8 |
| 4 | Ability to adopt professionalism into daily activities. | 8 |
| 5 | Observe gender sensitive language and workplace etiquette in his professional life. | 8 |

**SKILLS:**

- ✓ *Balance social and emotional intelligence quotients though SWOC, JOHARI etc. activities.*
- ✓ *Prepare tailor made resume and face various job interviews with enriched personality traits.*
- ✓ *Plan personal and professional goals.*
- ✓ *Solve personal and professional life hiccups with confidence and maturity.*

**UNIT - I** **P - 6**

**SOFT SKILLS**: Need for soft skills; Professionalism; Employability skills; **Communication:** Need for effective communication - the process of communication, levels of communication, flow of communication, choice of diction and style with reference to setting (formal, semi-formal or informal) -communication networks, barriers to communication, miscommunication, noise and ways to overcome the barriers; **Career Planning**: Job vs. career, goal setting, SWOT analysis, planning and prioritization, time management- four quadrant system, self-management, stress-management.

**ACTIVITIES:** Johari Window for SWOT analysis; Setting a SMART goal using the provided grid; Writing a Statement of Purpose (SOP) - Stephen Covey's Time Management matrix.

**UNIT - II** **P - 6**

**VOCABULARY BUILDING:** Word etymology- roots, prefixes & suffixes, synonyms & antonyms, collocations, one-word substitutes, analogies, idioms and phrases, contextual guessing of unfamiliar words, task-oriented learning (50 words); **Functional English:** Situational dialogues; Role plays (including small talk); Self introduction, Opening and closing a telephonic conversation; Making an appointment; Making a query; Offering/Passing on information; Communicating with superiors; Expressing agreement/objection; Opening bank account (combination of prepared and impromptu situations given to each student); **Group Discussion:** Articulation and flow of oral presentation; Dynamics of group discussion; Intervention; Summarizing and conclusion; Voice modulation; Content generation; Key Word Approach (KWA); Social; Political; Economic; Legal and Technical Approach (SPELT); View Point of Affected Part (VAP); Language relevance; Fluency and coherence.

**ACTIVITIES:** Making a flash card (one per day by each student) – vocabulary exercises with hand-outs – vocabulary quiz - viewing a recorded video of GD & Mock sessions on different types of GD topics- controversial, knowledge, case study (including topics on current affairs).

**UNIT - III** **P - 6**

**RESUME PREPARATION:** Structure and presentation; Defining career objective; Projecting one's strengths and skill-sets, summarizing, formats and styles and covering letter.

**FACING INTERVIEWS:** Interview process; Understanding employer expectations; Pre-interview planning; Opening strategies; Impressive self-introduction, answering strategies, other critical aspects such as body language, grooming, other types of interviews such as stress-based interviews, tele- interviews, video interviews, frequently asked questions (FAQs) including behavioural and HR questions and the aspect looked at by corporate during interviews.

**ACTIVITIES:** Appraising some samples of good and bad resumes; Preparing the resume; Writing an effective covering letter- writing responses and practicing through role plays and mock interviews on the FAQs including feedback.

**UNIT - IV** **P - 6**

**READING COMPREHENSION:** Reading as a skill; Techniques for speed reading; Understanding the tone; Skimming and scanning; Appreciating stylistics; Impediments for speed reading; Eye fixation; Sub-vocalization, critical reading, reading based on purpose, reading for information, reading for inference; **Listening Comprehension:** Listening as a skill; Different types of listening; Active and passive listening; Top-down approach; Bottom-up approach; Understanding the non verbal cues of communication; Intonation and stress.

**ACTIVITIES:** Reading comprehension exercises with texts drawn from diverse subject areas (Hand-outs); Narration of a story; Speech excerpts with different accents (Indian, British, American); Listening comprehension exercises with audio and video excerpts.

**UNIT - V** **P - 6**

**PAPER PRESENTATION:** Selection of a topic; Preparing an abstract; Gathering information; Organizing the information; Drafting the paper; Citing reference sources – writing striking introductions, discussing the methodology used, developing the argument, presentation style, language, presenting the paper and spontaneously answering audience questions; **Mind your language:** How language reflects personality**;** Gender sensitive language in MNCs; **Seven essential skills:** For a team player; attentive listening, intelligent questioning, gently persuading, respecting other's views, assisting others, sharing, participating actively.

**ACTIVITIES:** Watching & discussing videos on corporate etiquette- presenting a paper, quiz on corporate etiquette.

## REFERENCE BOOKS:


1. Edward Holffman, "Ace the Corporate Personality", McGraw Hill, 2001.
2. Adrian Furnham, "Personality and Intelligence at work", Psychology Press, 2008.
3. John Adair Kegan Page, "Leadership for Innovation" 1st edition, Kogan, 2007.
4. Krishna Mohan & NP Singh, "Speaking English Effectively" 1st edition, Macmillan, 2008.
5. Dr. S.P. Dhanvel, "English and Soft Skills", Orient Blackswan, 2011.
6. Rajiv K. Mishra, "Personality Development", Rupa & Co. 2004.


**ACTIVITIES:**

- *Formal and Informal Communication*
- *SWOT Analysis*
- *Stephen Covey Time Management Matrix*
- *Stress Management Technique*
- *Vocabulary Flashcards*
- *Group Discussions*
- *Resume Preparation*
- *Mock-Interviews*
- *Reading Comprehension Activities*
- *Listening Comprehension Activity by Watching American Accent Video*

# 19HS301 HUMAN VALUES, PROFESSIONAL ETHICS & GENDER EQUITY


*Source: www.google.com*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 2 | - | - | 2 |

Total Hours :

| L | T | P |
|---|---|---|
| 30 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 6 | 6 | 7 | - | - | 10 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The course will provide students with an understanding on Engineering Ethics and the nature of moral issues and dilemmas faced by engineers in their professional lives. It will give them an awareness on professional rights and responsibilities of an engineer and acquaint them on the Code of Conduct and Ethics prescribed by professional bodies like IEEE, ASME, etc for its members.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Ability to engage in an informed critical reflection on the nature of professionalism and ethical challenges inherent in engineering profession. | 6, 7 8,9,12 |
| 2 | Apply awareness of professional rights and responsibilities of an engineer to conduct themselves ethically within an organization. | 6,7,8 9,12 |
| 3 | Apply understanding of safety norms to highlight ethical issues in risky situation. | 6,7,8 9,12 |
| 4 | Understand the role of professional bodies, and the code of ethics and industrial standards prescribed for engineers. | 6,7,8 9,12 |

**SKILLS:**

- ✓ *Safety & Environment consciousness.*
- ✓ *Ethical behaviour and decision-making at workplace.*
- ✓ *Ability to work in large teams.*
- ✓ *Emotional intelligence for workplace.*

**UNIT – I** **L-6**

**INTRODUCTION TO PROFESSIONAL ETHICS:** Morals, values and ethics; Civic virtue; Respect for others, Living peacefully; Caring; Sharing; Honesty; Valuing time; Co-operation; Commitment, Empathy; Self-confidence; Courage; Character; Spirituality; Service learning; Introduction to Engineering Ethics; Profession; Professionalism.

**UNIT – II** **L-6**

**NATURE OF MORAL ISSUES:** Moral dilemmas (Problem of vagueness, conflicting reasons & disagreement); Types of inquiry (Normative, conceptual & factual); Moral autonomy; Kohlberg's & Carol Gilligan's theory; Impediments to responsible action; Theories of right action (Bentham's Theory of Utilitarianism, Theory of Consequentialism etc.).

**UNIT – III** **L-6**

**ENGINEERING AS SOCIAL EXPERIMENTATION:** Engineers' responsibility for safety ; Assessment of safety and risk; Testing for safety; Risk benefit analysis; Reducing risk; Government regulator's approach to risk; A balanced outlook on law; Discussion of case studies: Challenger disaster / Chernobyl disaster; Code of ethics; Professional societies; Sample code of ethics like ASME, ASCE, IEEE etc.

**UNIT – IV** **L-6**

**RIGHTS AND RESPONSIBILITIES AT WORKPLACE:** Organizational complaint procedures; Whistle blowing; Environment and the workplace; Gender equity; Understanding gender; Organizational policies regarding gender; Gender roles; Looking beyond stereotypical generalizations; Service rules; Conflict of interest; Prevention of sexual harassment; Women rights under labour laws.

**UNIT – V** **L-6**

**ETHICS IN A GLOBAL CONTEXT:** Multinational Corporations; Intellectual Property Rights; Business ethics; Transparency & fair practices; Discussion of case study-Enron-Dhabol project; Environmental Ethics; Challenge of sustainable development; UN Conventions & protocols on environment; Discussion of case studies: Bhopal gas tragedy, Pacific gas & Electric company Vs. Environmental activist, Erin Brockovich; Computer ethics; Automation & artificial intelligence; Cyber security & Cyber laws; Case study; Wiki leaks; Role in technological development; Weapons development.

## TEXT BOOKS:

1. Martin Mike and Schinzinger Roland, "Introduction to Engineering Ethics", 2nd Edtion, McGraw-Hill Higher Education, 2010.
2. M. Govindarajan, S.Natarajan and V. S. Senthil Kumar, "Engineering Ethics", Prentice Hall of India, Reprint 2013.
3. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics: Concepts and Cases", 4th edition Wadsworth Thompson Learning, 2009.

## REFERENCE BOOKS:

1. Charles B. Fleddermann, "Engineering Ethics", 4th edition, Pearson Education/Prentice Hall, 2014.
2. Edmund G. Seebauer and Robert L. Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, 2008.
3. "A Comprehensive Guide to Women's Legal Rights"–Prepared by Majlis Legal Centre for IIT-Kanpur, 2018.

# 19PC011 INTER-DEPARTMENTAL PROJECTS-I

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| - | - | 4 | 2 |

Total Hours :

| L | T | P |
|---|---|---|
| - | - | 60 |

***Source:***

*https://www.google.com/search?q=3.+Inter-disciplinary+project+I&rlz=1C1GCEB_enIN833IN833&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi7h8GZ9qTjAhUjSo8KHVTwCigQAUIESgC&biw=1366&bih=625#imgrc=-dFL_VXrz5spXM:*

**COURSE DESCRIPTION AND OBJECTIVES:**

These projects are aimed at enabling students understand the relationship between the courses of various programs. Students will get an idea of how interesting technologies or processes, prototype or working model can be developed by culmination of technologies from courses of different programs.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Ability to map different courses to gain the knowledge of intra-disciplinary Engineering. | 1 |
| 2 | Function effectively as an individual and as a member or leader in diverse teams. | 9 |
| 3 | Comprehend and write effective reports and make effective presentations. | 10 |

## LIST OF INTER - DEPARTMENTAL PROJECTS-I

- Biorefineries and Value added chemicals from biomass.
  (Chemical engineering, Biotechnology)
- Durable and Regenerable Antimicrobial Textiles.
  (Chemical engineering, Biotechnology, Textile technology)
- Optimal Groundwater remediation.
  (Chemical engineering, Civil engineering)
- Enzymatic route to polyurethanes.
  (Chemical engineering, Biotechnology)
- Studies on plants extracts as corrosion inhibitor for metal in acidic environment.
  (Chemical engineering, Biotechnology)
- Assessment of cold chain for perishable commodities.
  (Chemical engineering, Food technology)
- Design of solid-state anaerobic digestion for methane production from food waste.

(Chemical engineering, Food technolgy)

- Profiling of cheddar cheese quality with time.
  (Chemical engineering, Food technology)
- Value addition of handloom cotton fabric through natural colour dyeing.

  (Chemical engineering, Textile technolgy)
- CFD analysis of drug injection.

  (Chemical engineering, Biotechnology)
- Fruit peels as efficient renewable adsorbents for removal of dissolved heavy metals and dyes from water.

  (Chemical engineering, Textile technolgy)
- Fruit and vegetable waste: their extraction and possible utilization.

  (Chemical engineering, Food technology)
- Extraction of colour from onion peel for dying the cloth material.

  (Chemical engineering, Textile technolgy)
- Removal of colour from textile dyeing effluent using temple waste flower (twf) as eco-friendly adsorbent.

  (Chemical engineering, Textile technolgy)
- Bioconversion of sugarcane biomass into ethanol as a source of fuel.

  (Chemical engineering, Food technology)
- Desulfurization of fuel oil by oxidation and extraction.

  (Chemical engineering, Petroleum engineering)
- Biocolours: a new generation additive for industries.

  (Chemical engineering, Textile technolgy)
- Ethanol production from potato peel waste.

  (Chemical engineering, Food technology)
- Utilization of banana fibre for making grease proof paper.

  (Chemical engineering, Food technology)
- Biodiesel production from waste cooking oil.

  (Chemical engineering, Food technology)
- Application of UV/solar photo-fenton oxidation process towards the decolourisation of textile dyeing waste water.

  (Chemical engineering, Textile technolgy)
- Defluoridation of fluoride laden drinking water using activated biochar of *colocasiaesculenta* stem. (Chemical engineering, Food technology)
- Application of honey as a natural milk preservative.

  (Chemical engineering, Food technology)

**NOTE:** The afore - mentioned list is not exhaustive and the objective is to provide an idea of some of the projects that can be executed by students arising from a combination of courses. Students are given full flexibility to choose any projects of their choice under the supervision of faculty Mentors.

# 19CH311 CHEMICAL ENGINEERING PLANT DESIGN AND ECONOMICS

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | - | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | 15 | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |


***Source:***

*https://www.google.com/search?safe=strict&rlz=1C1GIWA_enIN770IN770&biw=1366&bih=608&tbm=isch&sa=1&ei=4yswXd*

**COURSE DESCRIPTION AND OBJECTIVES :**

This course deals with fundamental concepts of process design and economics. The objective of this course is to familiarize the student with estimation of capital investments, interest, investment cost, taxes, insurance, depreciation, profitability and optimum design in chemical process industries.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Analyze projects using the methods of net present value, discounted cash flow and equivalent minimum investment period. | 2 |
| 2 | Design solutions for plant capital cost based on published data. | 3 |
| 3 | Apply the knowledge of taxation, depreciation and investment incentives on the economic viability of a project. | 1 |
| 4 | Apply appropriate techniques involved in optimum designing. | 5 |

**SKILLS:**

- ✓ *Analyze, synthesize and design processes for manufacturing products commercially.*
- ✓ *Use commercial flow sheeting software to simulate processes and design process equipment.*
- ✓ *Recognize economic, construction, safety, operability and other design constraints.*
- ✓ *Estimate fixed and working capitals and operating costs of process plants.*
- ✓ *Evaluate the profitability of process industries.*

**UNIT - I** **L-9, T-3**

**INTRODUCTION TO PROCESS DESIGN:** Introduction to process design development; Design project procedure; General design considerations; Health and safety hazards; HAZOP study; Environmental protection; Plant location; Plant layout; Cost and asset accounting; Project financing.

**UNIT - II** **L-9, T-3**

**ESTIMATION OF CAPITAL INVESTMENT:** Cash flow for industrial operations; Cumulative cash position; Factors affecting investment and production costs; Estimation of capital investments, Cost indexes; Cost factors in capital investment; Methods for estimating capital investment; Estimation of total product cost.

**UNIT - III** **L-9, T-3**

**INTEREST AND INVESTMENT COSTS:** Types of interest- simple interest, compound interest, nominal and effective interest rates, continuous interest; Present worth and discount; Annuities; Perpetuities and capitalized costs.

**UNIT - IV** **L-9, T-3**

**TAXES AND INSURANCE:** Types of taxes; Federal income taxes; Carry back and carry forward of losses; Taxes and depreciation; Types of insurance; Self insurance.

**DEPRECIATION:** Types of depreciation; Service life; Salvage value; Present Value; Methods for determining depreciation: Single unit and group depreciation.

**UNIT - V** **L-9, T-3**

**PROFITABILITY :** Profitability standards; Mathematical methods for profitability evaluation; Rate of return on investment; Discounted cash flow; Net present worth; Capitalized costs; Payout period; Alternative investments: Replacements.

## TEXT BOOKS :

1. Timmerhaus K. D. and Peters M. S., “Plant Design and Economics for Chemical Engineers”, 4th edition, McGraw-Hill, 2004.
2. Gavin Towler and Ray Sinnott, “Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design”, 2nd edition, Elsevier Science, 2012.

## REFERENCE BOOK :

1. Gavin Towler and Ray Sinnott, “Chemical Engineering Design”, 2nd edition, Butterworth-Heinemann, 2013.

# 19CH312 INDUSTRIAL PHARMACY

***Source:***
*https://www.google.com/search?q=industrial+pharmacy&safe=strict&rlz=1C1GIWA_enIN770IN770&source=lnms&tbm=isch&sa=X&ved=0ahUKEwj1stGkhb7jAhWLYH0KHTMBB8kQ_AUIEigC&biw=1366&bih=608#imgrc=meGF-z8y4mzARM:*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

**PRE-REQUISITE COURSES :** General Pharmacy

**COURSE DESCRIPTION AND OBJECTIVES :**

This course deals with formulation development of solid, liquid, biphasic, sterile, semisolid dosage forms, pharmaceutical aerosols and pilot plant scale-up techniques used in pharmaceutical manufacturing. The objectives of this course are to familiarize the students with drug delivery designs, drug dosage design, good manufacturing concepts, techniques and applications of production and operation management.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply and integrate basic pharmaceutical skills in pharmaceutical production process. | 2 |
| 2 | Expose to pharmaceutical pre formulation and product development. | 3 |
| 3 | Develop management skills pertaining to industrial pharmacy ethical and behavioural skills. | 9,11 |
| 4 | Use laboratory scale production equipments and communicate of laboratory results. | 2,4 |

**SKILLS:**

- ✓ *Use research and design for development and testing of new medicines and treatments, ensuring their safety and quality.*
- ✓ *Use the latest technologies, processes and methods to develop new medicines for patients.*
- ✓ *Evaluate product for supply to the market and confirming that it has been made and tested to the required quality standards in line with the registered methods and processes.*
- ✓ *Analyze formulation development, drug discovery, manufacturing and packaging or clinical trials.*

**UNIT – I** **L-9**

**FORMULATION AND DEVELOPMENT OF TABLETS:** Definition; Advantages; Disadvantages; Classification of tablets; Additives used in formulation; Granulation techniques; Formulation of various types of tablets; Equipment used in manufacturing; Advances in equipment; Materials and processes.

**TABLET COATING :** Types of coating techniques; Additives used for coating; Coating equipment; Advances in equipment; Materials and processes.

**UNIT – II** **L-9**

**FORMULATION AND DEVELOPMENT OF CAPSULES:** Definition; Advantages; Disadvantages; Hard gelatin capsules - formulation, additives used, equipment used, advances in ingredients and equipments used; Soft gelatin capsules - formulation, additives used, minim gram factor, base adsorption factor, equipment used and advances in ingredients and equipments used.

**UNIT – III** **L-9**

**FORMULATION AND DEVELOPMENT OF PARENTRALS:** Introduction; Classification; Sterilization methods; Additives; Solvents like water for injection used; Preservation measures; Pyrogenicity; Formulation; Equipment used; Advances in equipment; Materials and processes.

**BUFFERS AND ISOTONICITY**: Biological buffers; Isotonicity and its adjustment methods.

**UNIT – IV** **L-9**

**FORMULATION AND DEVELOPMENT OF PHARMACEUTICAL AEROSOLS:** Introduction; Study of propellants; Principles; Formulation; Manufacturing processes; Filling equipments for aerosols; Advances.

**METERED DOSE INHALERS:** Advances in equipment; Materials and processes used in aerosols.

**UNIT – V** **L-9**

**PILOT PLANT SCALE-UP TECHNIQUES :** Pilot plant - technology transfer from R&D to pilot plant to pilot scale considerations of steps involved with manufacture (design, facility, equipment selection) of tablets, capsules, suspensioins, emulsions and semisolids.

**SCALE- UP:** Importance; Scaleup process- size reduction, mixing, blending, granulation, compression, tablet coating, capsules filling & liquid-liquid mixing.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS-30**

1. Formulation of tablets by direct compression method.
2. Evaluation of tablets prepared by direct compression method.
3. Formulation of tablets by dry granulation method.
4. Evaluation of tablets prepared by dry granulation method.
5. Formulation of tablets by wet granulation method.
6. Evaluation of tablets prepared by wet granulation method.
7. Coating of prepared tablets [Film coating and enteric coating].
8. Selection of suitable capsule size and filling of hard gelatin capsule.
9. Preparation and evaluation of capsules.
10. Determination of base adsorption factor and minimum gram factor and base adsorption factor.
11. Large volume Parentrals [dextrose sodium chloride infusion], Small volume parentrals [Ascorbic acid injection, calcium gluconate injection].
12. Evaluation of parentrals [sterililty testing], Adjustment of tonicity of given parentral solutions.
13. Evaluation of glass containers using water attack test and powdered glass test.
14. Evaluation of plastic containers for extractable substances and water vapor permeability test.
15. Evaluation of rubber closures for fragmentation test and self seal ability test.

**TEXT BOOKS:**

1. Liberman & Lachman, The Theory and Practice of Industrial Pharmacy, CBS, 4th edition, 2013.
2. M. E. Aulton, “Pharmaceuties The Science of Dosage Form Design”, 2nd edition.

**REFERENCE BOOKS:**

1. Bio Pharmaceutics and Pharmacokinetics, D.M.Bramankars and Sunil B.Jaiswal.
2. Banker, Modern Pharmaceutics.
3. Remington’s Pharmaceutical Sciences.

# 19CH313 SAFETY IN CHEMICAL INDUSTRIES - I

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | - | 4 |

Total Hours :

| L | T | P |
|---|---|---|
| 45 | 15 | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | 5 | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with safety and hazard analysis of chemical and allied industries. The objectives of this course are to familiarize the students with safety principles, chemical hazards, health hazards, control of hazards in various process industries.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Design of various emergency response systems in chemical industries. | 3 |
| 2 | Analysis and interpretation of material safety data sheet and synthesis of the information to provide valid conclusions to address societal problems. | 4,6 |
| 3 | Apply appropriate techniques to hazards engineering control of plant instrumentation. | 5 |
| 4 | Design and develop solutions for handling operation and process hazards. | 3,12 |

**SKILLS :**

- ✓ *Analyze various emergency response systems for hazardous material.*
- ✓ *Recognize various chemical hazards.*
- ✓ *Estimate materials safety data.*
- ✓ *Compare various operations of hazardous safety.*

**UNIT - I** **L-9**

**INTRODUCTION :** Industrial safety principles; Site selection and plant layout; Legal aspects; Design for ventilation; Emergency response systems for hazardous goods; Basic rules and requirements which govern the chemical industries.

**UNIT - II** **L-9**

**HAZARDS :** Chemical hazards; Classification; Hazards due to fire; Explosion and radiation; Reduction of process hazards by plant condition monitoring; Materials safety data sheets; National fire protection agency's classifications.

**UNIT - III** **L-9**

**DISEASES :** Dangerous occupational diseases; Poisoning; Dust effect; Biomedical and engineering response to health hazards.

**UNIT - IV** **L-9**

**CONTROL OF HAZARDS :** Hazards engineering control of plants instrumentation; Colour codes for pipe lines; Safety aspects of reactive chemicals.

**UNIT - V** **L-9**

**OPERATION AND PROCESS HAZARDS** - Operation and process hazards; Safety in operations and processes; Runaway reactions; Unstable products.

## TEXT BOOKS:

1. H. H. Fawcett and W. S. Wood, "Safety and Accident Prevention in Chemical Operation", 2nd edition, Interscience, 1982.
2. "Loss Prevention and Safety Promotion in Chemical Process Industries Vol. III", Institution of Chemical Engineers U.K., 1983.
3. Daniel. A. Crowl, Joseph. F. Louvar, "Chemical process safety: Fundamentals with applications', 2nd edition, Prentice Hall, 2001.

## REFERENCE BOOKS:

1. Yoshida, T., "Safety of Reactive Chemicals, Vol. I", Elsevier, 1987.
2. Fawcett H. H, Wood W. S., "Safety and Accident Prevention in Chemical Operation", 2nd edition, Wiley Inter science, 1982.

# 19EL103 PROFESSIONAL COMMUNICATION LABORATORY

*Source: https:// encrypted*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| - | - | 2 | 1 |

Total Hours :

| L | T | P |
|---|---|---|
| - | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 15 | 10 | - | 10 | - | - |

**COURSE DESCRIPTION AND OBJECTIVES:**

To improve the overall communication skills (LSRW) of students and prepare them for their profession as engineers and managers. To provide them exposure to conventions of corporate communication and training them on how to function in the business world.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Ability to communicate effectively both in their academic as well as professional environment. | 10 |
| 2 | Clear grasp on the register of business language. | 8 |
| 3 | Possess the ability to write business reports and proposals clearly and precisely to succeed in their future. | 12 |
| 4 | Potentiality to make effective presentations and participate in formal meetings. | 10 |

**SKILLS:**

- ✓ *Articulate effective spoken and listening abilities needed for professional and social success in interpersonal situations, group interactions, and personal and professional presentations.*
- ✓ *Explore specific functions and vocabulary in a business context.*
- ✓ *Produce short business reports, proposals and correspondence.*
- ✓ *Write various business documents through reading techniques.*

**ACTIVITIES:**

- *Paraphrasing an article or a video in own words and finding topic sentence in newspaper articles*
- *Finding out new words from a professional view point and understanding the meaning and its usage*
- *Reviewing samples of well prepared proposals and reports*
- *Drafting different proposals / reports on assigned topics*
- *Classroom activities of team and individual presentations*
- *Finding missing appropriate sentence in the text*
- *Using vocabulary in context*

**UNIT - I** **P - 6**

**BUSINESS ENGLISH VOCABULARY:** Glossary of most commonly used words (formal and informal usage).

**ELEMENTS OF TECHNICAL WRITING:** Sentence structure; Reducing verbosity; Arranging ideas logically; Building coherence; Cohesive devices and transitional words.

**MECHANICS OF WRITING:** Stylistic elements; The purpose; The reader's viewpoint (audience); Elementary rules of grammar; Choice of diction; Elementary principles of composition; Matters of form; Punctuation; Conventions of business communication- language and professional tone, code of conduct (not sending illegal, offensive, disparaging personal remarks or comments) in written business communication.

**ACTIVITY:** Basic grammar practice; Framing paragraphs on topics allocated; Paraphrasing an article or a video; Finding topic sentences in newspaper articles; Finding out new words from a professional viewpoint and understanding the meaning and its usage.

**UNIT - II** **P - 6**

**BUSINESS CORRESPONDENCE:** E-mail- nature and scope, e-mail etiquette, clear call for action, common errors in composing e-mails; Office communication- such as meeting agenda and minutes of the meeting, notice, circular and memo.

**LETTER-WRITING**: Formal and informal letters- structure of formal letters, expressions of salutations, different types of letters [such as sales letter, complaint letter, response to the complaint letter (dispute resolution), letter of permission, letter of enquiry, claim letter – letter of apology], introductory and concluding paragraphs and clear call for action.

**PROFESSIONAL PROPOSAL/REPORT:** Differentiating proposals and reports; Drafting formal business proposals; Types of reports such as factual reports; Feasibility reports and survey reports; Parts of a report (such as title page, declaration, acknowledgements, table of contents, abstract, introduction, findings, conclusion and recommendations).

**ACTIVITY:** Perusing samples of well-prepared business emails, memo, letter writing and short proposals and reports, students will draft business correspondence writing tasks and different proposals/reports on topics assigned.

**UNIT - III** **P - 6**

**SPEAKING:** Speaking in business context; Assertiveness; Politeness; Making requests; Queries and questions; Negotiations; Asking for information; Offering suggestions; Conflict resolution; Contacting clients; Initiating; Addressing delegates (in public); Features of a good power-point presentation (making PPT), delivering the presentation effectively, telephone etiquettes, delivering seminar/proposal/report effectively, team meeting etiquettes (face to face and conference call), making effective one minute presentations.

**ACTIVITY:** Watching videos/listening to audios of business presentations; Classroom activities of team and individual presentations; Using PPTs; Mock exercises for BEC speaking; Presenting (speaking) the written components completed in UNIT I.

**UNIT - IV** **P - 6**

**READING:** Reading and comprehending business documents- learning business register, regularizing the habit of reading business news, suitable vocabulary, skimming and scanning text for effective and speedy reading and dealing with ideas from different sectors of corporate world in different business contexts.

**ACTIVITY:** Hand-outs; Matching the statements with texts; Finding missing appropriate sentence in the text from multiple choice; Using right vocabulary as per the given context and editing a paragraph.

**UNIT - V** **P - 6**

**LISTENING:** Specific information in business context- listening to telephonic conversations/messages and understanding the intended meaning, understanding the questions asked in interviews or in professional settings, summarizing speaker's opinion or suggestion.

**ACTIVITY:** Working out BEC/TOEFL/IELTS listening exercises with hand-outs; Matching the statements with texts; Finding missing appropriate sentence in the text from multiple choices- using right vocabulary in context-editing a paragraph, listening to a long conversation such as an interview and answer MCQs based on listening.

## REFERENCE BOOKS:


1. Guy Brook Hart, "Cambridge English Business Bench Mark: Upper Intermediate", 2nd edition, CUP, 2014.
2. CUP, Cambridge: BEC VANTAGE Practice Papers, CUP, 2002.
3. Schnurr, "Exploring Professional Communication: Language in Action". London: Routledge, S 2013.
4. Seely John, " The Oxford Guide to Effective Writing and Speaking". Oxford: OUP, 2005.

# 19PC014 INTER-DEPARTMENTAL PROJECTS-II

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| - | - | 4 | 2 |

Total Hours :

| L | T | P |
|---|---|---|
| - | - | 60 |

***Source:***

*https://www.google.com/search?q=3.+Inter-disciplinary+project+I&rlz=1C1GCEB_enIN833IN833&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi7h8GZ9qTjAhUjSo8KHVTwCigQAUIESgC&biw=1366&bih=625#imgrc=-dFL_VXrz5spXM:*

**COURSE DESCRIPTION AND OBJECTIVES:**

These projects are aimed at enabling students understand the relationship between the courses of various programs. Students will get an idea of how interesting technologies or processes, prototype or working model can be developed by culmination of technologies from courses of different programs.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Ability to map different courses to gain the knowledge of intra-disciplinary Engineering. | 1 |
| 2 | Function effectively as an individual and as a member or leader in diverse teams. | 9 |
| 3 | Comprehend and write effective reports and make effective presentations. | 10 |

## LIST OF INTER - DEPARTMENTAL PROJECTS-II

- Recycling of water from textile industry effluents and its utilization as agricultural water source. (Chemical engineering, Textile technolgy, Food technology)
- Extraction of d-limonene from sweet orange peels.

  (Chemical engineering, Food technology)
- Preparation of Ionic Liquids.

  (Chemical engineering, Chemistry)
- Production of bio diesel from foods (food wastes).

  (Chemical engineering, Food technology)
- Developing a Green Tea Based Natural Energy Drink.

  (Chemical engineering, Food technology)

- Glucose production process from rice husk by solid state mermentation method.
  (Chemical engineering, Food technology)
- Recovery of value added products from rice husk ash to explore an economic way for recycle and reuse of agricultural waste.
  (Chemical engineering, Food technology)
- Study the presence of oxalate Ion content In guava fruit at different atages of ripening.
  (Food technology and Biotechnology)
- Development of bakery products with high dietary fiber content.
  (Chemical engineering, Food technology)
- Study the presence of insecticides or pesticides (nitrogen containing) in various fruits and vegetables.
  (Chemical engineering, Food technology)

**NOTE:** The afore - mentioned list is not exhaustive and the objective is to provide an idea of some of the projects that can be executed by students arising from a combination of courses. Students are given full flexibility to choose any projects of their choice under the supervision of faculty Mentors.

IV

YEAR

# CHEMICAL ENGINEERING

## B.Tech.

**I SEMESTER**

| | | |
|---|---|---|
| 19CH401 | - | Quality Control of Pharmaceutical dosage forms |
| 19CH402 | - | Safety in Chemical Industries - II |
| 19CH403 | - | Industrial Process Technologies - I |
| 19CH404 | - | Industrial Process Technologies - II |
| 19PC015 | - | Societal Centric and Industry Related Project |
| | - | Department Elective - IV |

**II SEMESTER**

| | | |
|---|---|---|
| 19PC016 | - | Internship / Project Work (Industry Oriented Projects) |

## COURSE CONTENTS

I SEM AND II SEM

# 19CH401 QUALITY CONTROL OF PHARMA-CEUTICAL DOSAGE FORMS

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |


***Source:***

*https://www.google.com/imgres?imgurl=https%3A%2F%2Fi1.wp.com%2Fwww.pharmapproach.com*

**COURSE DESCRIPTION AND OBJECTIVES:**

The main objective of this course imparts the analysis of tablets and capsules as per official compendium. This course also deals with analysis of solutions, suspensions and emulsions as per official compendium. This course also deals with the packaging materials and labelling of different pharmaceutical products.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Identify the need, procedure for assessing the quality of tablets and capsules. | 2 |
| 2 | Develop solutions for control test of suspensions and emulsions. | 3 |
| 3 | Formulate the procedure for performing the quality control tests for sterile products. | 2 |
| 4 | Apply appropriate techniques to evaluate the quality of suppositories, pessaries and oral controlled release dosage forms. | 5 |

**SKILLS:**

- ✓ *Quality control test of tablets and capsule.*
- ✓ *Quality control test of mono phasic and biphasic solutions.*
- ✓ *Quality control test of eye, ear and nasal drops.*
- ✓ *Quality control test of semisolids like ointments, creams.*
- ✓ *Quality test on packaging and labelling of pharmaceutical products.*

**UNIT - I** **L-9**

**TABLETS :** Processing problems of tablets & suitable remedies; Quality control tests for various types of tablets as per IP.

**CAPSULES :** Quality control tests for hard and soft gelatin capsules as per IP.

**ORAL CONTROLLED RELEASE DOSAGE FORMS :** Quality control tests as per IP.

**UNIT - II** **L-9**

**MONO PHASIC LIQUIDS :** Quality control tests for various types of solution and elixirs as per IP.

**BI PHASIC LIQUIDS :** Quality control tests for suspensions and emulsions as per IP.

**UNIT - III** **L-9**

**PARENTRALS :** Plant layout for parentrals; Aseptic area maintenance; Quality control tests for parenteral preparations as per IP.

**OPTHALMIC PREPARATIONS :** Quality control tests for Eye; Ear and nasal drops as per IP.

**UNIT - IV** **L-9**

**SEMISOLID PREPARATIONS :** Quality control tests for ointments; Creams; Pastes; Jellies; Suppositories and pessaries as per IP.

**AEROSOLS :** Quality control tests for aerosols as per IP.

**UNIT - V** **L-9**

**PACKAGING AND LABELLING OF PHARMACEUTICALS :** Desirable features of containers and closures; Materials used for packaging (Glass, Plastic for containers and Rubber for closures); Labelling requirements; Quality control tests for packaging materials as per IP.

## TEXT BOOKS:

1. Y. Anjaneyulu and R.Marayya, “Quality Assurance and Quality Management in Pharmaceutical Industry”, 1st edition, Pharma book Syndicate Publishers, 2005.
2. P.D. Sthi, “Quantitative Analysis of Drugs in Pharmaceutical Formulations”, 3rd edition, CBS Publishers and distributors, 2015.
3. Libermann & Lachman, “Indian Pharmacopoeia”, Vol. 1, 2 & 3.

## REFERENCE BOOKS:

1. Remington’s, “The Science and Practice of Pharmacy,” 21st edition, Lippincott Williams & Wilkins, 2005.
2. Banker & Rhodes, “Modern pharmaceutics”, 4th edition, CRC Press, 2002.

# 19CH402 SAFETY IN CHEMICAL INDUSTRIES-II

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | 5 | - | 5 | 5 |


***Source:***

*https://www.google.com/imgres?imgurl=https%3A%2F%2Fcomps.canstockphoto.com%2Fsafety-industrial-gear-kit-and-tools-set-clip-art-*

**COURSE DESCRIPTION AND OBJECTIVES:**

The aim of the course is to enable students to recognise, analyse and where possible quantify, by core engineering knowledge and numerical methods, the sound conditions and limits of design and operation that will ensure the integrity and continuation of production of process plant, without unacceptable impact on its environment.

**COURSE OUTCOMES:**

Upon completion of the course,the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the fundamentals of chemical engineering for designing pressure systems. | 1,3 |
| 2 | Develop innovative solutions for industrial problems. | 3 |
| 3 | Formulate the Problems in commissioning and maintenance stages. | 2 |
| 4 | Design of emergency components for chemical industry problems. | 3 |

**SKILLS:**

- ✓ Inspection of chemical process industries.
- ✓ Operational procedure of chemical plants.
- ✓ Identify processing equipments.
- ✓ Storage of chemicals.
- ✓ Fire prevention and protection.

**UNIT - I** **L-9**

**SAFETY IN PRESSURE SYSTEM DESIGN :** Standards and codes- pipe works and valves, heat exchangers, process machinery, over pressure protection; Pressure relief devices and design; Fire relief; Vacuum and thermal relief; Special situations; Disposal- flare and vent systems; failures in pressure system.

**UNIT - II** **L-9**

**PLANT COMMISSIONING AND INSPECTION :** Commissioning phases and organization; Pre-commissioning documents; Process commissioning; Commissioning problems; Post commissioning documentation; Plant inspection; Pressure vessel; Pressure piping system; Non destructive testing; Pressure testing; Leak testing and monitoring; Plant monitoring; Performance monitoring.

**UNIT - III** **L-9**

**PLANT OPERATIONS :** Operating discipline; Operating procedure and inspection; Format; Emergency procedures; Hand over and permit syste; Start up and shut down operation; Refinery units- operation of -fired heaters, driers; Storage- operating activities and hazards, trip systems, exposure of personnel.

**UNIT - IV** **L-9**

**PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING :** Management of maintenance; Hazards- preparation for maintenance; Isolation; Purging; Cleaning; Confined spaces; Permit system-maintenance equipment, hot works, tank cleaning- repair and demolition, online repairs, maintenance of protective devices, modification of plant; Emergency planning; Disaster planning; Onsite emergency; Offsite emergency.

**UNIT - V** **L-9**

**STORAGES :** General consideration; Petroleum product storages; Storage tanks and vessel- storages layout segregation, separating distance, secondary containment; Venting and relief- atmospheric vent, pressure, vacuum valves, flame arrestors; Fire relief- fire prevention and protection- LPG storages, pressure storages.

## TEXT BOOKS :

1. "Accident Prevention Manual for Industrial Operations", 8th edition, National Safety Council, Chicago, 1980.
2. "Quantitative Risk Assessment in Chemical Process Industries" American Institute of Chemical Industries, Centre for Chemical Process safety.
3. Carbide of Calcium Rules, Government of India, 1987.

## REFERENCE BOOKS:

1. Howard. H. Fawcett and William S. Wood, "Safety and Accident Prevention in Chemical Operations" , 2nd edition, 1982.
2. GREEN, A.E., "High Risk Safety Technology", 2nd edition, Wiley-Interscience publication, 1982.
3. Frank Lees, "Lees' Loss Prevention in Process Industries-Hazard Identification, Assessment and Control," 4th edition, Butterworth-Heinemann, 2012.

# 19CH403 INDUSTRIAL PROCESS TECHNOLOGIES- I

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | - | 4 |

| L | T | P |
|---|---|---|
| 45 | 15 | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

***Scource:***

*https://niagaracanada.com/welland-attracts-almost-1-5-million-sq-ft-of-new-industrial-development/*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course helps the students to understand the various processes involved in chemical industries for the production of inorganic chemicals. The objective of this course is to (I) provide the essential features of chemical process industries, which will enable the students to understand the engineering principles associated in industrial processes, (II) develop an ability to read and abstract the process flow diagrams, (III) impart the knowledge on the importance of various unit processes and unit operations involved in industrial processes.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the knowledge of processing of basic petrochemicals to solve industrial problems. | 1 |
| 2 | Analyze the processes for producing third generation petrochemicals. | 2 |
| 3 | Apply appropriate techniques for characterization of polymers . | 5 |
| 4 | Interpret the production processes of fibres. | 4 |

**SKILLS:**

- ✓ *Draw process flow sheet of petrochemical industries.*
- ✓ *Constructing standardized flow sheet for new product development.*
- ✓ *Identify processing equipments in a process flow sheet.*
- ✓ *Identify the methods of production of petrochemicals.*

**UNIT - I** **L-9, T-3**

**CHEMICALS FROM $C_1$ COMPOUNDS :** Introduction; Definition of petrochemicals; Petrochemical industry characteristics; Production of methanol; Formaldehyde; Chloromethanes; Trichloroethylene; Perchloroethylene.

**UNIT - II** **L-9, T-3**

**CHEMICALS FROM $C_2$ COMPOUNDS :** Introduction; Manufacture of ethylene and acetylene; Production of ethylene dichloride; Vinyl chloride; Ethylene oxide, Ethanolamines; Vinyl acetate; Acetaldehyde.

**UNIT - III** **L-9, T-3**

**CHEMICALS FROM $C_3$ COMPOUNDS :** Sources of propylene; Manufacture of propylene; Manufacture of isopropyl benzene; Production of acrylonitrile; Isoprene; Propyle oxide; Oxo process.

**UNIT - IV** **L-9, T-3**

**CHEMICALS FROM $C_4$ COMPOUNDS :** Properties of butadiene and methods of production; Manufacture of phenol; Styrene production; Phthalic anhydride production; Production of TPA and DMT.

**UNIT - V** **L-9, T-3**

**POLYMERIZATION INDUSTRIES :** Classification of polymer applications; Types of industrial polymerization process; Production of PVC; Polymerization reactions; Production of poly ethylene.

## TEXT BOOK:

1. M.Gopal Rao and M. Sittig, “Dryden’s outlines of Chemical Technology”, 2nd edition, East west press, 2000.

## REFERENCE BOOKS:

1. Shreves J., “Chemical Process Industries”, 5th edition, McGraw-Hill,1999.
2. I. D. Mall, “Petrochemical Process Technology”, 1st edition, Macmillan India Ltd., 2007.

# 19CH404 INDUSTRIAL PROCESS TECHNOLOGIES- II

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | 2 | 4 |

| L | T | P |
|---|---|---|
| 45 | - | 30 |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

***Scource:***
*https://www.google.com/imgres?imgurl=https%3A%2F%2Fwww.sumitomo-chem.co.*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course helps the students to understand the various processes involved in petrochemical industries for the production of petrochemicals the objective is course is to provide the essential features of petrochemical process industries, which will enable the students to understand the engineering principles associated in petrochemical industry processes.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the knowledge of engineering fundamentals for manufacturing various products. | 1 |
| 2 | Develop solutions to solve various problems of chemical industries. | 3 |
| 3 | Apply appropriate techniques for new product development. | 5 |
| 4 | Identify appropriate method for manufacturing a given chemical product. | 2 |

**SKILLS:**

- ✓ *Draw process flow sheet of chemical process industries.*
- ✓ *Constructing standardized flow sheet for new product development.*
- ✓ *Identify the processing equipments in a process flow sheet.*
- ✓ *Identify the methods for production of chemicals.*
- ✓ *Identify the major engineering problems in chemical industries.*

**UNIT - I** **L-9**

**FERTILIZER INDUSTRIES :** Introduction; Ammonia production; Nitric acid production, Urea production; Ammonium phosphates and nitrophosphates; Major engineering problems faced by the fertilizer industry.

**UNIT - II** **L-9**

**SULFUR, SULFURIC ACID INDUSTRIES :** Introduction; Chemical industries-facts and figures; Sources of sulphur; Methods of sulphur production; Properties of sulphuric acid; Methods of sulphuric acid production; Producer gas and methods of production; Water gas and methods of production; Coke oven gas and natural gas production.

**UNIT - III** **L-9**

**CHLOR-ALKALI INDUSTRIES :** Manufacture of soda ash; Chlorine and caustic soda; Unit operations and chemical conversions; Calcium hypochlorite; Sodium hypochlorite and sodium chlorite.

**UNIT - IV** **L-9**

**CEMENT INDUSTRIES :** Types of cements; Manufacture of cement; Portland cement; Lime; Gypsum; Miscellaneous calcium compounds; Miscellaneous magnesium compounds.

**UNIT - V** **L-9**

**SOAP AND PAPER INDUSTRIES :** Production and extraction of vegetable oils; Production of soaps; Manufacture of detergents; Methods of pulping; Production of sulphate and sulphite pulp; Production of paper.

## LABORATORY EXPERIMENTS

**LIST OF EXPERIMENTS** **TOTAL HOURS-30**

1. Estimation of Glucose.
2. Estimation of Sucrose.
3. Estimation of Iodine value of Oil.
4. Estimation of Saponification value of Oil.
5. Estimation of Acid value of Oil.
6. Preparation of Acetanilide.
7. Preparation of Aspirin (Acetyl Salicylic Acid).
8. Preparation of Azo dye (Phenyl Azo-2-Naphthol).
9. Preparation of Nitrobenzene from Benzene.
10. Preparation of M-Dinitro Benzene from Nitro Benzene.
11. Preparation of Urea Formaldehyde Resin.
12. Preparation of Phenol Formaldehyde Resin.
13. Preparation of Soap.
14. Preparation of Ammonium Phosphate Fertilizer.
15. Isolation of Casein from Milk.
16. Preparation of Potash Alum.
17. Preparation of Ammonium Phosphate Fertilizer.
18. Field visit.

### TEXT BOOK:

1. M. Gopal Rao and M. Sittig, “Dryden’s Outlines of Chemical Technology”, 2nd edition, East west press, 2000.

### REFERENCE BOOKS:

1. Shreves. J., “Chemical Process Industries”, 5th edition, McGraw-Hill,1999.
2. I. D. Mall, “Petrochemical Process Technology”, 1st edition, Macmillan India Ltd., 2007.

# 19PC015 SOCIETAL-CENTRIC AND INDUSTRY RELATED PROJECTS

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| - | - | 6 | 3 |

Total Hours :

| L | T | P |
|---|---|---|
| - | - | 90 |


***Source:***

*https://www.google.com/search?q=8.+Socio-centric+and+Industry+related&rlz=1C1GCEB_enIN833IN833&source=lnms&tbm=isch&sa=X&=0ahUKEwiKyvfr96TjAhVKs48KHS2AAEsQ_AUIECgB&biw=1366&bih=625#imgrc=YwHIE84GREENVM:*

**COURSE DESCRIPTION AND OBJECTIVES:**

The major objective of the societal-centric projects is to connect students to society through their technical knowledge. The prerequisite to start the project is to submit a report pertaining to the Societal-centric or industry related problem in the preceeding semester.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Study the problems which are related to the society in their production / occupational activities. | 2 |
| 2 | Work on technology applications which can either solve the problems or make the activities less stenuous. | 3 |
| 3 | Design an implement or process to achieve the second outcome. | 4 |

## LIST OF SOCIETAL-CENTRIC AND INDUSTRY RELATED PROJECTS

- Paper pulp from groundnut shell.
- Utilization of waste plastic in asphalting of road.
- Extraction of caffeine from waste tea leaves.
- Production of bio-diesel from waste oil.
- Alcohol production from potato peel waste.
- Utilization of banana fibre for making wrapping paper.
- Utilization of banana fibre for making wrapping paper.
- High-purity nano silica powder from rice husk using a simple chemical method.
- Power alcohol from agricultural wastes.

- Production of charcoal using agriculture waste in rural areas.
- Defluoridation of water and household application .
- Preparation of porous carbons from plastic waste.
- Design and fabrication of low cost solar water heater.
- A study on Pyrolysis of plasti wastefor product recovery.
- Pyrolysis of tender coconut shells.
- Biogas production from food waste.
- Gasifiaction of agricultural residue.
- Removal of dyes from effluent using activated carbon.
- Recycling industrial waste for production of bioethanol.
- Anerobic digestion of solid waste.
- Production of hydrogen from municipal waste water.
- Conversion of waste polythene bags/wrappers to useful products.
- Catalytic and non catalytic thermolysis of waste polystyrene for recovery of fuel grade products.
- Utilization of rice husk ash for de-fluoridation of water.
- Adsorption of dyes from aqueous solution using egg shell powder.
- Hydrothermal carbonization.
- Production of biodesiel from cultivated microalgae.
- Recovery of valuable metals from e waste.
- Production of charcoal clay briquettes for environmental friendly cooking in rural areas.
- Preparation of moringa powder.
- Crystalliation of mentha oil.
- Extraction of valuable products from banana stem.

DEPT. ELECTIVES AND ONLINE COURSESE

**B.Tech.**

# CHEMICAL ENGINEERING

**ELECTIVE -I**

- 19CH231 - Material Technology
- 19CH232 - Industrial Effluent Treatment Methods
- 19CH233 - Energy Management and Auditing
- 19CH234 - Mineral Process Technology
- 19CH235 - Polymer Science and Engineering
- 19CH236 - Petro Chemicals
- 19CH237 - Fudamentals of Biotechnology

**ELECTIVE -II**

- 19CH331 - Process Modelling and Simulation
- 19CH332 - Solid Waste Management and Treatment
- 19CH333 - Petroleum Refinery Engineering
- 19CH334 - Colloidal and Interfacial Science
- 19CH335 - Fundamentals of Nanotechnoogy
- 19CH336 - Membrane Technology
- 19CH337 - Bio Process Engineering

**ELECTIVE -III**

- 19CH338 - Transport Phenomena
- 19CH339 - Energy Conservation and Waste Heat Recovery
- 19CH340 - Non Conventional Energy Sources
- 19CH341 - Computational Fluid Dynamics
- 19CH342 - Introduction to Matlab Programming

**ELECTIVE -IV**

- 19CH431 - Design and Analysis of Experiments
- 19CH432 - Matlab Programming for Numerical Computation
- 19CH433 - Optimization in Chemical Engineering
- 19CH434 - Chemical Process Equipment Design
- 19CH435 - Environmental Regulations and Impact Analysis

## COURSE CONTENTS

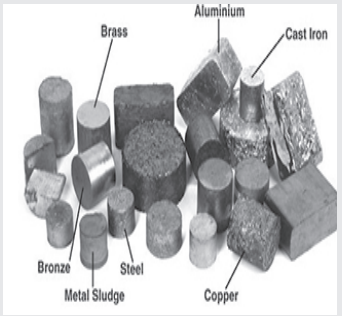
# 19CH231 MATERIAL TECHNOLOGY

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 40 | - | - | 5 | 5 |




***Source:***
*https://www.google.co.in/search?q=metals+and+alloys+images*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course will emphasize the structure-property relationships of engineering materials. The objective of this course is to provide knowledge in basic principles of material science and also to study structure of materials at all length scales.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply heat treatment processes to change structure of materials. | 1 |
| 2 | Analyze structure and properties of ceramic and composite materials. | 2 |
| 3 | Design various coatings for materials to avoid corrosion. | 3 |
| 4 | Create new composite or nano or ceramic material. | 3 |

**SKILLS:**

- ✓ *Identify the type of material: ceramic ,polymer, metal or composite.*
- ✓ *Select materials with suitable properties for a given application.*
- ✓ *Predict the type of fracture/failure in a material.*
- ✓ *Read and draw conclusion from binary phase diagrams.*
- ✓ *Suggest manufacturing methods for metals, ceramics and polymeric materials.*
- ✓ *Determine basic mechanical properties of materials using universal testing machine.*

**UNIT - I** **L-9**

**ENGINEERING MATERIALS :** Classification; Levels of structure; Properties (Mechanical, thermal, electrical, and magnetic properties); Structure - property relationship; Structure of solids; Crystalline and non crystalline state; Inorganic solids; Crystal Imperfections (point defects, line defects and surface imperfections, grain boundaries).

**UNIT - II** **L-9**

**METALS AND ALLOYS:** Elastic and plastic deformations; Re-crystallization; Cold and hot working; Creep; Fatigue and fracture; Phase diagrams and their applications; Phase rule; Completely soluble, Partially soluble; Insoluble in solid phase; Peritectic phase diagrams; Iron - Iron carbide phase diagram.

**HEAT TREATMENT PROCESSES :** Annealing; Quenching; Tempering; Age hardening.

**UNIT – III** **L-9**

**CERAMIC PHASES AND THEIR PROPERTIES :** Structure of ceramics; Mechanical and electrical properties; Abrasives; Silicon carbide; Various silicates; Structure of quartz and uses; Piezo and Ferroelectric material - $BaTiO_3$; Composite materials- fiber, particle and plastic reinforced composites, whiskers; Porosity; Bulk characteristics; Agglomerated materials; Concrete; Asphalt and asphalt mixtures.

**UNIT - IV** **L-9**

**CORROSION :** Definition; Electrochemical principles; Environmental effects (oxidizers, temperature, agitation (velocity) and polarization), passivity; Forms of corrosion(brief)- galvanic, crevice corrosion, selective leaching, erosion and hydrogen damage, corrosion of metals and alloys due to sulfuric, hydrochloric, nitric, phosphoric and acetic acids; Corrosion prevention and control- selection of materials, design principles; Inhibitors; Alteration of environment; Anodic protection; Inorganic and metallic coatings; Organic coatings.

**UNIT - V** **L-9**

**NANOMATERIALS :** Evolution of nanotechnology; Electron microscopy; Priniciples of SEM, TEM, SPM and STM; Manipulation of atoms (manipulator, tweezer, nanodots, self assembly, nanolithography); Nano materials- plasma arcing, chemical vapor deposition, sol gel, ectrode position, ball milling, applications of nanomaterials.

## TEXT BOOKS

1. Van Vlack L. R., “Elements of Material Science and Engineering” , 6th edition, Pearson, 1989.
2. Mars G. Fontana, “Corrosion Engineering”, 3rd edition, McGraw Hill, 1989.
3. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons and Burkhard Reguse, “Nanotechnology : Basic Science and Emerging Trends”, Chapman & hall, 2002.

## REFERENCE BOOKS :

1. V. Raghavan, “Material Science and Engineering”, 6th edition, PHIL, .
2. William F. Smith, “Principles of Materials Science and Engineering”,3rd edition, McGraw-Hill, 1996,

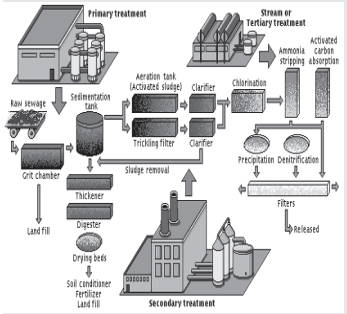
# 19CH232 INDUSTRIAL EFFLUENT TREATMENT METHODS

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 40 | 5 | - | 5 | 5 |




***Source:***

*https://www.google.com/search?q=industrial+effluent+treatment*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with air pollution, industrial waste water treatment, toxicity and sludge management. The objective of this course is to impart knowledge in pollution prevention through planning and treatment technologies. This course also deals with the detailed understanding of various equipments related to sampling, measurement and capturing process towards the control and treatment methods.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply reasoning to identify the constituents accountable for air pollution and different sources of effluent waste water and effect of pollutant on environment. | 6 |
| 2 | Identify and characterize the various parameters for effluent samples, ambient air and stack air sampling from their sources to provide valid conclusions. | 4 |
| 3 | Analyse the impact of sampling, measurement and characterization of various air sampling and different effluent water and adopting advanced techniques to demonstrate the need for sustainable development. | 2,7 |
| 4 | Identify and demonstrate the knowledge to use suitable equipment for abatement of air pollution and effluent waste water towards the control of air and water pollution. | 7 |

**SKILLS:**

- ✓ *Implement industrial management strategies for pollution prevention.*
- ✓ *Analyze and determine effluent toxicity.*
- ✓ *Develop solutions for industrial effluent toxicity.*

**UNIT - I** **L-9**

**EFFLUENTS AND THEIR REGULATIONS :** Types of waste from chemical industries and effects on environment; Environment legislation; Types of pollution; Sources of waste water; Effluent guidelines and standards.

**UNIT - II** **L-9**

**CHARACTERIZATION OF EFFLUENT STREAMS :** Oxygen demands and their determination (BOD, COD and TOC); Oxygen sag curve; BOD curve mathematical; Controlling of BOD curve; Self purification of running streams; Sources and characteristics of pollutants infertilizer, paper and pulp industry.

**UNIT - III** **L-8**

**TREATMENT METHODS :** General methods of control and removal of sulfur dioxide; Oxides of nitrogen and organic vapors from gaseous effluent; Treatment of liquid and gaseous effluent in fertilizer industry.

**UNIT - IV** **L-10**

**AIR POLLUTION SAMPLING AND MEASUREMENT :** Types of pollutant and sampling and measurement; Ambient air sampling- collection of gaseous air pollutants, collection of particulate air pollutants; Stack sampling- sampling system, particulate sampling and gaseous sampling; Analysis of air pollutants- sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and ozones, hydrocarbons, particulate matter.

**UNIT - V** **L-10**

**AIR POLLUTION CONTROL METHODS AND EQUIPMENTS :** Source collection methods- raw material changes, process changes and equipment modification, cleaning of gaseous equipments ; Particulate emission control- collection efficiency, control equipment like gravitational settling chambers, cyclone separators, fabric filters, scrubbers, packed beds and plate columns, venturi scrubbers and their design aspects; Control of gaseous emissions- absorption by liquids, absorption equipments, adsorption by solids.

## TEXT BOOKS :

1. G. L. Karia and R. A. Christian, “Waste Water Treatment : Concepts and Design Approach”, 2nd Edition, Prentice Hall of India, 2013.
2. A. D. Patwardhan, “Industrial Waste Water Treatment”, 2nd Edition, Prentice Hall of India, 2009.
3. C. S. Rao, ”Environmental Pollution Control Engineering”, 2nd Edition, New Age International Publishers, New Delhi, 2006.

## REFERENCE BOOKS :

1. Mahajan. S. P., “Pollution Control in Process Industries”,2nd Edition, Tata McGraw-Hill Education Private Ltd., New Delhi, 2008.
2. Murali Krishna K. V. S. G., “Air Pollution and Control”, 1st Edition,University Science Press, 2015.

# 19CH233 ENERGY MANAGEMENT AND AUDITING

***Source:***

*https://https://www.google.co.in/search?q=chemical+engineering+thermodynamics*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES :**

This course provides an understanding on the energy efficiency measures which can be implemented by industrial and domestic users. The objective of this course is to demonstrate energy technologies that include lighting, air conditioning, compressed air, steam, hot water, chilled water and a number of process specific technologies.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Analyze and interpret energy efficiency and demand of management project proposals. | 4 |
| 2 | Apply modern techniques in energy auditing methods. | 5 |
| 3 | Design and develop energy efficient solutions for industry problems. | 3 |
| 4 | Formulate thermal performance, energy management and audit. | 2 |

**SKILLS:**

- ✓ Analyze energy systems from a supply and demand perspective.
- ✓ Develop energy efficiency solutions and demand management strategies.
- ✓ Apply energy efficiency technologies for engineering applications.

**UNIT - I** **L-9**

**ENERGY AUDIT:** Types and methodology; Energy audit reporting format; Understanding energy costs; Benchmarking and energy performance; Matching energy usage to requirement; Maximising system efficiency; Fuel and energy substitution; Energy audit instruments; Duties and responsibilities of energy auditors.

**UNIT - II** **L-9**

**ENERGY CONSERVATION:** Energy conservation and its importance; Energy strategy for the future; The energy conservation act 2001 and its features.

**ENERGY MANAGEMENT:** Definition and objectives of energy management; Importance; Indian need of energy management; Duties and responsibilities of energy managers.

**UNIT - III** **L-9**

**ENERGY ECONOMICS:** Costing techniques; Financial appraisal and profitability; Cost optimization; Optimal target investment schedule; Project management energy utilization and conversion systems; Furnaces; Loses; Hydraulic power systems; Compressed air; Steam turbines; Combined power and heating systems; Energy conversion; District heating.

**UNIT - IV** **L-9**

**ENERGY MONITORING AND TARGETING:** Definition; Elements of monitoring and targeting system; A rationale for monitoring; Targeting and reporting; Data and information analysis; Relating energy consumption and production; CUSUM; Case study.

**UNIT - V** **L-9**

**HEAT RECOVERY:** Sources of waste heat and its potential applications; Heat recovery systems; Incinerators; Regenerators and recuperators; Waste heat boilers.

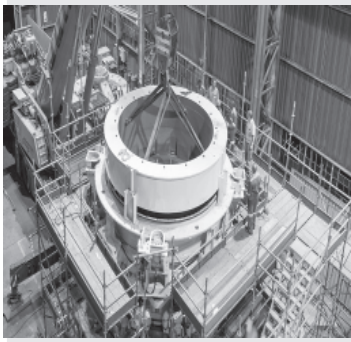
## TEXT BOOKS :

1. W. R. Murphy, G. McKay, "Energy Management", 2nd edition, Bio Green Books, 2007.
2. Barun Kumar De, "Energy Management, Audit and Conservation", 2nd edition, Vrinda Publications, 2014.
3. W. C. Turner, "Energy Management Handbook", 7th edition, Fairmont Press, 2007.

## REFERENCE BOOKS :

1. Fengyuan Wang and Andy Chen, "Energy Management Handbook", 1st edition, BSR Publishers, 2012.
2. Y. P. Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", 2nd edition, TERI Press, 2006.

# 19CH234 MINERAL PROCESS TECHNOLOGY



***Source:***
*https://www.google.com/search?q=mineral+process+technology*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES :**

This course deals with the identification of ores and their processing for valuable minerals. The objective of this course is to explain the principles of various methods of minerals concentration, processing and equipment.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply principles of mineral processing to predict structure and textures of minerals. | 1 |
| 2 | Analyze various industrial minerals. | 2 |
| 3 | Develop process flow sheet for mineral processing plant. | 3 |

**SKILLS:**

- ✓ *Identify the structures and textures of minerals.*
- ✓ *Perform ore compositional analysis by chemical and mineral logical techniques.*
- ✓ *Prepare metallurgical mass balance, recovery, grade and loss.*

**UNIT - I** **L-9**

**MINERALS AND THEIR PROPERTIES:** Names; Compositions and properties of the important minerals of common metals- iron, copper, lead, zinc, tin, chromium, aluminum, manganese, gold, silver, uranium, thorium, titanium, zirconium.

**UNIT - II** **L-9**

**ORES AND THEIR SUITABILITY:** Cutoff, Average and concentrate grades of each ore; Information about industrial minerals- calcite, silimanite, phosphate, granite, dolomite, magnesite, limenite, rutile, zircon, garnet, monazite, pyrite, quartz, feldspar.

**UNIT - III** **L-9**

**BENEFICIATION OF IRON ORES:** Beneficiation circuits for hematite and magnetite iron ores; Dry and wet processes; Their scopes and limitations; Estimation of water requirements and pumping loads.

**UNIT - IV** **L-9**

**COMMINUTION OF CIRCUITS AND EQUIPMENT:** Beneficiation circuits for lead, zinc and copper ores; Optimization of the grinding process for liberation of the minerals and minimization of slime loss; Scope and limitations of regrinding circuits.

**UNIT - V** **L-9**

**BENEFICIATION OF BEACH MINERALS AND OTHER ORES:** Concentrate upgradation and separation processes for beach sand minerals; Effects of repeated cleaner operations on grades and recoveries; Overview of the beneficiation circuits ores of- gold, tin, manganese, lime stone, graphite and other industrial minerals.

## TEXT BOOKS:

1. A. F. Taggart, “Elements of Ore Dressing”, 2nd edition, John Wiley and Sons,1964.
2. Barty A. Wills, “Mineral Processing Technology”, 3rd edition, Pergamon Press, 1985.

## REFERENCE BOOK:

1. A.M.Gaudin,”Mineral Dressing”, 1st edition, McCraw-Hill,1980.

# 19CH235 POLYMER SCIENCE AND ENGINEERING

***Source:***
*https://www.google.com/search?q=polymer+science+engineering*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES :**

This course provides the structure/property relationships that drive the continued expansion of polymers into a wide array of applications. The objective of this course is to introduce the fundamentals of polymer science and also to elucidate the effect of structure on the properties of various polymeric materials.

**COURSE OUTCOMES :**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply fundamentals of polymer science to predict kinetics of polymer reactions. | 1 |
| 2 | Analyze polymer processing, rheology and its methods. | 2 |
| 3 | Design a production processes for various polymers. | 3 |

**SKILLS:**

- ✓ *Compare and contrast the yield and fracture behavior of polymers with metallic and ceramics materials.*
- ✓ *Interpret the results from common thermal characterization (TGA, DSC, DMA) techniques and relate the moto polymer structure.*
- ✓ *Identification of dielectric behavior of polymers.*

**UNIT - I** **L-9**

**CLASSIFICATION OF POLYMERS :** Functionality; Mechanisms of polymerization; Chain polymerisation - free radical, ionic and cationic polymerisation, step polymerization methods; Stereoisomerism in polymers, chemicals and geometrical structures in polymers, block and graft polymers; Molecular weight of polymers- weight average, number average, viscosity average molecular weight; Principles and calculations for determination of the molecular weights- osmometry, ebulliometry, light scattering, ultracentrifugation, end group analysis and viscosity methods.

**UNIT - II** **L-9**

**SOLUBILITY AND KINETICS OF POLYMERS :** Transition in polymers; Crystallinity in polymers; Polymer degradation method; Kinetics of polymerization reaction- free radical, ionic polymerization and step polymerization reactions, derivation of rate equations and related numerical problems.

**UNIT - III** **L-9**

**POLYMERIZATION METHODS :** Bulk; Solution; Suspension and emulsion polymerization; Comparison of polymerization methods; Fabrication methods- compounding injection molding, extrusion blow, blow extrusion, calendaring, rotational molding, thermoforming and vacuum forming.

**POLYMER PROCESSING AND RHEOLOGY :** Non-Newtonian flow; Viscosity of polymer solutions and suspensions, Constitutive equations; Capillary rheometer; Couette rheometer; Cone and plate rheometer; Rheometric characterization of polymer solution and melts.

**UNIT - IV** **L-9**

**INDIVIDUAL POLYMERS :** Brief description; Reaction equations; Brief process description with a schematic flow sheet; Physical properties and uses of following polymers- thermosets, phenol formaldehyde, urea formaldehyde, polyester and epoxy resins, polyrethane; Thermo plastics- polyethylene, polypropylene, PVC, polystyrene, co-polymers, PMMA, polycarbonates.

**UNIT - V** **L-9**

**APPLICATIONS OF POLYMERS :** Membrane separations- membrane applications for polymeric materials, mechanisms of transport and membrane preparation; Biomedical applications- artificial organs, controlled drug delivery, hemodialysis and hemo filtration; Electronics- electrically conductive polymers, electronic shielding, encapsulation, photonic polymers.

## TEXT BOOKS :

1. V. R. Gowariker, M. V. Viswanthan, Jaidev Sridhar, “Polymer Science”, 1st edition,Wiley eastern Ltd, 2005.
2. R. J. Crawford, “Plastics engineering”, 2nd edition, Pergamon Press, 1992.

## REFERENCE BOOKS :

1. R. Sinha, “Outlines of Polymer Technology: Manufacture of Polymers”, 1st edition, Prentice Hall India, 2004.
2. R. Chandra and S. Mishra, “Rubber and Plastic Technology”, 1st edition, CBS Publication, 1995.

# 19CH236 PETROCHEMICALS

***Source:***
*https://www.google.co.in/search?q=PETROCHEMICALS+images*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with thermal, catalytic process, fractionation of crude oil and various chemicals used in petroleum industries. The objective of this course is to get the familiarity with the various chemical processes deployed in petroleum industries.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply various chemical process for production petrochemicals. | 1 |
| 2 | Analyze sources of petroleum resources. | 2 |
| 3 | Evaluate petrochemicals by advance techniques. | 3 |

**SKILLS:**

- ✓ *Draw the specific PFD & PsID diagrams.*
- ✓ *Analyze the principles behind the production of aldehydes and alcohols.*

**UNIT - I** **L-9**

**SOURCE OF PETROLEUM:** Origin and formation of petroleum; Reserves and deposits of world; Indian Petroleum industry.

**UNIT - II** **L-9**

**FRACTIONATION OF PETROLEUM:** Dehydration and desalting of crudes; Heating of crude pipe still heaters; Distillation of petroleum; Blending of gasoline.

**UNIT - III** **L-9**

**THERMAL AND CATALYTIC PROCESSES:** Cracking; Catalytic cracking; Catalytic reforming; Naphtha cracking; Coking; Hydrogenation processes; Alkylation processes; Isomerisation processes.

**UNIT - IV** **L-9**

**PETROCHEMICAL TECHNOLOGY:** Chemicals from ethane; Ethylene and acetylene; Synthetic ethanol; Acetaldehyde and acetic acid; Vinyl acetate; Butraldehyde; 2-Ethyl hexanol and drop ethylene; Oxide; Ethyleneglycols; Acrilonitrile; Polyesters; Ethandaminess; Ethylchloride,;Ethylenedichloride.

**UNIT - V** **L-9**

**CHEMICALS FOR MBUTANES:** Butanes; Pentanes; Butadiene; Butane epoxides and butanol aminesbutanol, Butylacetate; Methyl ethylketone; Isoprene; Amylalcohol.

## TEXT BOOK:

1. B.K.Bhaskara Rao, “A Text onPetrochemicals”, 5th edition, Khanna Publishers, 2003.

## REFERENCE BOOKS:

1. S Grueses and D.R.Stevens,”Chemical Technology of Petroleum”,1st edition, McGraw-Hill,1980.
2. Waddams A.L., “Chemicals from Petroleum”,1st edition, Chemical Publishing,1969.

# 19CH237 FUNDAMENTALS OF BIOTECHNOLOGY

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The main objective of the course is to acquire knowledge on various chemical processes a ssociated with living cell machinery and familiarize students on the complex structures of biomolecules, their synthesis, interaction and metabolism. Also to acquaint about the fermentation process for the development of industrially important microorganisms.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Evaluate the bioenergetics of metabolic pathway. | 2 |
| 2 | Analyze the influence of enzymes in anabolic and catabolic steps of biological reactions. | 2 |
| 3 | Estimate the complex structures of macromolecules in biological samples. | 2 |

**SKILLS:**

- ✓ *Isolation of microbes.*
- ✓ *Differentiate between microbial species.*
- ✓ *Identify biomolecules by colorimetric and biochemical assays.*
- ✓ *Quantify macromolecules using UV-VIS Spectrophotometer.*

**UNIT - I** **L-9**

**BASIC MICROBIOLOGY:** Microorganisms - discovery, classification of microorganisms; Prokaryotic cells- morphological and structural characteristics, biosynthetic capabilities; Eukaryotic cells- morphological and structural characteristics, biosynthetic capabilities; Nutrient and energy requirement of microbes.

**UNIT - II** **L-9**

**CHEMICALS OF LIFE – I:** Carbohydrates- classification, structure, properties, biological importance of polysaccharides like starch, cellulose, chitin, alginic acids, pectins; Lipids – building blocks of lipids, classification, physico-chemical properties of fatty acids, salient features of bacterial lipids; Nucleic Acids – types and classification; DNA and RNA; Vitamins; Growth hormones and regulators.

**UNIT - III** **L-9**

**CHEMICALS OF LIFE – II:** Proteins- classification and physico-chemical properties of amino acids, peptide bond, properties and functions of peptides ; Protein classification – structure ( primary, secondary, tertiary and quaternary), structure, function relationship; Catalytic Proteins – classification, nomenclature, composition and structure, enzymes as biocatalysts, denaturation and renaturation.

**UNIT - IV** **L-9**

**CELL METABOLISM:** Bioenergetics **–** concepts of free energy and thermodynamic principles in biology, energy transformation, adenosine phosphates, redox potentials, free energy changes in redox potentials, photosynthesis; Metabolic pathways – utilization of sugars (EMP, ED, HMP), respiration (TCA cycle and respiratory chain), amphibolic nature of pathways, metabolic organization and regulation.

**UNIT - V** **L-9**

**MICROBIAL TECHNOLOGY:** Fermentation**-** nature of fermentation, oxygen requirement for growth and fermentation, description of a typical fermentation process; Basics of microbial genetics – genomes, genes, plasmids, transposans, genetic recombinations, rDNA technology as tools, cloning strategies, transgenics.

## TEXT BOOKS:

1. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, “Prescott’s Microbiology”, International Edition, 10th Edition, McGraw Hill Higher Education, 2017.
2. A.L. Lehninger, O.L. Nelson and M.M. Cox, “Principles of Biochemistry”, 7th edition, CBS Publications, 2017.

## REFRENCE TEXT BOOKS:

1. J.L. Jain, “Fundamentals of Biochemistry”, 7th edition, S. Chand Publishers, 2009.
2. L. Stryer, J.M. Berg, JL Tymockzo, “Biochemistry”, 8th edition, WH Freemen & Co., 2015.

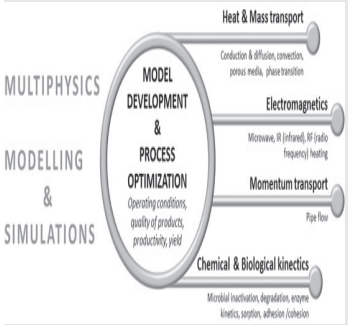
# 19CH331 PROCESS MODELLING AND SIMULATION

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |




***Source:***

*https://www.google.com/search?q=process+modeling+and+simulation*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with understanding physical systems in chemical engineering and to develop their mathematical models. The objective of this course is to train the student on the modeling and simulation techniques and their applications in chemical engineering systems.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the fundamental laws and classification towards mathematical models. | 1 |
| 2 | Identify and design various mathematical modeling of different chemical systems. | 3 |
| 3 | Analyze and investigate the mathematical models of various chemical systems. | 2,4 |
| 4 | Development of algorithms for different chemical systems using appropriate numerical method. | 3 |
| 5 | Creation of simulation programs to various chemical systems using MATLAB. | 5 |

**SKILLS:**

- ✓ *Model development for a given engineering system.*
- ✓ *Write programs using MATLAB.*
- ✓ *Solve process model equations using numerical techniques.*
- ✓ *Simulate modelling equations for a given system.*

**UNIT - I** **L-9**

**FUNDAMENTALS:** Mathematical models for chemical engineering systems; Fundamentals; Introduction to fundamental laws.

**EXAMPLES OF MATHEMATICAL MODELS OF CHEMICAL ENGINEERING SYSTEMS:** Constant and variable volume CSTRs in series; Two heated tanks.

**UNIT - II** **L-9**

**EXAMPLES OF MATHEMATICAL MODELS OF CHEMICAL ENGINEERING SYSTEMS:** Gas phase pressurized CSTR; Non-isothermal CSTR; Single component vaporizer; Batch reactor; Reactor with mass transfer; Ideal binary distillation column; Batch distillation with holdup.

**UNIT - III** **L-9**

**NUMERICAL METHODS:** Newton–Raphson method; False position method.

**NUMERICAL INTEGRATION OF ODES:** Euler method; Runge-Kutta fourth order method.

**INTERPOLATION:** Lagrange interpolation; Forward & backward interpolation**.**

**UNIT - IV** **L-9**

**CLASSIFICATION OF MATHEMATICAL MODELLING:** Independent and dependent- variables and parameters; Classification based on variation of independent variables; Classification based on the state of the process; Classification based on type of the process; Boundary conditions; The black box principle; Artificial neural networks.

**UNIT - V** **L-9**

**COMPUTER SIMULATION EXAMPLES:** Gravity flow tank; Three CSTRs in series; Binary distillation column; Batch reactor; Non-isothermal CSTR; VLE dew point; Bubble point calculations; Countercurrent heat exchanger.

## TEXT BOOKS:

1. W. L. Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, 2nd edition, McGraw-Hill, 1990.
2. B. V. Babu, “Process Plant Simulation”, Oxford University Press, 2004.

## REFERENCE BOOKS:

1. K. Balu and K. Padmanabhan, “Modeling and Analysis of Chemical Engineering Processes”, IK International Private Limited, 2007.
2. Santosh. K. Gupta, “Numerical Methods in Engineering”, 2nd edition, New Age International(P) Ltd., 2003.

# 19CH332 SOLID WASTE MANAGEMENT AND TREATMENT

***Source:***
*https://www.google.com/search?safe=strict&rlz=1C1GIWA_enIN770IN770&biw=1366&bih=608&tbm=isch&sa=1&ei=1QcwXY-CFYi89QPtilHIBA&q=solid+waste+management+and+treatment*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 20 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The course deals with waste disposal and conversion techniques. The Objective of this course is to identify key sources, typical quantities generated, composition, and properties of solid and hazardous waste, the relevant regulations that apply for disposal, and destruction of waste.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply reasoning to identify the constituents accountable for solid waste sources and their effective management and treatment. | 1 |
| 2 | Identify and characterize the various sources and effective processing of municipal solid wastes and the harmful effects of the same on environment to provide valid conclusions. | 2,5 |
| 3 | Analyze the impact of storage, transportation and effective disposal of solid waste and adopting advanced techniques to demonstrate the need for sustainable development. | 2,7 |
| 4 | Investigate and demonstrate the knowledge to use suitable equipment for abatement of solid waste management and treatment towards the control of air and water pollution. | 4 |

**SKILLS:**

- ✓ *Analyze the functional elements for solid waste management.*
- ✓ *Design waste management systems.*
- ✓ *Design modern sanitary landfill for waste disposal.*
- ✓ *Design the proper leachate treatment process.*

**UNIT - I** **L-9**

**SOURCES AND TYPES OF MUNICIPAL SOLID WASTES :** Sources and types of solid wastes; Factors affecting generation of solid wastes; Characteristics; Methods of sampling and characterization; Effects of improper disposal of solid wastes; Public health effects; Principle of solid waste management; Social and economic aspects; Public awareness; Role of NGOs; Legislation.

**UNIT - II** **L-9**

**ON-SITE STORAGE & PROCESSING :** On-site storage methods; Materials used for containers; On-site segregation of solid wastes; Public health and economic aspects of storage; Options under Indian conditions; Critical evaluation of options.

**UNIT - III** **L-9**

**COLLECTION AND TRANSFER :** Methods of collection; Types of vehicles; Manpower requirement; Collection routes; Transfer stations; Selection of location; Operation and maintenance; Options under Indian conditions.

**UNIT - IV** **L-9**

**OFF-SITE PROCESSING:** Processing techniques and equipment; Resource recovery from solid wastes; Composting; Incineration; Pyrolysis.

**UNIT - V** **L-9**

**DISPOSAL:** Dumping of solid waste; Sanitary land fills; Site selection; Design and operation of sanitary landfills; Leachate collection and treatment.

## TEXT BOOKS:

1. George Tchobanoglous, “Integrated Solid Waste Management Engineering Principles and Management Issues”, 2nd edition, McGraw-Hill, 1993.
2. William A. Worrell and P. Aarne Vesilind, “Solid Waste Engineering”, 2nd edition, C L Engineering, 2011.

## REFERENCE BOOKS:

1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000.
2. Qian X., Koerner R. M. and Gray D. H., “Geotechnical Aspects of Landfill Design and Construction”,1st edition, Pearson, 2002.

# 19CH333 PETROLEUM REFINERY ENGINEERING

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 40 | - | - | 5 | 5 |

***Source:***

*https://www.google.com/search?q=petroleum+refinery+engineering*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with the conversion of crude oil and intermediate streams into finished products. The objective of this course is to impart the student about the knowledge of distillation, cracking and reforming processes used in a typical refinery.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the basic knowledge of composition and related chemistry of petroleum and its characterization along with thermal properties in refining during treatment of petroleum. | 1 |
| 2 | Identify and analyze the different reforming techniques used for petroleum industries that meet the specific requirements with approximate considerations. | 2 |
| 3 | Investigate and conduct experiment through a cracking unit to obtain desired products, considering the impact of the processes on environment to assess the society. | 4,7 |
| 4 | Apply the knowledge towards the design of crude distillation column and catalytic reforming unit. | 3 |

**SKILLS:**

- ✓ *Recognize the obligatory specifications of the different types of distillation.*
- ✓ *Analyze the working condition of the vacuum and fractional distillation.*
- ✓ *Select suitable reforming process.*
- ✓ *Design waste water treatement from lubeoil manufacturing unit.*

**UNIT - I** **L-9**

**CHARACTERIZATION AND CLASSIFICATION OF CRUDE OILS:** Composition of petroleum; Laboratory tests; Refinery feedstock and products; General definitions; Introduction to petroleum refinery; Classification of crude oil; Characterization of crude oil; Composition of crude; Physical properties of crude oil; Analysis and distillation; Introduction to refinery feedstocks and refinery products.

**UNIT - II** **L-9**

**DISTILLATION OF CRUDE OIL:** Evaluation of crude oil properties and design of crude oil distillation column; Dehydration and desalting of crude; Crude Assay - ASTM, TBP distillations; API gravity various average boiling points and mid percent curves; Evaluation of properties of crude oil and its fractions; Design concept of crude oil distillation column; Furnace design.

**UNIT - III** **L-9**

**THERMAL AND CATALYTIC CRACKING:** Coking and thermal process; Delayed coking; Catalytic cracking; Cracking reactions; Zeolite catalysts; Cracking feed stocks and reactors; Effect of process variables; FCC cracking; Catalyst coking and regeneration; Design concepts; New designs for fluidized-bed catalytic cracking units; Catalytic reforming; Objective and application of catalytic reforming process; Reforming catalysts; Reformer feed; Reforming reactor design- continuous and semi regenerative process.

**UNIT - IV** **L-9**

**HYDROTREATING AND HYDROCRACKING:** Objectives and hydrocracking reactions; Hydrocracking feed stocks; Modes of hydrocracking; Effects of process variables; Hydro treating process and catalysts; Residue hydro processing; Effects of process variables; Reactor design concepts-isomerization, alkylation and polymerization, isomerization process reactions, effects of process variables, alkylation process, feedstocks, reactions, products, catalysts and effect of process variables, polymerization process, reactions, catalysts and effect of process variables.

**UNIT - V** **L-9**

**LUBE OIL MANUFACTURING :** Lube oil processing; Propane deasphalting; Solvent extraction; Dewaxing; Additives production from refinery feedstocks; Environmental issues and new trends in petroleum refinery operations; Ecological consideration in petroleum refinery; Waste water treatment; Control of air pollution; New trends in refinery.

## TEXT BOOKS:

1. J. B. Maxwell, “Data Book of Hydrocarbons”, Krieger publishing company, 1975.
2. W. C. Edmister, “Applied Hydrocarbon Thermodynamics Vol-I and Vol-II”, Gulf Publishing, Company, 1988.
3. Joseph Hilyard, “International Petroleum Encyclopedia (Volume-III)”, Pennwell Corporation, 2008.

## REFERENCE BOOKS:

1. W. L. Nelson, “Petroleum Refining Engineering”, 4th edition, Mc Graw-Hill, 1968.
2. R. N. Watkins, “Petroleum Refinery Distillation”, Gulf Publishing Company, 1979.
3. Robert A. Meyers, “Hand Book of Petroleum Refining Process” 3rd edition, Mc Graw-Hill, 2004.
4. James G Speight, “The Chemistry and Technology of Petroleum”, 4th edition, CRC, Press, 2006.

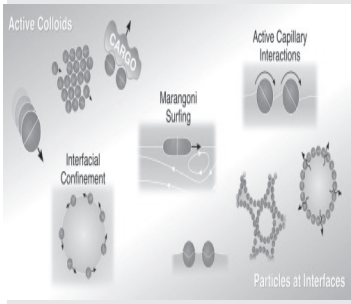
# 19CH334 COLLOIDAL AND INTERFACIAL SCIENCE

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 40 | - | - | 5 | 5 |




***Source:***

*https://www.google.com/search?q=Colloidal+and+Interfacial+Science*

**COURSE DESCRIPTION AND OBJECTIVES:**

Fundamental principles of colloid and interface science involved in disperse systems, surfactants and their solution properties. To understand the science and technology of colloids and interfacial phenomena and processes often appeared in high value added products and modern technologies.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the basic concepts of colloids and interfacial phenomena along with the estimation of rheological properties of colloid dispersions. | 1 |
| 2 | Identify and correlate their theoretical knowledge towards surfactants and their properties of interfacial science and the impact of engineering solutions in environmental perspectives and society. | 2,7 |
| 3 | Analyze and interpret the data of adsorption in interface phenomena and effects of adsorption isotherm incorporates the electrostatic effects and adsorption dynamics at interface. | 4 |
| 4 | Conduct experiment and measurement of surface and interfacial tension, measurement of contact angle, intermolecular and surface forces and provide valid conclusions on suitability of the process. | 4 |

**SKILLS:**

- ✓ *How to identify interfacial phenomena, solid-fluid interfaces, colloids.*
- ✓ *Determine properties of colloid dispersions.*
- ✓ *Characteristics of surfactants and their properties.*
- ✓ *Predict dynamics of adsorption of surfactants at the interfaces.*

**UNIT - I** **L-9**

**BASIC CONCEPTS OF COLLOIDS AND INTERFACES:** Introduction; Examples of Interfacial phenomena; Solid-Fluid Interfaces; Colloids; Properties of colloid dispersions- introduction, sedimentation under gravity, sedimentation in a centrifugal field, Brownian motion, osmotic pressure, optical properties, electrical properties, rheological properties.

**UNIT - II** **L-9**

**SURFACTANTS AND THEIR PROPERTIES:** Introduction; Surfactants and their properties; Emulsions and microemulsions; Foams; Surface and interfacial tension- introduction, surface tension, interfacial tension, contact angle and wetting, shape of the surfaces and interfaces.

**UNIT - III** **L-9**

**SURFACE AND INTERFACIAL TENSION:** Measurement of surface and interfacial tension; Measurement of contact angle; Intermolecular and surface forces- introduction, Vanderwalls forces, electrostatic double layer force, the DLVO theory, non-DLVO forces.

**UNIT - IV** **L-9**

**ADSORPTION AT INTERFACES-I:** Introduction; The Gibbs dividing surface; Gibbs adsorption equation; Langmuir and Frumkin adsorption isotherms; Surface equation of state (EOS); Effect of salt on adsorption of surfactants.

**UNIT - V** **L-9**

**ADSORPTION AT INTERFACES-II:** Adsorption isotherms incorporating the electrostatic effects; Calculation of free energy of adsorption; Adsorption of inorganic salts at interfaces; Dynamics of adsorption of surfactants at the interfaces; Adsorption at solid-fluid interfaces.

## TEXT BOOKS:

1. Pallab Ghosh, “Colloid and Interface Science”, PHI, New Delhi, 2009.
2. R. J. Hunter, “Foundations of Colloid Science”, 2nd edition, Oxford University Press, USA, 2001.

## REFERENCE BOOKS:

1. Paul C. Hiemenz and Raj Rajagopalan, “Principles of Colloid and Surface Chemistry”, 3rd edition, CRC Press, 1997.
2. Authur W. Adamson and Alice P. Gast “Physical Chemistry of Surfaces”, 6th edition, John Wiley & Sons, 1997.
3. G. Barnes and I. Gentle, “Interfacial Science: An Introduction”, 2nd edition, Oxford University Press, USA, 2006.

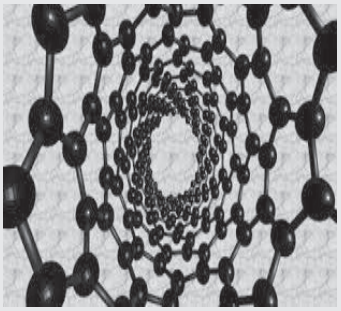
# 19CH335 FUNDAMENTALS OF NANO TECHNOLOGY

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 40 | - | - | 5 | 5 |



***Source:***

*https://www.google.com/search?q=fundamentals+of+nanotechnology*

**COURSE DESCRIPTION AND OBJECTIVES:**

The course deals about various types of nano materials and their importance. It includes the study of nanotechnology with their characterization, nano science, nano products etc.

The objective of this course is to impart the student about the knowledge of nano particle synthesis, processing, characterization and various nano engineering applications.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the basics of nanoscale hypothesis along with nano-materials properties and their applications. | 1 |
| 2 | Formulate and design suitable fabrication technique for the synthesis of nanoparticles and nanomaterial. | 2,3 |
| 3 | Identify and analyze estimated instrumental techniques for characterization of nanoparticles with an considerate of their limitations to assess for future perceptive. | 2,6 |
| 4 | Demonstrate the numerous applications of nanotechnology towards electronics, chemical, automobile and aerospace engineering to evaluate the societal health and safety. | 4,7 |

**SKILLS:**

- ✓ *How to synthesize the nano material.*
- ✓ *Determine the step towards the formation of special nano material.*
- ✓ *Find the characteristics of nano material as a several form.*
- ✓ *Know the importance of different nano structure and their specific utilization.*

**UNIT - I** **L-9**

**INTRODUCTION:** Importance of nanotechnology; Emergence of nanotechnology; Size range of nano particles; Thermodynamics and properties of nano scale materials; Classification of nano structured materials; Bottom-up and top-down approaches; Challenges in nanotechnology; Future of nanotechnology in chemical and biochemical engineering.

**UNIT - II** **L-9**

**SYNTHESIS OF NANO PARTICLES AND PROCESSING:** Methods for creating nano structures; Processes for producing ultra fine powders; Mechanical grinding; Wet chemical synthesis of nano materials; Sol-gel emulsion processes; Liquid-solid reactions; Gas phase synthesis of nano materials- furnace, flame assisted ultra sonic spray pyrolysis, gas condensation (CVC), cold plasma methods, particle precipitation aided CVD.

**UNIT - III** **L-9**

**CHARACTERIZATION OF NANO SYSTEMS:** Sample preparation and characterization techniques of nano structured materials– scanning electron microscopy (SEM), transition election microscopy and X-ray photo electron and Auger electron spectroscopy (XPS, AES), scanning tunneling microscopy (STM), atomic force microscopy (AFM), powder X-ray difractometry (XRD).

**UNIT - IV** **L-9**

**SPECIAL NANO MATERIALS:** Carbon fullerences and nanotubes – onions – carbon fullerrence-formation; Properties and uses; Porous silicon preparation methods; Nano particles of SiC; Alumina and zirconia and their sintering techniques; Wafer preparation; Wafer cleaning techniques; Lithography; Etching; Mechanical attrition; Nano composites.

**UNIT - V** **L-9**

**NANO – ENGINEERING APPLICATIONS:** Micro electromechanical systems (MEMS) and nano electromechanical systems (NEMS); Sensors; Microfluidic devices– nano pump, molecular motors, nano bots; Nano medicine; Drug delivery systems; Catalyis by gold nano particles; Wear resistance coatings; Weapons; Battery and fuel cell electrodes; Thermal management; Automotive and aerospace components; Environmental impact of nano-particles; Ethical, legal and social issues.

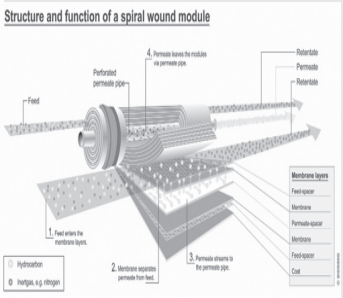
## TEXT BOOKS:

1. Charles P. Poole and Jr. Frank Jowens, “Introduction to Nanotechnology”, John wiley & Sons, 2003.
2. B. C. Carndall and J. Lewis, “Nanotechnology Research and Perspectives”, 1st edition, The MIT Press,1992.

## REFERENCES BOOK:

1. Poorvi Dutta and Sushmita Gupta, “Understanding of Nano Science and Technology”, 2nd edition, Global Vision Publishing House, 2016.

# 19CH336 MEMBRANE TECHNOLOGY




***Source:***

*https://www.google.com/search?q=Membrane+Technology*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The course will describe in detail membrane separation technology and wide range of applications including water treatment and desalination. The objective of the course is to give the students the technical background on membrane technology and to provide wide level of knowledge to design, using appropriate combinations of unit processes and water treatment plant.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Formulate and apply various transport models for the calculation of membrane fluxes and the extent of separation for various membrane systems. | 1 |
| 2 | Identify and apply the principle of novel separation process to evaluate societal, health and safety by subsequent responsibilities. | 2,3 |
| 3 | Apply the fundamentals and design of membrane process and characterization and correlate their theoretical knowledge to determine rates of separation and design the system components for various operations. | 2,6 |
| 4 | Conduct experiments via membrane process and design components to carry out a specific separation. | 4,7 |
| 5 | Interpret experimental data to estimate concentration driven separation techniques and provide valid conclusions on suitability of the process. | 4 |

**SKILLS:**

- ✓ *Characterize the membrane.*
- ✓ *Specify the suitable membrane for the given seperation process.*
- ✓ *Identify the suitable process for seperation using membrane.*

**UNIT - I** **L-9**

**INTRODUCTION TO MEMBRANE PROCESSES:** Separation process; Introduction to membrane processes; Definition of a membrane; Classification of membrane processes; Preparation of synthetic membranes; Types of membrane materials; Phase inversion membranes; Preparation technique for immersion precipitation; Preparation technique for composite membranes.

**UNIT - II** **L-9**

**CHARACTERIZATION OF MEMBRANES:** Introduction; Membrane characterization; Characterization of porous membranes; Characterization of non-porous membranes; Transport in membranes-introduction, driving forces, non-equilibrium thermodynamics, transport through porous,non-porous, and ion exchange membranes.

**UNIT - III** **L-9**

**MEMBRANE PROCESSES:** Pressure driven membrane processes; Introduction; Microfiltration-membranes for microfiltration, industrial applications; Ultrafiltration- membranes for ultrafiltration, industrial applications; Reverse osmosis and nanofiltration- membranes for reverse osmosis and nanofiltration, industrial applications; Electrically driven processes- introduction, electrodialysis, process parameters, membranes for electrodialysis, applications, membrane electrolysis, bipolar membranes, fuel cells.

**UNIT - IV** **L-9**

**CONCENTRATION DRIVEN MEMBRANE PROCESSES:** Gas separation- gas separation in porous and nonporous membranes, membranes for gas separation, applications, pervaporation, membranes for pervaporation, applications; Dialysis- membranes for dialysis, applications; Liquid membranes- aspects, liquid membrane development, choice of the organic solvent and carrier, applications; Introduction to membrane reactors.

**UNIT - V** **L-9**

**POLARIZATION PHENOMENON AND FOULING:** Introduction to concentration polarization; Turbulence promoters; Pressure drop; Gel layer model; Osmotic pressure model; Boundary layer resistance model; Concentration polarization in diffusive membrane separations and electrodialysis; Membrane fouling; Methods to reduce fouling; Compaction; Module and process design- introduction, plate and frame module, spiral wound module, tubular module, capillary module, hollow fiber module, comparison of module configurations.

## TEXT BOOKS:

1. Marcel Mulder, "Basic Principles of Membrane Technology", 2nd edition, Springer Publications, 2007.
2. R. Philip., C. W. Anket, "Rate-Controlled Separations", 1st edition, Springer, 2005.

## REFERENCE BOOKS:

1. S. P. Nunes and K. V. Peinemann, "Membrane Technology in the Chemical Industry", Wiley-VCH, 2nd edition, 2006.
2. Rautanbach and R. Albrecht, "Membrane Process", John Wiley & Sons, 1st edition, 1986.
3. J. G. Crespo and K. W. Bodekes, "Membrane Processes in Separation and Purification", Kluwer Academic Publications,1st edition,1994.
4. C .J. Geankoplis, "Transport Processes and Unit Operations", 3rd edition, PHI, 2003.

# 19CH337 BIOPROCESS ENGINEERING

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

Study of the engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Emphasis is placed on enzyme kinetics and technology, bioreaction kinetics, design, analysis, and control of bioreactors and fermenters, and downstream processing of bioreaction products. This course provides students with basic concepts and prepares them to meet the challenges of the new and emerging biotechnology industry.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Analyze and formulate mechanisms for enzymatic reactions. | 2 |
| 2 | Regulate metabolic pathways during cell growth. | 4 |
| 3 | Design bioreactors for the production of various bio-products. | 3 |
| 4 | Develop product recovery strategies for various bio-products. | 3 |

**SKILLS:**

- ✓ *Design and operation of bioreactors.*
- ✓ *Design fermentation medium for the production of bioproducts.*
- ✓ *Development of growth kinetics.*
- ✓ *Application of sterilization techniques.*
- ✓ *Development of product recovery strategies.*

**UNIT - I** **L-9**

**ENZYMES:** Introduction; Mechanism of catalytic action; Enzyme kinetics; Immobilized Enzyme systems; Methods and kinetics; Large scale production of enzymes; Medicinal and industrial utilization of enzymes.

**UNIT - II** **L-9**

**CELLS:** Microbial diversity; Naming of cells; Cell nutrients; Metabolic regulation; Transport of small molecules across cellular membrane; Cell Growth- batch growth, quantifying cell growth, cell growth in continuous culture.

**UNIT - III** **L-9**

**BIOREACTORS - I:** Operating considerations; Choosing the cultivation method; Batch and continuous reactors; Immobilized cell systems; Solid state fermentations.

**UNIT - IV** **L-9**

**BIOREACTORS - II:** Selection; Scale-up and control- scale up; Bioreactor instrumentation and its control; Sterilization of process fluids.

**UNIT - V** **L-9**

**RECOVERY AND PURIFICATION OF PRODUCTS :** Product recovery strategy; Separation of insoluble products; Cell disruption; Separation of soluble products; Finishing steps; Integration of reactor and separation.

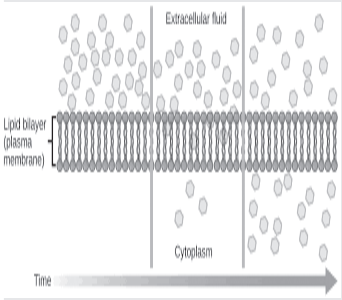
## TEXT BOOK:

1. Michael L. Shuler, Fikret Kargi and Matthew DeLisa, “Bioprocess Engineering – Basic Concepts”, 3rd edition, Prentice Hall of India, 2017.

## REFERENCE BOOKS:

1. T. Palmer and P. L. Bonner,”Enzymes”, 2nd edition, Woodhead, 2007.
2. Peter Stanbury Allan Whitaker and Stephen Hall, “Principles of Fermentation Technology”, 3rd edition, Butterworth-Heinemann, 2016.
3. B. Sivasankar, “Bioseparations Principles and Techniques”, Kindle edition, PHI, 2010.
4. P. M. Doran, “Bioprocess Engineering Principles”, 2nd edition, Elsevier, 1995.

# 19CH338 TRANSPORT PHENOMENA




***Source:***
*https://www.abstractclasses.in/2017/09/26/1907/*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The course provides fundamental understanding of various transport processes occurring in process industries. The objective of this course is to train the student in momentum transfer, heat transfer and mass transfer phenomena and their applications.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Analyze the steady state operations for momentum, heat & mass transfers to interpret practical data to provide valid conclusions. | 4 |
| 2 | Apply appropriate reasoning for shell momentum, energy & mass balances for laminar flows across various geometry and boundary conditions to predict and model the behaviour. | 5 |
| 3 | Understand the impact of equation of changes in various co-ordinate systems with its influence on analogies between momentum, heat and mass transport which encourages them to engage in independent and life-long learning. | 12 |
| 4 | Apply the basic knowledge of mathematics and engineering fundamentals to solve various chemical engineering problems. | 1 |

**SKILLS:**

- ✓ *Estimation of transport properties.*
- ✓ *Predict appropriate boundary conditions for fluid flow.*
- ✓ *Develop velocity, temperature and concentration distribution profiles for simple geometries.*

**UNIT - I** **L-9**

**INTRODUCTION:** Momentum; Energy and mass transport operations; Newton's law of viscosity; Newtonian and non-Newtonian fluids; Fourier's law of heat conduction; Fick's law of diffusion; Effect of temperature and pressure on transport properties of fluids; Numerical problems.

**UNIT - II** **L-9**

**VELOCITY DISTRIBUTION IN LAMINAR FLOW:** Different flow situations; Steady state shell momentum balances; Boundary conditions applicable to momentum transport problems; Flow over a flat plate; Flow through a circular tube; Flow through annulus; Flow between parallel plates and a slit; Numerical problems.

**UNIT - III** **L-9**

**STEADY STATE SHELL ENERGY BALANCES:** General boundary conditions applicable to energy transport problems of chemical engineering; Heat conduction through compound walls; Overall heat transfer coefficient based on inner and outer surface area.

**TEMPERATURE DISTRIBUTION IN SOLIDS AND IN LAMINAR FLOW :** Heat conduction with internal generation by- electrical, nuclear, viscous energy sources; Numerical problems; Heat conduction in cooling fin; Forced and free convection heat transfer.

**UNIT - IV** **L-9**

**CONCENTRATION DISTRIBUTIONS IN LAMINAR FLOW:** Steady state shell mass balances; General boundary conditions applicable to mass transport problems of chemical engineering; Diffusion through stagnant gas and liquid films; Equimolar counter diffusion; Numerical problems; Diffusion with homogeneous and heterogeneous reaction; Diffusion into falling film- forced convection mass transfer; Numerical problems.

**UNIT - V** **L-9**

**ANALOGIES BETWEEN MOMENTUM, HEAT AND MASS TRANSPORT**: Reynold's, Prandtl's and Chilton & Colburn analogies.

**EQUATIONS OF CHANGE**: Equation of continuity; Equation of motion- Navier-Stokes equation, Euler's equation.

## TEXT BOOK:

1. Bird R. B., Stewart W. E. and Lightfoot. B., "Transport Phenomena", 3rd edition, Mc Graw-Hill, 2003.

## REFERENCE BOOKS:

1. James. R. Welty, Robert. E. E. Wilson, "Fundamentals of Momentum, Heat and Mass Transfer", 2nd edition, John Wiley & Sons, 2002.
2. Theodore L., "Transport Phenomena", 2nd edition, John Wiley & Sons, 2002.
3. Geankoplis J., "Transport Processes & Unit Operations", 3rd edition, Prentice Hall of India, 2003.

# 19CH339 ENERGY CONSERVATION AND WASTE HEAT RECOVERY

***Source:***
*https://www.mapsofindia.com/my-india/india/national-energy-conservation-day-save-energy-find-alternative-sources*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The proposed course introduces us to various methods of Waste Heat Recovery that has been employed by the industry to harness the energy stored in waste heat and use it for generation of additional electric power. The objective of this course is to provide the knowledge about upcoming concept of Cogeneration and Waste Heat Recovery Systems and also enables the students to think and analyze the techno economic viability of various energy efficient systems.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the basic knowledge of waste heat recovery systems, economic analysis, thermodynamics, power plant cycles and environmental considerations. | 1 |
| 2 | Analyze and interpret power plant cycles to solve industry problems. | 2 |
| 3 | Use appropriate techniques for energy storage. | 5 |
| 4 | Analyze the techno economic viability of various energy efficient systems. | 2 |

**SKILLS:**

- ✓ *Carryout energy accounting and balancing.*
- ✓ *Conduct energy audit and suggest methodologies for energy savings.*
- ✓ *Analyze the energy data of industries.*

**UNIT - I** **L-9**

**INTRODUCTION TO WASTE HEAT:** Importance of waste heat recovery; Review of thermodynamics – energy and energy efficiencies, rankine cycle.

**UNIT - II** **L-9**

**POWER PLANT CYCLES:** Energy cascading; Combined cycles; Cogenerations; Bottoming cycle options for WHR; Vapor absorption refrigeration; Ejector refrigeration.

**UNIT - III** **L-9**

**HEAT EXCHANGERS FOR WASTE HEAT RECOVERY:** Recuperator; Regenerator; Special heat exchanger devices; Heat pipes & vapor chambers; Heat exchanger network.

**UNIT - IV** **L-9**

**DIRECT CONVERSION TECHNOLOGIES:** Thermoelectric generators; Thermoionic conversion; Thermo-PV; MHD; Heat pump; Heat recovery from incinerators.

**UNIT - V** **L-9**

**ENERGY STORAGE TECHNIQUES:** Pumped hydro; Compressed air; Fly-wheel; Superconducting magnetic storage; Thermal storage (sensible & latent); Battery; Chemical energy storage; Energy economics.

## TEXT BOOK:

1. Institute of Fuel, London, “Waste Heat Recovery”, Chapman & Hall Publishers, London, 1963.

## REFERENCE BOOK:

1. Yacov Y. Hamies, Marguerite A. H. Ruffner, “Energy Auditing and Conservation: Methods, Measurements, Management & Case Study”, Hemisphere, Washington, 1980.

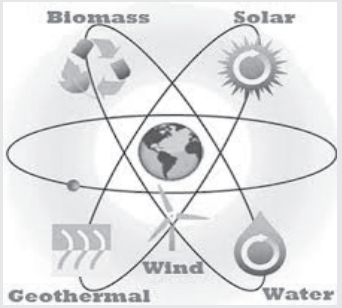
# 19CH340 NON CONVENTIONAL ENERGY SOURCES

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 40 | - | - | 5 | 5 |




***Source:***
*https://nonconventional.weebly.com/*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course provides a comprehensive overview of renewable energies including solar energy, wind power, hydropower, fuel cells, biomass, and alternative transportation options. The objective of this course is to teach overview of alternative energy sources, its availability, current status and basic principles for harnessing this resource.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels. | 1 |
| 2 | Analyze the technological basis for harnessing renewable energy sources. | 2 |
| 3 | Interpret the effects that current energy systems based on fossil fuels have over the environment and the society. | 4 |
| 4 | Design various components of different renewable energy systems. | 12 |
| 5 | Compare different renewable energy technologies and choose the most appropriate based on local conditions. | 5 |

**SKILLS:**

- ✓ *Able to assess the viability of a wind power hydropower or biomass system for a given site.*
- ✓ *Able to explain the impact of government regulations on the use of renewable energies.*
- ✓ *Able to analyze these renewable energy systems and will calculate savings fractions backup energy needs financing options and economic analyses.*
- ✓ *Able to investigate the potentials of renewable energy technologies to help solve environmental and economic problems within society.*

**UNIT - I** **L-9**

**SOLAR ENERGY:** Solar radiation; Measurement and prediction; Solar thermal flat plate collectors; Concentrating collectors; Applications- heating, cooling, desalination, power generation, drying, cooking etc.; Principle of photovoltaic conversion of solar energy; Types of solar cells and fabrication; Photovoltaic applications- battery charger, domestic lighting, street lighting and water pumping; Power generation schemes.

**UNIT - II** **L-9**

**WIND ENERGY:** Atmospheric circulations; Classification; Factors influencing wind; Wind shear, Turbulence; Wind speed monitoring; Betz limit; Aerodynamics of wind turbine rotor site selection; Wind resource assessment; Wind energy conversion devices- classification, characteristics, applications; Hybrid systems; Safety and environmental aspects.

**UNIT - III** **L-9**

**BIO-ENERGY:** Biomass resources and their classification; Chemical constituents and physicochemical characteristics of biomass; Biomass conversion processes- thermo chemical conversion, direct combustion, gasification, pyrolysis and liquefaction; Biochemical conversion- biogas, generation, types of biogas plants, applications, anaerobic digestion; Alcohol production from biomass; Chemical conversion process- hydrolysis and hydrogenation.

**UNIT - IV** **L-9**

**HYDROGEN AND FUEL CELLS:** Thermodynamics and electrochemical principles; Basic design; Types and applications; Production methods; Biophotolysis; Hydrogen generation from algae biological pathways; Storage; Cryogenic and metal hydride transportation; Fuel cell- principle of working, various types, construction and applications.

**UNIT - V** **L-9**

**OTHER TYPES OF ENERGY:** Ocean energy resources; Principles of ocean thermal energy conversion systems; Ocean thermal power plants; Principles of ocean wave energy conversion and tidal energy conversion; Hydropower; Site selection; Construction; Environmental issues; Geothermal energy- types of geothermal energy sites, site selection and geothermal power plants.

## TEXT BOOKS:

1. G. D. Rai, “Non-Conventional Energy Sources”, 5th edition, Khanna Publishers, 2010.
2. G. N. Tiwari and R. K. Mishra, “Advanced Renewable Energy Sources”, RSC Publishing, 2012.

## REFERENCE BOOKS:

1. S.P. Sukhatme and J.K. Nayak, “Solar Energy : Principles of Thermal Collection and Storage”, 3rd edition, Tata McGraw-Hill, 2008.
2. John Twidell and Tony Weir, “Renewable Energy Sources”, 3rd edition, Routledge Publisher, 2015.

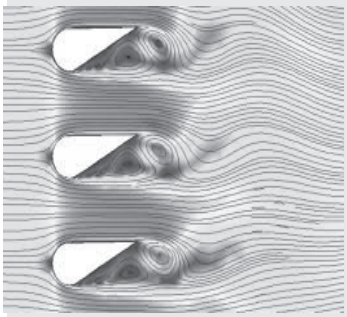
# 19CH341 COMPUTATIONAL FLUID DYNAMICS

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |



***Source:***

*https://xiengineering.com/technologies/computational-fluid-dynamics/*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course provides an understanding of the major approaches and methodologies used in CFD. The objective of this course is to increase skills in implementing and using of basic CFD.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply modern CFD software tools to build flow geometries. | 5 |
| 2 | Develop an adequate mesh for an accurate solution. | 3 |
| 3 | Apply appropriate solvers to obtain a flow solution, and visualize the resulting flow field. | 5 |
| 4 | Identify the type of fluid flow that is occurring in a particular physical system and to use the appropriate model equations to investigate the flow. | 2 |

**SKILLS:**

- ✓ *Establish the best CFD model for the targeted problem.*
- ✓ *Articulate how to execute both steady state and transient (time dependent) fluid flow simulations.*
- ✓ *Comprehend mathematical components of governing equations.*
- ✓ *Establish the methodical application of the model equations and problems used in CFD.*

**UNIT - I** **L-9**

**CONSERVATION LAWS:** Mass conservation; Momentum and energy equation; Differential and integral forms; Conservation and non-conservation form.

**UNIT - II** **L-9**

**TURBULENCE:** Characteristics of turbulent flows; Time averaged Navier Stokes equations; Turbulence models – one and two equation, Reynolds stress, LES and DNS.

**UNIT - III** **L-9**

**FINITE VOLUME METHOD:** Diffusion problems; Explicit and implicit time integration; Convection-diffusion problems; Properties of discretisation schemes- central, upwind, hybrid, QUICK schemes; Solution of discretised equations.

**UNIT - IV** **L-9**

**FLOW FIELD COMPUTATION:** Pressure velocity coupling; Staggered grid; SIMPLE algorithm; PISO algorithm for steady and unsteady flows.

**UNIT - V** **L-9**

**GRID GENERATION:** Physical aspects; Simple and multiple connected regions; Grid generation by PDE solution, Grid generation by algebraic mapping.

## TEXT BOOKS:

1. Anderson J. D., “Computational Fluid Dynamics: The Basics with Applications”, Mc Graw Hill,1995.
2. Fletcher C. A. J., “Computational Techniques for Fluid Dynamics”, Springer Verlag, 1997.

## REFERENCE BOOK :

1. Versteeg, H.K. and Malalaseker A. W., “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Pearson Education Ltd., 2007.

# 19CH342 INTRODUCTION TO MATLAB PROGRAMMING

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 45 | - | - | 5 | 5 |


***Source:***
*https://www.mathworks.com/*

**COURSE DESCRIPTION AND OBJECTIVES:**

It is an introductory programming course that uses MATLAB to illustrate general concepts in programming. The objective of this course is to introduce the elements and practicalities of computer programming through the MATLAB, mathematical computing environment.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply basic computing tools and languages to solve engineering problems. | 1 |
| 2 | Perform statistical data analysis, data interpolation using Matlab tool, solve differentiation equation with Matlab. | 5 |
| 3 | Design optimization algorithms. | 3 |
| 4 | Solve linear and non linear equations, constrained and unconstrained optimization problems by Matlab. | 4 |

**SKILLS:**

- ✓ *List basic Matlab comands.*
- ✓ *Describe the method of the problem solvin using Matlab.*
- ✓ *Explain the description of dynamic systems in Matlab.*
- ✓ *Use Matlab for simulation of the dinamic systems.*

**UNIT – I** **L-9**

**INTRODUCTION TO MATLAB PROGRAMMING:** Basics of MATLAB programming; Array operations in MATLAB; Loops and execution control; Scripts and functions; Plotting and program output; Approximations and errors; Defining errors and precision in numerical methods; Truncation and round-off errors; Error propagation; Global and local truncation errors.

**UNIT - II** **L-9**

**NUMERICAL DIFFERENTIATION AND INTEGRATION:** Numerical differentiation in single variable; Numerical differentiation- higher derivatives, differentiation in multiple variables; Newton-Cotes integration formulae; Multi-step application of trapezoidal rule; MATLAB functions for integration.

**UNIT - III** **L-9**

**LINEAR AND NON-LINEAR EQUATIONS:** Linear algebra in MATLAB; Gauss elimination; LU decomposition and partial pivoting; Iterative methods-Gauss Siedel, Special matrices- tridiagonal matrix algorithm; Nonlinear equations in single variable- MATLAB function zero in single variable, fixed-point iteration in single variable, Newton-Raphson in single variable; MATLAB function solve in single and multiple variables; Newton-Raphson in multiple variables.

**UNIT - IV** **L-9**

**REGRESSION AND INTERPOLATION:** Introduction; Linear least squares regression (including lsqcurvefit function); Functional and nonlinear regression (including lsqnonlin function); Interpolation in MATLAB using spline and pchip.

**UNIT - V** **L-9**

**ORDINARY DIFFERENTIAL EQUATIONS:** Introduction to ODEs; Implicit and explicit Euler's methods; Second-Order Runge-Kutta Methods; MATLAB ode45 algorithm in single variable; Higher order Runge-Kutta methods; Error analysis of Runge-Kutta method; MATLAB ode45 algorithm in multiple variables; Stiff ODEs and MATLAB ode15s algorithm; Practical example for ODE-IVP; Solving transient PDE using method of lines.

## TEXT BOOKS:

1. Amos Gilat Hoboken, N. J. Chichester, "MATLAB: An Introduction with Applications", 4th edition, Wiley International student edition, 2011.
2. William J. Palm, "Introduction to MATLAB for Engineers", 3rd edition, Mc Graw-Hill, 2011.

## REFERENCE BOOKS:

1. Edward P. Magrab and Shapour Azarm, " An engineer's guide to MATLAB", 1st edition, Prentice Hall, 2000.
2. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, Kevin R. Coombes, John R. Osborn, Garrett J. Stuck, "A guide to MATLAB for Beginners and Experienced Users", 2nd edition, Cambridge University Press, 2006.

# 19CH431 DESIGN AND ANALYSIS OF EXPERIMENTS

***Source:***
*https://www.google.com/search?safe=strict&biw=1366&bih=608&tbm=isch&sa=1&ei=D0QwXficL8y6vgSPq7DQAQ&q=design+and+analysis+of+experiments*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

The objective of this course is to impart students a holistic view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications. The objective of ths course is to design experiments carry them out and analyze the data.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Design and analysis of experiments with basic concepts and applications. | 2,3 |
| 2 | Formulate and analyze experimental designs using randomized complete block design (RCBD). | 2,3 |
| 3 | Formulate and design experimental designs using full factorial and 2k factorial. | 3,4 |
| 4 | Apply and analyze response surface methodology. | 1,2 |
| 5 | Can able to use MINITAB software. | 5 |

**SKILLS:**

- ✓ *Developing experimental design and analysis skills.*
- ✓ *Usage of MINITAB software.*
- ✓ *Applying response surface methodology.*

**UNIT - I** **L-9**

Introduction to design and analysis of experiments with basic concepts and applications, Basic statistics; Analysis of variance (ANOVA).

**UNIT - II** **L-9**

Regression, Experimental designs- randomized complete block design (RCBD), variants of RCBD such as latin square, central composite design, etc.

**UNIT - III** **L-9**

Experimental designs- full factorial experiments, 2k factorial experiments.

**UNIT - IV** **L-9**

Experimental designs- fractional factorial experiments, 2k-p factorial experiments.

**UNIT - V** **L-9**

Response surface methodology; Introduction to software MINITAB.

## TEXT BOOK:

1. D. C. Montgomery, “Design and analysis of Experiments”, 8th edition, John Wiley & Sons Inc, 2014.

# 19CH432 MATLAB PROGRAMMING FOR NUMERICAL COMPUTATION

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |


***Source:***
*https://www.mathworks.com/*

**COURSE DESCRIPTION AND OBJECTIVES:**

MATLAB is a popular language for numerical computation. This course introduces students to MATLAB programming, and demonstrate it's use for scientific computations. The basis of computational techniques are expounded through various coding examples and problems, and practical ways to use MATLAB will be discussed. The objective of this course is to introduce undergraduate students to computational methods using MATLAB. At the end of this course, a student would: Learn basics of MATLAB programming get introduced to numerical methods for engineering problems will be able to use MATLAB to solve computational problems software used.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Apply basics of MATLAB programming. | 1 |
| 2 | Using of MATLAB for solving linear equations. | 1,5 |
| 3 | Solving nonlinear equations using MATLAB. | 1,5 |
| 4 | Approximating the solution by using regression methods. | 4 |
| 5 | Review MATLAB ode45 algorithm. | 2 |

**SKILLS:**

- ✓ *Solve higher derivatives numerically.*
- ✓ *Solve linear equations using MATLAB.*
- ✓ *Solve nonlinear equations using numerical methods.*
- ✓ *Approximate the solution by using linear least squares regression.*
- ✓ *Solve differential equations using various numerical methods.*

**UNIT - I** **L-9**

**INTRODUCTION TO MATLAB PROGRAMMING:** Basics of MATLAB programming; Array operations in MATLAB; Loops and execution control; Scripts and Functions; Plotting and program output.

**APPROXIMATIONS AND ERRORS:** Defining errors and precision in numerical methods; Truncation and round-off errors; Error propagation; Global and local truncation errors.

**UNIT - II** **L-9**

**NUMERICAL DIFFERENTIATION AND INTEGRATION:** Numerical differentiation in single variable; Numerical differentiation- higher derivatives; Differentiation in multiple variables; Newton-Cotes integration formulae; Multi-step application of trapezoidal rule; MATLAB functions for integration.

**UNIT - III** **L-9**

**LINEAR EQUATIONS:** Linear algebra in MATLAB; Gauss elimination; LU decomposition and partial pivoting; Iterative methods- Gauss Siedel; Special Matrices- tridiagonal matrix algorithm.

**NONLINEAR EQUATIONS:** Nonlinear equations in single variable; MATLAB function fzero in single variable; Fixed-point iteration in single variable; Newton-Raphson in single variable; MATLAB function solve in single and multiple variables; Newton-Raphson in multiple variables.

**UNIT - IV** **L-9**

**REGRESSION AND INTERPOLATION:** Introduction; Linear least squares regression (including Isqcurvefit function); Functional and nonlinear regression (including isqnonlin function); Interpolation in MATLAB using spline pchip.

**UNIT - V** **L-9**

**DIELECTRIC ORDINARY DIFFERENTIAL EQUATIONS (ODE) – PART 1:** Introduction to ODEs; Implicit and explicit Euler's methods; Second order Runge-Kutta methods; MATLAB ode 45 algorithm in single variable; Higher order Runge-Kutta methods; Error analysis of Runge-Kutta method.

**ORDINARY DIFFERENTIAL EQUATIONS (ODE)-PRACTICAL ASPECTS :** MATLAB ode45 algorithm in multiple variables; Stiff ODEs and MATLAB ode15s algorithm; Practical example for ODE-IVP; Solving transient PDE using method of lines.

## TEXT BOOK:

1. L. V. Fausett, "Applied Numerical Analysis Using MATLAB" 2nd edition, Pearson Education, 2009.

## REFERENCE BOOK:

1. S. C. Chapra, R. P. Canale, Numerical methods for engineers, 5th edition, McGraw Hill, 2006.

# 19CH433 OPTIMIZATION IN CHEMICAL ENGINEERING

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

***Source:***

*https://www.google.com/search?q=optimization+in+chemical+engineering&safe=strict&source=lnms&tbm*

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with optimization algorithms, modeling skills to describe and formulate optimization problems. The objective of this course is to familiarize the student with formulation of optimization problems, single and multivariable optimization, linear programming and optimization of chemical processes.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Identify different types of optimization problems. | 1, 2 |
| 2 | Analyze different optimization techniques. | 2 |
| 3 | Solve single and multi variable optimization problems. | 3, 4 |
| 4 | Solve problems using the method of least squares. | 3, 4 |
| 5 | Solve problems using graphical method. | 3, 4 |
| 6 | Solve problems using simplex method. | 3, 4 |

**SKILLS:**

- ✓ *Formulation of optimization problems.*
- ✓ *Fit the model for data.*
- ✓ *Optimize the constrained and unconstrained engineering process.*

**UNIT - I** **L-9**

**NATURE AND ORGANIZATION OF OPTIMIZATION PROBLEMS:** What optimization is all about; Why optimize; Scope and hierarchy of optimization; Examples of applications of optimization; Essential features of optimization problems; General procedure for solving optimization problems.

**FITTING MODELS TO DATA:** Fitting functions to empirical data; Method of least squares; Factorial experimental designs; Fitting a model to data subject to constraints.

**UNIT - II** **L-9**

**BASIC CONCEPTS OF OPTIMIZATION:** Continuity of functions; Unimodal versus multimodal functions; Convex and concave functions; Convex region.

**OPTIMIZATION OF UNCONSTRAINED FUNCTIONS, ONE-DIMENSIONAL SEARCH:** Numerical methods for optimizing a function of one variable; Scanning and bracketing procedure; Newton, Quasi-Newton and secant methods.

**UNIT - III** **L-9**

**UNCONSTRAINED MULTIVARIABLE OPTIMIZATION:** Direct methods - random search, grid search, univariate search, simplex method, conjugate search, Powell's methods; Indirect methods for first order- gradient method, conjugate method; Indirect method for second order- Newton's method.

**UNIT - IV** **L-9**

**LINEAR PROGRAMMING AND APPLICATIONS:** Basic concepts in linear programming; Degenerate LP's–graphical solution; Natural occurrence of linear constraints; Simplex method of solving linear programming problems; Standard LP form; LP applications.

**UNIT - V** **L-9**

**OPTIMIZATION OF UNIT OPERATIONS:** Recovery of waste heat; Evaporator design; Optimal design of staged distillation column; Optimal pipe diameter; Optimal residence time for maximum yield in an ideal isothermal batch reactor; Introduction to nonlinear programming.

## TEXT BOOKS:

1. T. F. Edgar and D. M. Himmelblau, "Optimization of Chemical Processes", 2nd edition, McGraw- Hill, 2001.
2. S. S. Rao, "Engineering Optimization", 4th edition, John Wiley & Sons, Inc., 2009.

## REFERENCE BOOKS:

1. K. M. Deb, "Optimization for Engineering Design", 2nd edition, Prentice Hall of India, 2012.
2. Suman Dutta, "Optimization in Chemical Engineering", Cambridge University Press, 2016.

# 19CH434 CHEMICAL PROCESS EQUIPMENT DESIGN

***Source:***
*https://chemical+process+equipment+design&safe*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 50 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

This course deals with the selection and design of chemical process equipments. The objective of this course is to acquire basic understanding of design parameters, complete knowledge of design procedures for commonly used process equipment and their attachments.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Design heat transfer equipment and mass transfer equipment. | 1,3 |
| 2 | Analyze internal pressure vessels and external pressure vessels. | 1,2 |
| 3 | Design rotary dryers. | 3 |
| 4 | Analyze engineering problems in distillation column. | 2 |
| 5 | Design cooling towers. | 3 |

**SKILLS:**

- ✓ *Design shell and tube heat exchanger.*
- ✓ *Analyze pressure vessels.*
- ✓ *Design dryers and sieve tray column.*
- ✓ *Design cooling towers.*

**UNIT - I** **L-9**

**DESIGN OF SHELL AND TUBE HEAT EXCHANGERS:** 1-2 heat exchanger; Arrangements for increased heat recovery; Calculations for process conditions; Design calculations of a shell and tube heat exchanger.

**UNIT - II** **L-9**

**PRESSURE VESSELS:** Introduction; Vessels subjected to internal pressure & combined loading; Stresses induced in vessels; Optimum proportions of a vessel; Optimum vessel size.

**UNIT - III** **L-9**

**DESIGN OF DRYERS:** Design of rotary dryer; Tray dryer and spray dryer.

**DESIGN OF PACKED TOWERS FOR ABSORPTION:** Flow of liquid over packing's; Limiting gas velocities; Pressure-drop calculations; Design of packed towers using absorption coefficients; Design of packed tower using transfer-unit method.

**UNIT - IV** **L-9**

**DESIGN OF SIEVE TRAY TOWER FOR DISTILLATION :** Introduction; Sieve tray; Tower diameter; Plate spacing; Entrainment; Flooding; Weepage; Tray Layout; Hydraulic parameters.

**UNIT - V** **L-9**

**COOLING TOWER PRACTICE :** Mechanism; Types; Rating duty and physical size of cooling towers; Cooling tower components; Construction material; Practical aspects of tower selection.

**COOLING TOWER DESIGN CALCULATIONS :** Heat transfer calculations; Selection of tower size for a given duty; Corrections for altitude; Use of charts for calculation of cooling tower duties.

## TEXT BOOKS:

1. D. Q. Kern, "Process Heat Transfer", 1st edition, Tata McGraw-Hill, 2001.
2. S. D. Dawande, "Process Equipment Design-Vol 1 & 2", 4th edition, Central Technom Publishers, 2005.

## REFERENCE BOOKS:

1. Robert E. Treybal, "Mass Transfer Operations", 3rd edition, McGraw-Hill, 2003.
2. Morris and Jackson, "Absorption Towers", Butter Worth's Scientific Publications, 1985.
3. Gerald Bowen Hill, E. J. Pring, Peter David Osborn and William Satnford, "Cooling Towers Principles and Practice", 3rd edition, Butter Worth-Heinemann, 1986.
4. R. K. Sinnott, "Coulson & Richardson's Chemical Engineering, Vol.6", 3rd edition,Butterworth Heinemann, 1999.

# 19CH435 ENVIRONMENTAL REGULATIONS AND IMPACT ANALYSIS

***Source:***
*https://Environmental+regulations&gs_l=img*

Hours Per Week :

| L | T | P | C |
|---|---|---|---|
| 3 | - | - | 3 |

| L | T | P |
|---|---|---|
| 45 | - | - |

| WA/RA | SSH/HSH | CS | SA | S | BS |
|---|---|---|---|---|---|
| 25 | 40 | - | - | 5 | 5 |

**COURSE DESCRIPTION AND OBJECTIVES:**

This course provides a overall review of environmental protection, acts and procedures. The objective of this course is to make a student aware of environmental protection acts and policies.

**COURSE OUTCOMES:**

Upon completion of the course, the student will able to achieve the following outcomes:

| COs | Course Outcomes | POs |
|---|---|---|
| 1 | Identify the environmental attributes to be considered for the EIA study. | 1,2 |
| 2 | Plan the methodology to monitor and review the environmental regulations. | 2,3 |
| 3 | Analyze and prevent water pollution and air pollution. | 2,3 |
| 4 | Analyze environment protection methods. | 2 |

**SKILLS:**

- ✓ *Analyze proposed development project plans for possible environmental effects and prepare appropriate initial studies.*
- ✓ *Solve environmental related issues according to the Indian environmental policy requirements.*

**UNIT - I** **L-9**

**INDIAN CONSTITUTION & ENVIRONMENT:** Introduction Indian constitution and environment; Environmental policy of India and the legislative framework.

**UNIT - II** **L-9**

**ENVIRONMENTAL POLICIES:** Institution mechanism and environmental policy; Environmental clearance and guidelines for Industries.

**UNIT - III** **L-9**

**ENVIRONMENTAL AUDIT:** Environmental standards; Hazardous wastes; Environmental audit and acts.

**UNIT - IV** **L-9**

**ENVIRONMENTAL POLLUTION:** Water pollution; Air pollution; Zero discharge; Public liability insurance.

**UNIT - V** **L-9**

**ENVIRONMENTAL ACTS:** National environment appellate authority; National environment tribunal; Indian forest service; Environment protection.

## TEXT BOOK:

1. R. K. Trivedi, “Handbook of Environmental Laws, Acts, Guidelines, Compliances & Standards”, 3rd edition, BS publications, 2010.

## REFERENCE BOOK:

1. Barathwal, R. R., “Environmental Impact Assessmen”, New Age International Publishers, 2002.