Estd 1995

# SETHU INSTITUTE OF TECHNOLOGY

ISO 9001:2008
FS 70973

## PULLOOR, KARIAPATTI – 626115

(An Autonomous Institution affiliated to
Anna University, Chennai)

# B.TECH. CHEMICAL ENGINEERING

## REGULATION 2015

CHOICE BASED CREDIT SYSTEM

## CURRICULUM AND SYLLABUS

Submitted in the Academic Council Meeting on 25.08.2018

CHAIRPERSON
DEPT OF CHEMICAL ENGG.
SETHU INSTITUTE OF TECHNOLOGY
PULLOOR, KARIAPATTI - 626 115.

CHAIRMAN
ACADEMIC COUNCIL
CHAIRMAN
ACADEMIC COUNCIL
Sethu Institute of Technology
Pulloor, Kariapatti - 625 115

Estd 1995

# SETHU INSTITUTE OF TECHNOLOGY

Pulloor, Kariapatti – 626 115

***(An Autonomous Institution)***

ISO 9001-2008
FS 70973

## B.TECH. Degree Programme

### CHOICE BASED CREDIT SYSTEM

### CURRICULUM (Regulations 2015)

## BACHELOR OF TECHNOLOGY IN CHEMICAL ENGINEERING

**OVERALL COURSE STRUCTURE**

| Category | Total No. of Courses | Credits | Percentage |
|---|---|---|---|
| Science & Humanities | 4 | 9 | 5 |
| Basic Science | 9 | 27 | 16 |
| Basic Engineering | 14 | 29 | 17 |
| Professional Subjects - CORE | 27 | 63 | 37 |
| Professional Subjects - ELECTIVE | 6 | 18 | 11 |
| Open Elective | 3 | 9 | 5 |
| Projects ( Technical and Major) | 2 | 15 | 9 |
| TOTAL | 65 | 170 | 100 |

**COURSE CREDITS – SEMESTER WISE**

| Branch | I | II | III | IV | V | VI | VII | VIII | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| CH | 22 | 21 | 22 | 23 | 20 | 23 | 19 | 20 | 170 |

# WINTER SEMESTER (ODD)

| S.No | Course Category | Course Code | Course Name | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1. | HS | 15UEN101 | Technical English – I<br>(Common to ALL Branches) | 2 | 0 | 0 | 2 |
| 2. | BS | 15UMA102 | Engineering Mathematics – I<br>(Common to ALL Branches) | 3 | 2 | 0 | 4 |
| 3. | BS | 15UPH103 | Engineering Physics- I<br>(Common to ALL Branches) | 3 | 0 | 0 | 3 |
| 4. | BS | 15UCY104 | Engineering Chemistry<br>(Common to MECH & CHEM) | 3 | 0 | 0 | 3 |
| 5. | ES | 15UCS107 | Computer Programming<br>(Common to ALL Branches) | 3 | 0 | 0 | 3 |
| 6. | ES | 15UME108 | Engineering Graphics<br>(Common to ALL Branches) | 2 | 0 | 4 | 4 |
| 7. | ES | 15UCS109 | Computer Programming Laboratory – 1<br>(Common to ALL Branches) | 0 | 0 | 2 | 1 |
| 8. | ES | 15UME110 | Engineering Practices Laboratory<br>(Common to MECH,CHEM, EEE and CIVIL) | 0 | 0 | 2 | 1 |
| 9. | BS | 15UGS112 | Basics Science Laboratory I<br>(Common to ALL Branches) | 0 | 0 | 2 | 1 |
| 10. | BS | 15UMA321 | Transforms and Partial Differential Equations<br>(Common to MECH, CIVIL, CHEM, ECE, | 3 | 2 | 0 | 4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | EEE & EIE) | | | | |
| 11. | PC | 15UCH301 | Introduction to Chemical Engineering | 3 | 0 | 0 | 3 |
| 12. | ES | 15UCH302 | Organic Chemistry | 3 | 0 | 0 | 3 |
| 13. | PC | 15UCH303 | Fluid Mechanics for Chemical Engineering | 3 | 0 | 0 | 3 |
| 14. | PC | 15UCH304 | Chemical Process Industries-I | 3 | 0 | 0 | 3 |
| 15. | ES | 15UEE324 | Electrical Drives and Control for Chemical Engineering | 3 | 0 | 0 | 3 |
| 16. | ES | 15UEE328 | Electrical Drives and Control for Chemical Engineering Laboratory | 0 | 0 | 2 | 1 |
| 17. | ES | 15UCH307 | Organic Chemistry Laboratory | 0 | 0 | 2 | 1 |
| 18. | PC | 15UCH308 | Chemical Engineering Fluid Mechanics Laboratory | 0 | 0 | 2 | 1 |
| 19. | PC | 15UCH501 | Chemical Engineering Thermodynamics – II | 3 | 0 | 0 | 3 |
| 20. | PC | 15UCH502 | Mass Transfer- I | 3 | 0 | 0 | 3 |
| 21. | PC | 15UCH503 | Heat transfer | 3 | 0 | 0 | 3 |
| 22. | PC | 15UCH504 | Instrumental Methods of Analysis | 3 | 0 | 0 | 3 |
| 23. | PC | 15UCH507 | Process Equipment Design and Drawing-I | 0 | 0 | 2 | 1 |
| 24. | PC | 15UCH508 | Heat Transfer Laboratory | 0 | 0 | 2 | 1 |
| 25. | PC | 15UCH701 | Transport Phenomena | 3 | 0 | 0 | 3 |
| 26. | PC | 15UCH702 | Chemical Engineering Process Economics and Industrial Management | 3 | 0 | 0 | 3 |
| 27. | PC | 15UCH703 | Chemical Reaction Engineering-II | 3 | 2 | 0 | 4 |
| 28. | PC | 15UCH707 | Chemical Reaction Engineering | 0 | 0 | 2 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Laboratory | | | | |
| 29. | PC | 15UCH708 | Process Equipment Design and Drawing-II | 0 | 0 | 2 | 1 |
| 30. | PC | 15UCH709 | Process Control Laboratory for Chemical Engineers | 0 | 0 | 2 | 1 |
| **TOTAL CREDITS: 71** | | | | **55** | **6** | **26** | **71** |

## SUMMER SEMESTER (EVEN)

| S.No | Course Category | Course Code | Course Name | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1. | HS | 15UEN201 | Business English and Presentations Skills<br>(Common to ALL Branches) | 3 | 0 | 0 | 3 |
| 2. | BS | 15UMA202 | Engineering Mathematics – II<br>(Common to ALL Branches) | 3 | 2 | 0 | 4 |
| 3. | BS | 15UPH203 | Material Science<br>(Common to MECH & CHEM) | 3 | 0 | 0 | 3 |
| 4. | HS | 15UCY207 | Environmental Science<br>(Common to ALL Branches) | 3 | 0 | 0 | 3 |
| 5. | ES | 15UEE208 | Basic Electrical and Electronics Engineering<br>(Common to MECH,, CIVIL & CHEM) | 3 | 0 | 0 | 3 |
| 6. | ES | 15UCH209 | Principles of Mechanics | 3 | 0 | 0 | 3 |
| 7. | BS | 15UGS210 | Basic Science Laboratory – II<br>(Common to ALL Branches) | 0 | 0 | 2 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8. | ES | 15UEE212 | Basic Electrical and Electronics Engineering Laboratory | 0 | 0 | 2 | 1 |
| 9. | BS | 15UMA422 | Numerical Methods<br>(EEE, EIE, ICE, CIVIL & CHEM) | 3 | 2 | 0 | 4 |
| 10. | PC | 15UCH401 | Chemical Engineering Thermodynamics -I | 3 | 0 | 0 | 3 |
| 11. | PC | 15UCH402 | Chemical Process Calculations | 3 | 0 | 0 | 3 |
| 12. | PC | 15UCH403 | Mechanical Operations | 3 | 0 | 0 | 3 |
| 13. | ES | 15UCH404 | Physical Chemistry | 3 | 0 | 0 | 3 |
| 14. | PC | 15UCH405 | Chemical Process Industries - II | 3 | 0 | 0 | 3 |
| 15. | PC | 15UGS431 | Reasoning and Quantitative Aptitude<br>(Common to ALL Branches) | 1 | 0 | 0 | 1 |
| 16. | ES | 15UCH407 | Physical Chemistry Laboratory | 0 | 0 | 2 | 1 |
| 17. | PC | 15UCH408 | Mechanical Operations Laboratory | 0 | 0 | 2 | 1 |
| 18. | ES | 15UCH409 | Technical Analysis Laboratory | 0 | 0 | 2 | 1 |
| 19. | PC | 15UCH601 | Mass Transfer-II | 3 | 0 | 0 | 3 |
| 20. | PC | 15UCH602 | Chemical Reaction Engineering-I | 3 | 0 | 0 | 3 |
| 21. | PC | 15UCH603 | Process Instrumentation Dynamics and Control | 3 | 0 | 0 | 3 |
| 22. | PC | 15UCH607 | Mass Transfer Laboratory | 0 | 0 | 2 | 1 |
| 23. | HS | 15UGS531 | Soft Skills and Communication Laboratory<br>Common to MECH, CIVIL, EIE & CHEM) | 0 | 0 | 2 | 1 |
| 24. | P | 15UCH608 | Technical Project | 0 | 0 | 6 | 3 |
| 25. | PC | 15UME801 | Professional Ethics<br>(Common to ALL Branches) | 2 | 0 | 0 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 26. | P | 15UCH801 | Project Work | 0 | 0 | 24 | 12 |
| **TOTAL CREDITS: 72** | | | | 48 | 4 | 44 | 72 |

**PROFESSIONAL ELECTIVES**

| S. No | Course Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Petroleum and Petrochemical** | | | | | | | |
| 1 | PE | 15UCH903 | Petroleum Refinery Engineering | 3 | 0 | 0 | 3 |
| 2 | PE | 15UCH906 | Polymer Technology | 3 | 0 | 0 | 3 |
| 3 | PE | 16UCH907 | Fertilizer Technology | 3 | 0 | 0 | 3 |
| **Energy and Environmental Engineering** | | | | | | | |
| 4 | PE | 15UCH911 | Air Pollution and Control | 3 | 0 | 0 | 3 |
| 5 | PE | 15UCH917 | Waste Water Treatment | 3 | 0 | 0 | 3 |
| 6 | PE | 15UCH918 | Electrochemical Engineering | 3 | 0 | 0 | 3 |
| 7 | PE | 15UCH910 | Energy Engineering | 3 | 0 | 0 | 3 |
| 8 | PE | 15UCH914 | Pinch Technology | 3 | 0 | 0 | 3 |
| **Process Modeling and Simulation** | | | | | | | |
| 9 | PE | 15UCH904 | Process Optimization | 3 | 0 | 0 | 3 |
| 10 | PE | 15UCH913 | Process Modeling and Simulation | 3 | 0 | 0 | 3 |
| 11 | PE | 15UCH916 | Pilot Plant and Scale Up | 3 | 0 | 0 | 3 |
| 12 | PE | 15UCH912 | Modern Separation Process | 3 | 0 | 0 | 3 |
| **Process Safety and Management** | | | | | | | |
| 13 | PE | 15UCH923 | Chemical Process Plant Safety | 3 | 0 | 0 | 3 |
| 14 | PE | 15UCH920 | Process Plant Utilities | 3 | 0 | 0 | 3 |
| 15 | PE | 15UCH919 | Entrepreneurial Skills for Chemical Product & Design | 3 | 0 | 0 | 3 |
| 16 | PE | 15UCH921 | Quality Management for Chemical Engineers | **3** | **0** | **0** | **3** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Bio Process Engineering** | | | | | | | |
| 17 | PE | 15UCH909 | Bio Chemical Engineering | 3 | 0 | 0 | 3 |
| 18 | PE | 15UCH901 | Food Science and Technology | 3 | 0 | 0 | 3 |
| 19 | PE | 15UCH908 | Fermentation Technology | 3 | 0 | 0 | 3 |
| 20 | PE | 15UCH922 | Drugs and Pharmaceutical Technology | 3 | 0 | 0 | 3 |
| **Modern Chemical Technology** | | | | | | | |
| 21 | PE | 15UCH902 | Fluidization Technology | 3 | 0 | 0 | 3 |
| 22 | PE | 15UCH905 | Pulp and Paper Technology | 3 | 0 | 0 | 3 |
| 23 | PE | 15UCH915 | Nano Science and Engineering | 3 | 0 | 0 | 3 |
| 24 | PE | 15UCH924 | Ceramic Technology | 3 | 0 | 0 | 3 |

## OPEN ELECTIVES

| S.No | Course Category | Course Code | Course Title | Credits | Offering Department |
|---|---|---|---|---|---|
| 1. | **OE** | 15UCH951 | Corrosion Science and Engineering | 3 | CHEMICAL |
| 2 | **OE** | 15UCH952 | Bio Sensor‟s | 3 | |
| 3. | **OE** | 15UCH953 | Energy Storage Systems | 3 | |
| 4. | **OE** | 15UCH954 | Alternate Energy Sources | 3 | |
| 5. | **OE** | 15UCH955 | Industrial Solid Waste Management | 3 | |

## ONE CREDIT COURSES

| S.No | COURSE CODE | COURSE NAME | CREDITS |
|---|---|---|---|
| 1. | 15UCH861 | MATLAB for Chemical Engineering | 1 |
| 2. | 15UCH862 | Simulation on Process Fundamentals | 1 |
| 3. | 15UCH863 | Sugarcane Processing and its Products | 1 |

| | | | |
|---|---|---|---|
| 4. | 15UCH864 | Dry Cement Manufacturing Process | 1 |
| 5. | 15UCH865 | Reclamation of Waste Lubricating Oils and its Products. | 1 |
| 6. | 15UCH866 | Pollution Control Engineering | 1 |
| **7.** | 15UCH867 | Enzymes for Environmental Applications | 1 |
| 8. | 15UCH868 | Reclamation of Press Mud Wax | 1 |
| 9. | 15UCH869 | Sensors for Air Pollution | 1 |
| 10. | 15UCH870 | Waste Recycling from Pulp and Textile Mills | 1 |
| 11. | 15UCH871 | Membrane Technology | 1 |
| 12. | 15UCH872 | Pyrotechnics | 1 |

## SEMESTER I

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 15UEN101 | Technical English – I (Common to ALL Branches) | 2 | 0 | 0 | 2 |
| 15UMA102 | Engineering Mathematics – I (Common to ALL Branches) | 3 | 2 | 0 | 4 |
| 15UPH103 | Engineering Physics- I (Common to ALL Branches) | 3 | 0 | 0 | 3 |
| 15UCY104 | Engineering Chemistry (Common to MECH & CHEM) | 3 | 0 | 0 | 3 |
| 15UCS107 | Computer Programming (Common to ALL Branches) | 3 | 0 | 0 | 3 |
| 15UME108 | Engineering Graphics (Common to ALL Branches) | 2 | 0 | 4 | 4 |
| **PRACTICAL** | | | | | |
| 15UCS109 | Computer Programming Laboratory – 1 (Common to ALL Branches) | 0 | 0 | 2 | 1 |
| 15UME110 | Engineering Practices Laboratory (Common to MECH,CHEM, EEE, EIE and CIVIL) | 0 | 0 | 2 | 1 |
| 15UGS112 | Basics Science Laboratory I (Common to ALL Branches) | 0 | 0 | 2 | 1 |
| **TOTAL** | | **16** | **2** | **10** | **22** |
| **Total No. of Credits - 22** | | | | | |

## SEMESTER II

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 15UEN201 | Business English and Presentations Skills (Common to ALL Branches) | 3 | 0 | 0 | 3 |
| 15UMA202 | Engineering Mathematics - II (Common to ALL Branches) | 3 | 2 | 0 | 4 |
| 15UPH203 | Material Science (Common to MECH & CHEM) | 3 | 0 | 0 | 3 |
| 15UCY207 | Environmental Science (Common to ALL Branches) | 3 | 0 | 0 | 3 |
| 15UEE208 | Basic Electrical and Electronics Engineering (Common to MECH,CIVIL & CHEM) | 3 | 0 | 0 | 3 |
| 15UCH209 | Principles of Mechanics | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | |
| 15UGS210 | Basic Science Laboratory - II (Common to ALL Branches) | 0 | 0 | 2 | 1 |
| 15UEE212 | Basic Electrical and Electronics Engineering Laboratory | 0 | 0 | 2 | 1 |
| **TOTAL** | | **18** | **2** | **4** | **21** |
| **Total No. of Credits - 21** | | | | | |

## SEMESTER III

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 15UMA321 | Transforms and Partial Differential Equations (Common to MECH, ECE, EEE, CIVIL, CHEMICAL, AGRI, BIO MEDICAL) | 3 | 2 | 0 | 4 |
| 15UCH301 | Introduction to Chemical Engineering | 3 | 0 | 0 | 3 |
| 15UCH302 | Organic Chemistry | 3 | 0 | 0 | 3 |
| 15UCH303 | Fluid Mechanics for Chemical Engineering | 3 | 0 | 0 | 3 |
| 15UCH304 | Chemical Process Industries-I | 3 | 0 | 0 | 3 |
| 15UEE324 | Electrical Drives and Control for Chemical Engineering | 3 | 0 | 0 | 3 |
| **PRACTICALS** | | | | | |
| 15UEE328 | Electrical Drives and Control for Chemical Engineering Laboratory | 0 | 0 | 2 | 1 |
| 15UCH307 | Organic Chemistry Laboratory | 0 | 0 | 2 | 1 |
| 15UCH308 | Chemical Engineering Fluid Mechanics Laboratory | 0 | 0 | 2 | 1 |
| **TOTAL** | | **18** | **2** | **6** | **22** |
| **Total No. of Credits – 22** | | | | | |

## SEMESTER IV

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 15UMA422 | Numerical Methods (EEE, CIVIL & CHEM) | 3 | 2 | 0 | 4 |
| 15UCH401 | Chemical Engineering Thermodynamics -I | 3 | 0 | 0 | 3 |
| 15UCH402 | Chemical Process Calculations | 3 | 0 | 0 | 3 |
| 15UCH403 | Mechanical Operations | 3 | 0 | 0 | 3 |
| 15UCH404 | Physical Chemistry | 3 | 0 | 0 | 3 |
| 15UCH405 | Chemical Process Industries - II | 3 | 0 | 0 | 3 |
| 15UGS431 | Reasoning and Quantitative Aptitude (Common to ALL Branches) | 1 | 0 | 0 | 1 |
| **PRACTICAL** | | | | | |
| 15UCH407 | Physical Chemistry Laboratory | 0 | 0 | 2 | 1 |
| 15UCH408 | Mechanical Operations Laboratory | 0 | 0 | 2 | 1 |
| 15UCH409 | Technical Analysis Laboratory | 0 | 0 | 2 | 1 |
| **TOTAL** | | **19** | **2** | **6** | **23** |
| **Total No. of Credits – 23** | | | | | |

## SEMESTER V

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 15UCH501 | Chemical Engineering Thermodynamics - II | 3 | 0 | 0 | 3 |
| 15UCH502 | Mass Transfer- I | 3 | 0 | 0 | 3 |
| 15UCH503 | Heat transfer | 3 | 0 | 0 | 3 |
| 15UCH504 | Instrumental Methods of Analysis | 3 | 0 | 0 | 3 |
| | Elective - I | 3 | 0 | 0 | 3 |
| | Elective - II | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | |
| 15UCH507 | Process Equipment Design and Drawing-I | 0 | 0 | 2 | 1 |
| 15UCH508 | Heat Transfer Laboratory | 0 | 0 | 2 | 1 |
| **TOTAL** | | **18** | **0** | **4** | **20** |
| **Total No. of Credits – 20** | | | | | |

## SEMESTER VI

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 15UCH601 | Mass Transfer-II | 3 | 0 | 0 | 3 |
| 15UCH602 | Chemical Reaction Engineering-I | 3 | 0 | 0 | 3 |
| 15UCH603 | Process Instrumentation Dynamics and Control | 3 | 0 | 0 | 3 |
| | Elective-III | 3 | 0 | 0 | 3 |
| | Elective-IV | 3 | 0 | 0 | 3 |
| | Open Elective- I | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | |
| 15UCH607 | Mass Transfer Laboratory | 0 | 0 | 2 | 1 |
| 15UGS531 | Soft Skills and Communication Laboratory (Common to MECH, CIVIL, EIE & CHEM) | 0 | 0 | 2 | 1 |
| 15UCH608 | Technical Project | 0 | 0 | 6 | 3 |
| **TOTAL** | | **18** | **0** | **10** | **23** |
| **Total No. of Credits – 23** | | | | | |

## SEMESTER VII

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 15UCH701 | Transport Phenomena | 3 | 0 | 0 | 3 |
| 15UCH702 | Chemical Engineering Process Economics and Industrial Management | 3 | 0 | 0 | 3 |
| 15UCH703 | Chemical Reaction Engineering-II | 3 | 2 | 0 | 4 |
| | Elective – V | 3 | 0 | 0 | 3 |
| | Open Elective-II | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | |
| 15UCH707 | Chemical Reaction Engineering Laboratory | 0 | 0 | 2 | 1 |
| 15UCH708 | Process Equipment Design and Drawing-II | 0 | 0 | 2 | 1 |
| 15UCH709 | Process Control Laboratory for Chemical Engineers | 0 | 0 | 2 | 1 |
| **Total** | | **15** | 2 | **6** | 19 |
| **Total No. of Credits - 19** | | | | | |

## SEMESTER VIII

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 15UME801 | Professional Ethics (Common to ALL Branches) | 2 | 0 | 0 | 2 |
| | Elective -VI | 3 | 0 | 0 | 3 |
| | Open Elective- III | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | |
| 15UCH801 | Project Work | 0 | 0 | 24 | 12 |
| **Total** | | **8** | **0** | **24** | **20** |
| **Total No. of Credits – 20** | | | | | |

| 15UEN101 | TECHNICAL ENGLISH | L | T | P | C |
|---|---|---|---|---|---|
| | (Common to ALL Branches) | 2 | 0 | 0 | 2 |

**OBJECTIVES:**

- To enhance the vocabulary of students
- To strengthen the application of functional grammar and basic skills
- To improve the language proficiency of students

**UNIT I** **6**

**Grammar** - Parts of Speech-Tense – **Vocabulary** – Technical Word Formation- Prefix- suffix - Synonyms and Antonyms- **Writing** – Instructions – Formal Letters - **Reading** Comprehension - Prose: A Nation"s Strength – Dr. Karan Singh

**UNIT II** **6**

**Grammar** – Concord -„Wh" Questions – **Vocabulary** – One Word Substitutes – Listening & Speaking – Conducting Meetings – **Writing** - Preparation of the Checklist, Essaywriting – **Reading** -Prose: My Vision of India-Dr.A.P.J.AbdulKalam

**UNIT III** **6**

**Grammar** – Voice – **Vocabulary**- Compound Nouns**Writing** – Minutes – Agenda - Transformation of Information (Transcoding)- **Reading Prose:** Professions of Women-Virginia Woolf.

**UNIT IV** **6**

**Grammar** - Conditional clauses - **Vocabulary** - Idioms & Phrases - **Writing** Letters to Editor - Making Invitations - Acceptance & Declining - Summarizing -**Reading** - Prose: Computers- Peter Laurie

**UNIT V** **6**

**Grammar** – Determiners – **Vocabulary** – Homophones & Homonyms – **Writing** Recommendations- Note Making - Report Writing-**Reading** – Prose: What We Must Learn From the West-Narayana Murthy

**TOTAL: 30(L) = 30 PERIODS**

***COURSE OUTCOMES***

After successful completion of this course the students will be able to:

- Use grammar effectively in writing meaningful sentences and paragraphs.
- Exhibit improved reading comprehension and vocabulary.
- Demonstrate writing skills in various formal situations.

- Demonstrate improved oral fluency.
- Presenting reports on various purposes.

**TEXT BOOK**:

1. S.M.Rajasangar*Technical English*, Rathna Arts,Sivakasi, 2018.

**REFERENCE BOOKS:**

1. AsrafRizvi.M, Effective Technical Communication, New Delhi, Tata McGraw-Hill Publishing Company Limited,2007.

2.Lakshminarayanan.K.R,EnglishforTechnicalCommunication,Chennai,ScitechPublications(India)Pvt.Ltd,2004.

| 15UMA102 | ENGINEERING MATHEMATICS – I | L | T | P | C |
|---|---|---|---|---|---|
| | (Common to ALL Branches) | 3 | 2 | 0 | 4 |

## OBJECTIVES :

- To make the students capable of identifying algebraic eigen value problems from practical areas and obtain the eigen solutions in certain cases.
- To make the students knowledgeable in integrating various types of functions using various integration methods.
- To familiarize the students with the basic rules of differentiation and use them to find derivatives of products and quotients that they might encounter in their studies of other subjects in the same or higher semesters.

### UNIT I DIFFERENTIAL CALCULUS 9 + 3

Introduction – Definition of derivatives – Limits and Continuity – Differentiation techniques (Product rule, Quotient rule, Chain rule) – Successive differentiation ($n^{th}$ derivatives) – Leibnitz theorem (without proof) – Maclaurin‟s series – Physical Applications (Newton‟s law of cooling – Heat flow problems, Rate of decay of radioactive materials - Chemical reactions and solutions, Ohm‟s law, Kirchoff‟s law – Simple electric circuit problems)

### UNIT II FUNCTIONS OF SEVERAL VARIABLES 9 + 3

Partial derivatives – Euler‟s theorem for homogenous functions – Total derivatives – Differentiation of implicit functions – Jacobian – Taylor‟s expansion – Maxima and Minima – Method of Lagrangian Multipliers.

### UNIT III INTEGRAL CALCULUS 8 + 3

Definitions and concepts of integrals – Methods of integration (Decomposition method, Substitution method, Integration by parts) – Definite integrals – Properties and problems – Reduction formulae – Beta and Gamma functions – Integration using Beta and Gamma functions.

### UNIT IV MULTIPLE INTEGRALS 8 + 3

Double integration – Cartesian and Polar coordinates – Change of order of integration – Change of variables between Cartesian and Polar coordinates – Triple integration in Cartesian coordinates – Area as double integral – Volume as triple integral.

### UNIT V MATRICES 8 + 3

Eigen value and eigenvector of a real matrix – Characteristic equation – Properties – Cayley-Hamilton theorem (excluding Proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Reduction of quadratic form to canonical form by orthogonal transformation – Applications of Matrices.

### SUPPLEMENT TOPIC (for internal evaluation only) 3

Evocation / Application of Mathematics, Quick Mathematics – Speed Multiplication and Division.

**TOTAL : 45 (L) + 30 (T) = 75 Periods**

## COURSE OUTCOMES:

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

- Find Eigen values and Eigenvectors for symmetric and non-symmetric matrices.
- Analyze functions using limits, continuity and derivatives to solve problems involving these functions.
- Use the Lagrange multiplier method to predict extreme values of functions with constraints and to find the absolute maximum and minimum of a function on different domains.
- Apply the various methods of integration for evaluating definite integrals.
- Apply the knowledge of multiple integrals to find the area and volume of region bounded by the given curves.

### TEXT BOOKS


1. BALI N. P and MANISH GOYAL, "A Text book of Engineering Mathematics", Laxmi Publications (P) Ltd, New Delhi, 8th Edition, (2011).
2. GREWAL. B.S, "Higher Engineering Mathematics", Khanna Publications, New Delhi, 42nd Edition, (2012).
3. KREYSZIG. E, "Advanced Engineering Mathematics", John Wiley & Sons, New York, 10th Edition, (2011).


### REFERENCE BOOKS


1. RAMANA B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 11th Reprint, (2010).
2. GLYN JAMES, "Advanced Engineering Mathematics", Pearson Education, New Delhi, 7th Edition, (2007).
3. JAIN R.K and IYENGAR S.R.K," Advanced Engineering Mathematics", Narosa Publishing House, New Delhi, 3rd Edition, (2007).
4. BHARATI KRISHNA TIRTHAJI, "Vedic Mathematics - Mental Calculation", Motilal Banarsidass Publications, New Delhi, 1st Edition, (1965).

| | | L | T | P | C |
|---|---|---|---|---|---|
| **15UPH103** | **ENGINEERING PHYSICS** | | | | |
| | **(Common To All Branches)** | 3 | 0 | 0 | 3 |

**OBJECTIVES :**

- To develop the research interest in crystal physics
- To make students to understand classification of sound and applications of Ultrasonics
- To use the principles of Lasers and its types
- To apply principles of Quantum physics in engineering field
- To develop knowledge on principles of Thermal Physics

**UNIT I CRYSTAL PHYSICS** **9**

Crystalline – Amorphous materials – single and poly crystal- Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – parameters of Unit cell – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – crystal growth technique- Bridgeman method.

**UNIT II ACOUSTICS AND ULTRASONICS** **9**

Classification of sound – decibel- weber- Fechner law – Units of Loudness- decibel- phon- sone- Reverberation – Absorption Coefficient –Introduction to ultrasonic- Magnetostriction effect – piezoelectric effect - piezoelectric generator- Detection of ultrasonic waves - properties – Cavitations -Velocity measurement – acoustic grating - Industrial applications – SONAR .

**UNIT III WAVE OPTICS AND LASERS** **9**

Introduction – interference – refractive index –Expression for plane, circularly and elliptically polarized light LASER: Introduction- Principles of Laser- Einstein theory of stimulated emission- Population inversion Methods - Types of lasers – $Co_2$ laser - semiconductor laser – homojunction –heterojunction- Applications.

**UNIT IV QUANTUM PHYSICS** **9**

Introduction to black body- de Broglie wavelength – Schrödinger‟s wave equation – Time dependent – Time independent equation – Physical significance of wave function - Compton Effect – Theory and experimental verification .

**UNIT V PROPERTIES OF SOLIDS AND THERMAL PHYSICS** **9**

Elasticity- Hooke‟s law –Different types of moduli of elasticity- stress -strain diagram – Poisson‟s ratio –Factors affecting elasticity –Bending moment – Depression of a cantilever – Young‟s modulus by uniform bending - Thermal conductivity- Newton‟s law of cooling – Lee‟s disc method - Concept of Entropy.

**COURSE OUTCOMES**:

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

- apply the crystal growth techniques
- discuss the basic concepts of Acoustics and Ultrasonics.

- acquire knowledge about wave optics and Lasers
- summarize the principles of quantum physics
- explain the methods of thermal conduction.

**TEXT BOOKS:**


1. Dr. Mani.P, “A Text Book of Engineering Physics”, Dhanam Publications, Edition ,2014, Chennai.
2. Rajendran.V, “Engineering,Physics”, Tata Mc-Graw Hill Publishing Company limited, New Delhi, Revised Edition 2013.
3. Palanisami P.K., “Physics For Engineers”, Scitech Publications (India), Pvt Ltd., Chennai, 2014.


**REFERENCE BOOKS:**


1. Raghuvenshi G.S., “Engineering Physics”, PHI Learning Private Limited, New Delhi, Revised Edition 2014.
2. Arul doss .G., “Engineering Physics”, PHI Learning Limited, New Delhi, Revised Edition 2013.
3. Marikani .A., “Engineering Physics”, PHI Learning Private Limited, New Delhi, Revised Edition 2012.
4. Sankar B.N., and Pillai .S.O., “A Text book of Engineering Physics”, New Age International Publishers Private Limited, New Delhi, Revised Edition 2013.
5. Avadhanulu M.N. and Kshirsagar P.G., “A Textbook: of Engineering Physics”, S.Chand& Company Ltd., New Delhi, 2015.

| 15UCY104 | ENGINEERING CHEMISTRY | L | T | P | C |
|---|---|---|---|---|---|
| | (Common To MECH & CHEM) | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

i) Introduce about bonding concepts and fundamentals of solution preparation
ii) Understand the principles and application of corrosion science.
iii) Acquire knowledge about Thermodynamics and Phase Rule
iv) Create an awareness among present generation about the various fuel sources
v) Acquire knowledge about the applications of alloys and composites

**MODULE I: CHEMICAL BONDING: 9**

**Chemical Bonding:** Electronic Configuration- Ionic Bond - Covalent Bond – Metallic bond – Aufbau principle, Octet Rule, Pauli Exclusion principle, Molecular Orbital theory, Valence bond theory and its limitations, Various types of hybridization and shapes of simple molecules and ions, bond strength and bond energy, Born-Haber cycle, Fajan's rule, - Hydrogen bonding, Vander Waals forces.

**MODULE II: ELECTROCHEMISTRY AND CORROSION: 9**

**Electrochemistry:** Introduction -Electrochemical cells- reversible and irreversible cells – EMF – measurement of EMF-Single electrode potential-Nernst equation.

**Chemical corrosion:** Introduction- Definition- Types - (Dry corrosion, mechanism and its Example)-Electrochemical corrosion(Wet corrosion, mechanism and its Types – Galvanic & Differential aeration Corrosion- Pitting, crevice & Wire fence corrosion). Factors influencing rate of corrosion. Corrosion prevention - Cathodic protection, Corrosion inhibitors, and Protective coatings – Paint, Electro plating – Gold plating-Risk Analysis, Alloy Plating, Electroless plating – Nickel plating.

**MODULE III: CHEMICAL THERMODYNAMICS AND PHASE RULE: 9**

**Terminology of thermodynamics - Second law**: Entropy - entropy change for an ideal gas, reversible and irreversible processes; Free energy and work function; Gibbs Helmholtz equation; Clausius – Clapeyron equation; Maxwell relations.

**Phase rule:** Introduction, definition of terms with examples, One Component System- water system - Reduced phase rule.

**MODULE IV: FUELS AND COMBUSTION: 9**

Calorific value – classification – Coal – proximate and ultimate analysis. metallurgical coke – manufacture by Otto-Hoffmann method – Petroleum processing and fractions – cracking – catalytic cracking and methods-knocking – octane number and Cetane number – synthetic petrol – Fischer Tropsch and Bergius processes – Gaseous fuels - water gas, producer gas, CNG and LPG, Flue gas analysis – Orsat apparatus.

**MODULE V: ALLOYS AND COMPOSITES: 9**

Metals – Classification and properties, alloys – importance, ferrous alloys –nichrome and stainless steel – heat treatment of steel, non-ferrous alloys – brass and bronze. Composites-Fundamentals of composites, characteristics, need for composites, Enhancement of properties, Reinforcements - glass fibers, boron fibers, carbon fibers, organic fibers, aramid fibers, ceramic fibers,oxide and nonoxidefibers, Matrix materials –Ceramic materials,Surface treatments.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

After completion of the course,the students are able to:

i) Have sound knowledge on the basics of chemistry related to bonding.
ii) Know the principles, various types of corrosion and corrosion control techniques.
iii) Gain knowledge about Thermodynamics and Phase Rule
iv) Create awareness on the need to utilise the fuel sources effectively in the environment
v) Describe the impact of composite materials and engineering plastics

**TEXT BOOKS**

1.Jain P.C. and Monica Jain, "Engineering Chemistry", DhanpatRai Publishing Company (P)Ltd., New Delhi, 2010
2. Dr.Sunita Rattan, "A Textbook of Engineering Chemistry" S.K.Kataria& Sons., New Delhi,2013.

**REFERENCE BOOKS**

1. Physical chemistry – Samuel Glasstone, Macmillan II edition, 1969.
2. Physical Chemistry – P. L. Sony, Sulthan Chand & Sons, Delhi - 6.
3. A. K. Kaw, *Mechanics of Composite Materials*, CRC Press, New Delhi 2005.
4. S. C. Sharma, *Composite materials*, Narosa Publications**,** New Delhi, 2000.

| 15UCS107 | COMPUTER PROGRAMMING | L | T | P | C |
|---|---|---|---|---|---|
| | (COMMON TO ALL BRANCHES) | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart the concepts in basic organization of computers and problem solving techniques.
- To familiarize the programming constructs of C.
- To explain the concepts of arrays, strings, functions, pointers, structures and unions in C

**UNIT I INTRODUCTION** **8**

Generation and Classification of Computers - Basic Organization of a Computer – Problem formulation – Problem Solving - Need for logical analysis and thinking – Algorithm – Pseudo code – Flow Chart.

**UNIT II C PROGRAMMING BASICS** **9**

Introduction to „ C‟ programming – fundamentals – structure of a „C‟ program – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in „C‟ – Managing Input and Output operations

**UNIT III DECISION MAKING AND LOOPING STATEMENTS** **10**

if - if-else - nested if-else – else-if ladder statement – switch – goto – for- while – do-while – break – continue statements – Problem solving with decision making and looping statements

**UNIT IV ARRAYS, STRINGS AND FUNCTIONS** **9**

Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays - String - String operations – string arrays - Function – definition of function – Declaration of function – Parameter passing methods – Recursion - Storage classes – Problem solving with arrays, strings and functions

**UNIT V POINTERS, STRUCTURES AND UNIONS** **9**

Pointers - Definition – Initialization – Pointers arithmetic – Pointers and arrays - Dynamic Memory allocation – Structure - need for structure data type – structure definition – Structure declaration – Structure within a structure - Union - Pre-processor directives

**TOTAL: 45 PERIOD**

**LEARNING OUTCOMES:**

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

- Illustrate the basics about computer
- Develop simple programs using branching and looping constructs
- Write C program to manage data using arrays
- Develop programs using functions
- Write C programs for simple applications

**TEXT BOOKS:**


1. Sutha . J, “Computer Programming”, Third edition 2015, Littlemoon Publications, Kariapatti.
2. Pradip Dey, Manas Ghosh, “Fundamentals of Computing and Programming in C”, Oxford University Press, First Edition, 2009.
3. Behrouz A. Forouzan, Richard F.Gilberg, “A Structured Programming Approach using C”, Third Edition, Thomson Course Technology, 2007.


**REFERENCE BOOKS :**


1. Yashavant P. Kanetkar. “ Let Us C”, BPB Publications, 2011.
2. Kernighan.B.W ,Ritchie.D.M, “The C Programming language”, Pearson Education, Second Edition, 2006.
3. Stephen G.Kochan, “Programming in C”, Pearson Education India, Third Edition, 2005.
4. Anita Goel ,Ajay Mittal, ” Computer Fundamentals and Programming in C””, Dorling Kindersley (India) Pvt. Ltd, Pearson Education in South Asia, 2011.
5. Byron S Gottfried, ” Programming with C ”, Schaum‟s Outlines, Tata McGraw-Hill, Second Edition, 2006.

**15UME108** **ENGINEERING GRAPHICS** **L T P C**
**(Common to ALL Branches)** **2 0 4 4**

**OBJECTIVES:**

- To develop in students graphic skill for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings
- To impart knowledge in development of surfaces, isometric and perspective projections

**CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION) 1**

Importance of Graphics in Engineering Applications – Use of Drafting Instruments – BIS Conventions and Specifications – Size, Layout and Folding of Drawing Sheets – Lettering and Dimensioning

**UNIT I PLANE CURVES, PROJECTION OF POINTS, LINES AND PLANE SURFACES 5+9**

**Plane Curves: (Not for Examination)**

Conics – Construction of ellipse, Parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of squad and circle – Drawing of tangents and normal to the above curves.

**Projections:**

Projection of points and straight lines located in the first quadrant – Determination of true lengths and true inclinations – Projection of polygonal surface and circular lamina inclined to both reference planes.

**UNIT II PROJECTION OF SOLIDS 6+9**

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

**UNIT III SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 6+9**

Sectioning of above solids in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Obtaining true shape of section.Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders and cones

**UNIT IV ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+9**

**Isometric Projections**

Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones.

**Perspective Projections (Not for Examination)**

Perspective projection of prisms, pyramids and cylinders by visual ray method.

**UNIT V ORTHOGRAPHIC PROJECTION 6+9**

Representation of Three Dimensional objects – General principles of orthographic projection – Need for importance of multiple views and their placement – First angle projection – layout views – Developing visualization skills of multiple views from pictorial views of objects.

**TOTAL: 30 (L) + 45 (P) = 75 PERIODS**

**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

- Discuss first angle projection to project straight line, planes and solids.
- Illustrate simple solids like prisms, pyramids, cylinder and cone.
- Construct section of solids and development of surfaces for engineering applications.
- Prepare isometric views of objects like truncated solids and frustums.
- Prepare orthographic views from isometric drawings.

**TEXT BOOKS**


1. Seeni Kannan P., Pitchayya Pillai G., and Arun Balasubramanian K., "Engineering Graphics", Little Moon Publication, (2012).
2. Bhatt N.D., "Engineering Drawing", 46th Edition, Charotar Publishing House, (2003).


**REFERENCE BOOKS**


1. Natarajan K.V., "A Text book of Engineering Graphics", Dhanalakshmi Publishers, (2006).
2. Venugopal K., and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, (2008).
3. Gopalakrishnan K.R., "Engineering Drawing" (Vol .I&II), Subhas Publications,(1998).
4. Dhananjay A.Jolhe, "Engineering Drawing with an introduction to Auto CAD", Tata Mc Graw Hill Publishing Company Limited, (2008).


**Publication of Bureau of Indian Standards:**

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

**Special points applicable to End Semester Examinations on Engineering Graphics:**

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. Whenever the total number of candidates in a college exceeds 150, the End Semester Examination in that college will be conducted in two sessions (FN and AN on the same day) for 50 percent of student (approx) at a time.

**15UCS109** **COMPUTER PROGRAMMING LABORATORY** **L T P C**

**(Common to ALL Branches )** **0 0 2 1**

**OBJECTIVES :**

- To make the students to work with Office software.
- To familiarize the implementation of programs in C.

**LIST OF EXPERIMENTS**

**Word Processing**

**a) Document creation, Formatting, Table Creation, Mail merge**

**b) Spread Sheet**

Chart - Line, XY, Bar and Pie, Formula - formula editor.

**c) C Programming**

- Programs using simple statements
- Programs using decision making statements
- Programs using looping statements
- Programs using one dimensional and two dimensional arrays
- Solving problems using string functions
- Programs using user defined functions and recursive functions
- Programs using pointers
- Programs using structures and unions

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

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

- Create the document in Word Processing software.
- Write programs using control constructs.
- Apply functions to reduce redundancy.
- Design and implement C programs for simple applications.

**HARDWARE / SOFTWARE REQUIRED FOR A BATCH OF 30 STUDENTSHARDWARE**

**LAN SYSTEM WITH 30 NODES (OR) STANDALONE PCS – 30 NOS.**

**SOFTWARE**

**OS – UNIX CLONE (License**

**free Linux) APPLICATION**

**PACKAGE – OFFICE SUITE**

**COMPILER – C**

**15UME110 ENGINEERING PRACTICES LABORATORY LT P C**
**(Common to MECH, EEE, EIE, CHEM & CIVIL Branches) 0 0 2 1**

**OBJECTIVES:**

- To demonstrate the plumbing and carpentry works.
- To train the students to perform welding and drilling operations.
- To demonstrate residential house wiring, fluorescent lamp wiring, measurement of earth resistance, colour coding of resistors, logic gates and soldering.

**LIST OF EXPERIMENTS**

**GROUP A (CHEM, CIVIL & MECHANICAL)**

**I) CIVIL ENGINEERING PRACTICE 6**

**Buildings:**

a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

**Plumbing works:**

a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
b) Study of pipe connections requirements for pumps and turbines.
c) Preparation of plumbing line sketches for water supply and sewage works.
d) Hands-on-exercise: Basic pipe connections-Mixed pipe material connection Pipe connections with different joining components.
e) Demonstration of plumbing requirements of high-rise buildings.

**Carpentry using power tools on:**

a) Study of the joints in roofs, doors, windows and furniture.
b) Hands-on-exercise: Wood work, joints by sawing, planning and cutting.

**II) MECHANICAL ENGINEERING PRACTICE 9**

**Welding:**

(a) Preparation of arc welding of butt joints, lap joints and tee joints.
(b) Study of Gas welding practice.

**Basic Machining:**

(a) Drilling Practice

**Sheet Metal Work:**

(a) Model making – Trays, funnels, etc.
(b) Study of Different type of joints.

**Machine assembly practice:**

(a) Study of centrifugal pump
(b) Study of air Conditioner

**Demonstration on:**

(a) Smithy operations, upsetting, swaging, setting down and bending.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c)

## GROUP B (ELECTRICAL & ELECTRONICS)

**III) ELECTRICAL ENGINEERING PRACTICE 7**

(a) Residential house wiring using switches, fuse, indicator, lamp and energy meter and Stair case wiring
(b) Fluorescent lamp wiring.
(c) Measurement of resistance to earth of electrical equipment.

**IV) ELECTRONICS ENGINEERING PRACTICE 8**

(a) Study of Electronic components and equipments – Resistor, colour coding measurement of AC Signal parameter (peak-peak, rms, period, frequency) using CRO.
(b) Study of logic gates AND, OR, EX-OR and NOT Gate.
(c) Soldering practice – Components, Devices and Circuits – Using general purpose PCB.

**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

- Perform basic plumbing and carpentry works.
- Demonstrate the welding and drilling.
- Build sheet metal models like tray and funnel.
- Accomplish basic residential house wiring.
- Acquire knowledge in soldering practice and logic gates.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

- Ability to fabricate carpentry components and pipe connections including plumbing works.
- Ability to use welding equipments to join the structures. ability to fabricate electrical and electronics circuits.

**REFERENCES**


1. Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, 2007.
2. Jeyapoovan T., Saravanapandian M. & Pranitha S., “Engineering Practices Lab Manual”, Vikas Puplishing House Pvt.Ltd, 2006.
3. Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, 2007.
4. Rajendra Prasad A. & Sarma P.M.M.S., “Workshop Practice”, Sree Sai Publication, 2002.
5. Kannaiah P. & Narayana K.L., “Manual on Workshop Practice”, Scitech Publications, 1999.

| 15UGS112 | BASIC SCIENCES LABORATORY 1 | L | T | P | C |
|---|---|---|---|---|---|
| | (Common To ALL Branches) | 0 | 0 | 2 | 1 |

**OBJECTIVES:**

- To create scientific temper among the students.
- To know how to execute experiments properly, presentation of observations and arrival of conclusions.
- To view and realize the theoretical knowledge acquired by the students through experiments.

## PHYSICS LABORATORY

### LIST OF EXPERIMENTS
### (Common to All Branches)

1. Laser – Determination of particle size and wavelength of Laser source. using Diode Laser.
2. Ultrasonic Interferometer - Determination of velocity of sound and compressibility of liquid.
3. Poiseuille‟s method - Determination of viscosity of liquid.
4. Spectrometer – Determination of dispersive power of a prism.
5. Compound pendulum – Determination of the acceleration due to gravity
6. Air Wedge method - Determination of thickness of a thin wire.

- **A minimum of FIVE experiments shall be offered**

**TOTAL: 30 Periods**

**COURSE OUTCOMES:**

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

- Familiarize the fundamentals of various science and technology subjects and thus acquire the capability to applying them.
- Acquire laboratory skills in handling various equipments and in turn make them knowledgeable in future research aspirations.

**Laboratory classes on alternate weeks for Physics and Chemistry**

## CHEMISTRY LABORATORY

**OBJECTIVES:**

- To impart knowledge on basic concepts in application of chemical analysis
- To train the students in instrumental methods
- To develop skills in estimation of various ions by chemical and instrumentation methods

### LIST OF EXPERIMENTS

a. COMPUTER SCIENCE ENGINEERING.

b. ELECTRONICS AND COMMUNICATION ENGINEERING.

c. ELECTRICAL AND ELECTRONICS ENGINEERING.

d. ELECTRICAL AND INSTRUMENTATION ENGINEERING.

e. INFORMATION TECHNOLOGY.

1. Preparation of molar and normal solutions of the following substances – Oxalic acid ,Sodium Carbonate , Sodium Hydroxide and Hydrochloric acid.
2. Conductometric Titration of strong acid with strong base
3. Estimation of $Fe^{2+}$ ion by potentiometry
4. Determination of Strength of given acid using pH metry
5. Determination of molecular weight of polymer by viscometry
6. Comparison of the electrical conductivity of two samples-conductometric method
7. Estimation of copper in brass by EDTA method

### LIST OF EXPERIMENTS

**a. MECHANICAL ENGINEERING**

**b. CHEMICAL ENGINEERING**

1. Preparation of molar and normal solutions of the following substances – Oxalic acid , Sodium Carbonate , Sodium Hydroxide and Hydrochloric acid.
2. Estimation of copper in brass by EDTA method .
3. Conductometric Titration of strong acid with strong base
4. Estimation of $Fe^{2+}$ ion by potentiometry
5. Determination of Strength of given acid using pH metry
6. Determination of corrosion rate by weight loss method.
7. Comparison of the electrical conductivity of two samples-conductometric method.

## LIST OF EXPERIMENTS

## CIVIL ENGINEERING

1. Preparation of molar and normal solutions of the following substances – Oxalic acid , Sodium Carbonate , Sodium Hydroxide and Hydrochloric acid.
2. Conductometric Titration of Mixture of Acids
3. Estimation of $Fe^{2+}$ ion by potentiometry.
4. Determination of Strength of given acid using pH metry
5. Determination of suspended and dissolved solids in water.
6. Comparison of the electrical conductivity of two samples-conductometric method
7. Estimation of copper in brass by EDTA method

**A minimum of FIVE experiments shall be offered for every course**

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student will able to

1. Estimate the ions present in the given sample
2. Determine the rate of corrosion, molecular weight and amount of solids in water.
3. Estimate the acidity of water sample

**(Common to all Branches of Engineering)**
**II Semester**
**15UEN201 – BUSINESS ENGLISH & PRESENTATION SKILLS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To use linguistic tools confidently in an English speaking context
- To listen and speak during normal business activities such as interviews, meetings, telephone conversations and negotiations.
- To write business letters, emails, reports, articles and comprehend information on the Internet and other media.
- To gain language skills for real business life situations

**Unit – I** **9**

**Grammar**- Numerical Adjective; **Vocabulary** - Job title and describing jobs; **Listening** - Listening to company culture; **Reading** - Quiz; **Writing** - Writing formal and semi formal business letters; **Speaking** – Personal information, Companies and products.

**Unit – II** **9**

**Grammar** -Modals; **Vocabulary –** Collocations; **Listening** - Business Proceedings; **Reading** - Designing websites and e- mail ; **Writing** – Memo - **Speaking -** Role play on various business situation.

**Unit – III** **9**

**Grammar** – prepositions – Articles; **Vocabulary –**Jargons related to Shares and stock; **Listening** – Interviews of celebrities; **Reading –** Shares and stock exchange transactions; **Writing** – Business report – Minutes of the Meeting; **Speaking** – Presentations, Making a business talk.

**Unit – IV** **9**

**Grammar** - Connectives; **Vocabulary** -Words related to finance; **Listening** - Listening to statistical information; **Reading** - Interpreting business related bar charts; **Writing** - Letters to express interest in new products; **Speaking** - Presenting a summary of an article.

**Unit - V** **9**

**Grammar -** Reported speech; **Vocabulary** – Words related to employment ; **Listening**- Listening to audio and video speech of business people; **Reading** - Reading News paper article/magazine articles on business; **Writing** - Writing a Proposal; **Speaking** - Discussing company policies.

**TOTAL: 45(L) = 45 PERIODS**

**COURSE OUTCOMES:**

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

- Use business vocabulary effectively to present the ideas.
- Accomplish verbal and written communications.
- Write effectively in a wide range of business letters.
- Prepare Business Proposals and Business Reports for various business purposes.
- Make a presentation in English in various business avenues.

**TEXT BOOK:**

1. Elankathiravan B.A, *Business English and Presentation Skills,* Sivakasi, Wakeup Publications, 2016.

**REFERENCE BOOKS:**

1. Michael McCarthy, Felicity O"Dell, English Collocations in Use, Noida, Cambridge University Press, 2006.
2. Allan Pease, Body Language, New Delhi, Sudha Publications (P) Ltd, 2005.
3. Malcolm Goodale, Professional Presentations, New Delhi, Cambridge University Press, 2006.
4. Randolph Hudson. H & Bernard Selzler. J. Business Communication, Jaico Publishing House, 2006

| 15UMA202 | ENGINERRING MATHEMATICS – II | L T P C |
|---|---|---|
| | (Common to ALL Branches) | 3 2 0 4 |

**OBJECTIVES :**

- To develop an understanding of the basics of vector calculus comprising of gradient, divergence and curl, and line, surface and volume integrals and the classical theorems involving them.
- To acquaint the student with the concepts of analytic functions and their interesting properties which could be exploited in a few engineering areas, and be introduced to the host of conformal mappings with a few standard examples that have direct application.
- To make the student acquire sound knowledge of Laplace transform and its properties and sufficient exposure to the solution of certain linear differential equations using the Laplace transform technique.

**UNIT I ANALYTICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS 8 + 6**

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy‟s and Legendre‟s linear equations – Applications of ODE (Bacterial growth, Population growth, Decayed problems).

**UNIT II VECTOR CALCULUS 8 + 6**

Gradient Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green‟s theorem in a plane, Gauss divergence theorem and Stokes‟ theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopiped.

**UNIT III ANALYTIC FUNCTIONS 8 + 6**

Functions of a complex variable – Analytic function – Necessary and Sufficient Conditions (excluding Proofs) – Harmonic function - Properties of an analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: w = z+c, cz, 1/z, and Bilinear transformation.

**UNIT IV COMPLEX INTEGRATION 9 + 6**

Statement and applications of Cauchy‟s integral theorem, Cauchy‟s integral formula and Cauchy Residue Theorem – Taylor‟s and Laurent‟s expansions – Applications of residue theorem to evaluate real integrals – Unit circle and semi-circular contour (excluding Poles on the real axis).

**UNIT V LAPLACE TRANSFORM 9 + 6**

Existence conditions – Transform of elementary functions – Basic properties – Transform of derivatives and integrals – Transform of unit step function, impulse function and periodic function - Inverse Laplace transform – Convolution theorem (excluding Proof) –Solution of linear ODE of second order with constant coefficients.

**SUPPLEMENT TOPIC (for internal evaluation only) 3**

Evocation / Application of Mathematics, Arithmetical, Ability – Time and Work – Time and Distance.

**TOTAL : 45 (L) + 30 (T) = 75 Periods**

## COURSE OUTCOMES:

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

- Solve first and higher order ordinary differential equations analytically and apply in real life engineering problems.
- Apply single step and multi-step methods to solve initial value problems for differential equations.
- Calculate the gradients and directional derivatives of functions of several variables.
- Apply the knowledge of standard techniques of complex variables for evaluating different functions

Apply Laplace Transform methods to solve initial value problems for constant coefficient linear ODEs.

### TEXT BOOKS


1. BALI N. P and MANISH GOYAL, "Text book of Engineering Mathematics", Laxmi Publications (P) Ltd., New Delhi, 3rd Edition, (2008).
2. GREWAL. B.S, "Higher Engineering Mathematics", Khanna Publications, New Delhi, 43rd Edition, (2014).
3. SANKAR RAO. K, "Numerical Methods for Scientists and Engineers", Prentice Hall of India, New Delhi, 3rd Edition, (2007).


### REFERENCE BOOKS


1. RAMANA B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 11th Reprint, (2010).
2. KREYSZIG. E, "Advanced Engineering Mathematics", John Wiley & Sons, New York, 10th Edition, (2011).
3. JAIN R.K and IYENGAR S.R.K, "Advanced Engineering Mathematics", Narosa Publishing House Pvt. Ltd., New Delhi, 3rd Edition, (2007).
4. GERALD C.F. and WHEATELEY, P.O. "Applied Numerical Analysis", Pearson Education, New Delhi, 7th Edition, (2003).
5. AGARWAL R.S., "Quantitative Aptitude", S. Chand Publications, New Delhi, 7th Edition, (2008), pp. 341-370, 384-404.

| | MATERIALS SCIENCE | L | T | P | C |
|---|---|---|---|---|---|
| **15UPH203** | (Common to Chemical &MechanicalBranches) | **3** | **0** | **0** | **3** |

**OBJECTIVES :**

- To gain knowledge about the physical properties of the various materials.
- To cover the fundamental scientific principles for the different synthesis techniques and assembly of the advanced materials.
- To achieve an understanding of principles of thermodynamics and to be able to use it for physical systems like boiler, pressure vessels etc.,

**UNIT I CONDUCTORS AND DIELECTRICS 9**

Conductors — Electrical and thermal conductivity – Wiedemann – Franz law – Fermi distribution function- Dielectric Materials: Introduction – Electrical susceptibility-Dielectric constant-Electronic, ionic, orientation and space charge polarization – Internal field – Claussius-Mosotti relation (Derivation).

**UNIT II SEMICONDUCTING MATERIALS 9**

Introduction- Intrinsic semiconductor – Electron concentration-Hole concentration-Intrinsic carrier concentration – Fermi level – Variation of Fermi level with temperature – Extrinsic semiconductor (Qualitative)- Hall effect –Determination of Hall coefficient –Applications.

**UNIT III MAGNETIC AND SUPER CONDUCTING MATERIALS 9**

Introduction– Bohr magnetron – Classification of magnetic materials – Domain theory – Hysteresis – soft and hard magnetic materials –Superconductivity: Properties - Types of super conductors – BCS theory of superconductivity (Qualitative) - High Tc superconductors – Applications – SQUID – Maglev train.

**UNIT IV ADVANCED ENGINEERING MATERIALS 9**

Metallic glasses– preparation – properties & applications - Nanomaterial: synthesis- plasma arcing – Solgel-Chemical vapour deposition – ball milling - properties and applications – Carbon nanotubes-types-structure.

**UNIT VSTRENGTHENING MECHANISM AND THERMODYNAMICS 9**

Introduction – crystal imperfections - Improvement of mechanical properties- Fracture- Fatigue Failure- Creep-Factors affecting creep –Introduction to Thermodynamics -Boyle‟s law-Charle‟s law-function of PVT-Laws of Thermodynamics- Entropy- Enthalpy-expression of a perfect gas –Carnot cycle

**TOTAL:45PERIODS**

**COURSE OUTCOMES**:

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

- summarize the properties of conductors, magnetic and superconducting materials
- analyze the different types of semiconducting materials and its applications.
- understand the mechanical properties of solids.
- synthesis the various methods of new engineering materials.
- acquire knowledge about the basic concepts, laws of thermodynamics and entropy.

**TEXT BOOKS:**


1. William D. Callister, Jr. "Material Science and Engineering", Seventh Edition, John Wiley & Sons Inc. New Delhi, 2010

2. Dr. Mani.P, " Engineering Physics II ", DhanamPublications,ChennaiRevised Edition. 2014.

3. Palanisamy P.K., "Engineering Physics", Scitech Publication, Chennai,Edition, 2014.


**REFERENCE BOOKS:**


1. Pillai S.O, "Solid State Physics", New Age Inc, Revised Edition 2014.
2. Kingery W.D., Bowen H.K. and Dr. Uhlmann, "Introduction to Ceramics", Second Edition, Wiley and son"s, Revised Edition 2012.
3. Raghavan.V, "Material Science and Engineering", Prentice Hall of India Private Limited, New Delhi, Revised Edition 2013.
4. Vijayakumari, "Engineering Physics", Vikas Publishing, New Delhi, Revised Edition 2012.

**15UCY207 ENVIRONMENTAL SCIENCE L T P C**
**(COMMON TO ALL BRANCHES) 3 0 0 3**

**OBJECTIVES**

- Understanding the concepts of ecosystem and biodiversity.
- Acquire knowledge about the impact of environmental pollution.
- Awareness on various types of resources.
- Understand the importance of environmental issues in the soceity.
- Awareness about the impact of environment related to human health .

**MODULE-I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 10**

Definition, scope and importance of environment – Need for public awareness – Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity – Definition: genetic, species and ecosystem diversity – Biogeographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity

**MODULE-II ENVIRONMENTAL POLLUTION 9**

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management: Causes, effects and control measures of municipal solid wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**MODULE-III FUTURE POLICY AND ALTERNATIVES 9**

Future policy and alternatives-fossil fuels-nuclear energy-solar energy-wind energy-hydroelectric energy-geothermal energy-tidal energy-sustainability-green power-nanotechnology-international policy.

**MODULE-IV SOCIAL ISSUES AND THE ENVIRONMENT 9**

From unsustainable to sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization - Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – Wasteland reclamation – Consumerism and waste products – Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation – Public awareness.

**MODULE-V HUMAN POPULATION AND THE ENVIRONMENT 8**

Population growth, variation among nations – Population explosion – Family welfare programme – Environment and human health – Human rights – Value education – HIV / AIDS – Women and child welfare – Role of information technology in environment and human health

**Total :45 Periods**

**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

- Comprehend the importance of environmental impact on ecosystem and biodiversity
- Understand current environmental challenges like pollution and its management.
- Remembering the fundamentals of physical and biological principles that govern natural processes.
- Perform their role in protecting the environment from social issues.
- Learn the importance of population explosion and its controlling measures.

**TEXT BOOKS**


1. AnubhaKaushik, kaushik C.P., "Environmental Science and Engineering", Third Edition, New Age International, New Delhi, 2009.
2. Benny Joseph "Environmental Science and Engineering", Tata Mc-Graw Hill, NewDelhi, 2006.


**REFERENCE BOOKS:**


1. Gilbert M.Masters, „Introduction to Environmental Engineering and Science", Pearson Education,Upper saddle River, New Jersey, 2008.
2. Miller T.G. Jr., Environmental Science", Wadsworth Publishing Company, Belmont, California, 2005.
3. De A.K., "Environmental Chemistry", Wiley Eastern Ltd., New Delhi, 2001.
4. Trivedi R.K., Goel P.K., "Introduction to Air Pollution", Techno-Science Publication, Jaipur, 2005.

**15UEE208 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C**

**(Common to MECH, CIVIL & CHEMICAL) 3 0 0 3**

**COURSE OBJECTIVE:**

- To introduce the principles of DC and AC fundamentals
- To study the Construction and operations of Electrical machines & measuring instruments
- To attain basic knowledge on semi conductor devices and digital principles
- To introduce the basic concepts of communication engineering

## UNIT I FUNDAMENTALS OF DC CIRCUITS AND AC CIRCUITS 9

Introduction to DC and AC circuits, Active and passive two terminal elements, Ohms law, Voltage-Current relations for resistor, inductor, capacitor , Kirchhoff's laws, Mesh analysis, Nodal analysis, Ideal sources –equivalent resistor, current division, voltage division. Generation of AC, Average and RMS values, Form and peak factors.

## UNIT II ELECTRICAL MACHINES AND MEASURING INSTRUMENTS 9

Working principle, construction and applications of DC machines (Generator and Motor) and AC machines (1 - phase transformers, single phase induction motors: split phase, capacitor start and capacitor run motors). Basic principles and classification of instruments -Moving coil and moving iron instruments.

## UNIT III SEMICONDUCTOR DEVICES 9

Passive components – resistors, capacitors & inductors (properties, common types, I-V relationship and uses). Semiconductor Devices - Overview of Semiconductors - basic principle, operation and characteristics of PN diode, zener diode, BJT.

## UNIT IV INTRODUCTION TO DIGITAL ELECTRONICS 9

Number systems – binary codes - logic gates - Boolean algebra, laws & theorems - simplification of Boolean expression - implementation of Boolean expressions using logic gates - standard forms of Boolean expression.

## UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING 9

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations. Communication Systems: Satellite and Optical Fiber. (Block Diagram Approach only).

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

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

- Describe the principles of DC and AC fundamentals
- Explain the Construction and operations of Electrical machines & measuring instruments
- Analyze the characteristics of semiconductor devices
- Wire Boolean expressions using logic gates digital principles
- Explain the concepts of communication engineering

### TEXT BOOKS


1. Mehta V K, “Principles of Electronics”, S.Chand& Company Ltd, fifth Edition New Delhi,2008
2. R. Muthusubramanian, S. Salivahanan, “Basic Electrical and Electronics Engineering”, Tata McGraw-Hill Education, Reprint 2012
3. Smarajt Ghosh, “Fundamentals of Electrical & Electronics Engineering”, PHI Learning - 2011.
4. B. Somanathan Nair, S.R. Deepa, “Basic Electronics”, I.K. International Pvt. Ltd., 2009.


### REFERENCE BOOKS


1. Kothari D. P and Nagrath IJ, “Basic Electrical Engineering”, Tata McGraw - Hill, 2009.

2. S. K. Bhattacharya, “Basic Electrical and Electronics Engineering”, Pearson Eduaction, 2011

| 15UCH209 | PRINCIPLES OF MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Preamble:**
The objective of this course is to inculcate in the student the ability to analyze any problem in a simple and logical manner and to predict the physical phenomena and thus lay the foundation for engineering applications.

**Prerequisite:** Nil

**COURSE OUTCOMES**

On completion of the course the student will be able to:

| **COURSE OUTCOMES** | | **Bloom's Level** |
|---|---|---|
| **CO1 :** | Understand the knowledge of engineering materials, Application & Usage | Understand |
| **CO2 :** | Analyze the forces in space - vector operations | Analyze |
| **CO3 :** | Identify the magnitude of moments and couple forces acting on rigid bodies. | Apply |
| **CO4 :** | Calculate the stress, strain and Materials properties of solid body | Apply |
| **CO5 :** | Calculate moment of surface and solids for different geometries | Apply |

**COURSE ARTICULATION MATRIX:**

| CO | POs | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | M | S | M | | | | | | | | | | | M |
| CO.2 | M | S | M | | | | | | | | | | | M |
| CO.3 | M | S | M | | | | | | | | | | | M |
| CO.4 | W | S | M | | | | | | | | | | | M |
| CO.5 | W | S | M | | | | | | | | | | | M |

**ASSESSMENT PATTERN:**

| Cognitive Level | Periodical Test – I (as marks) | Periodical Test – II (as marks) | Periodical Test – III (as marks) | End Semester Examinations |
|---|---|---|---|---|
| Remember | 6 | 6 | 6 | 10 |
| Understand | 12 | 12 | 12 | 10 |
| Apply | 16 | 32 | 32 | 64 |
| Analyze | 16 | - | - | 16 |
| Evaluate | - | - | - | - |
| Create | - | - | - | - |
| **Total (50)** | **50** | **50** | **50** | **100** |

**ASSESSMENT QUESTIONS:**

**CO 1: UNIT -I -MATERIALS OF CONSTRUCTION FOR ENGINEERING MATERIALS**

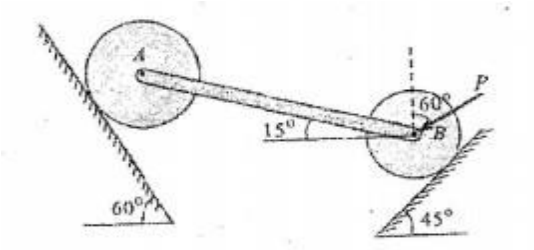
1.What are the chemical & physical perperties factor of materials ((UnderStand)
2.Explain Generalized properties and Fields of Applications of metals(Apply)
3.Classification of steel & their uses?(Remember)
4. Explain Generalized properties and Fields of Applications of Non metals(Apply)

**CO 2: UNIT -2 - STATICS OF PARTICLES**

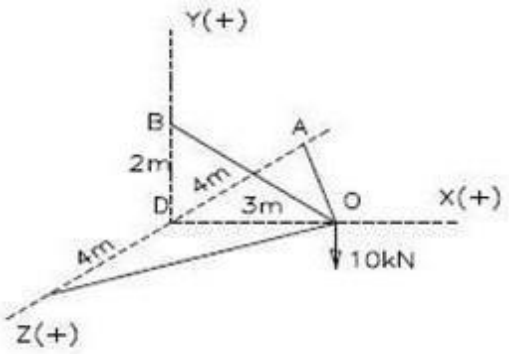
**1.** State Parallelogram law of forces.**(Remember)**

**2.** Distinguish the following system of forces with a suitable sketch. a) Coplanar b) Collinear. **(Understand)**

**3.** Two cylinders, having weight WA = 2000N and WB = 1000 N are resting on smooth inclined planes having inclination 60* and 45° with the horizontal respectively as shown in figure. They are connected by a weightless bar AB with hinge connections. The bar AB makes 15 ° angle with the horizontal. Find the magnitude of the force P required to hold the system in equilibrium .**(Apply)**

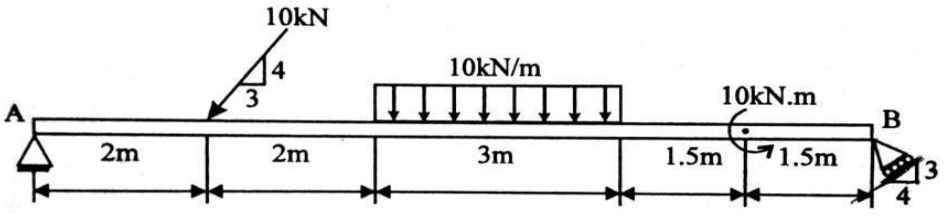



**4.** Members OA, OB and OC form a three member space truss. A weight of 10 KN is suspended at the joint „O" as shown in fig. Analyze magnitude and nature of forces in each of the three members of the truss.**(Analyze)**

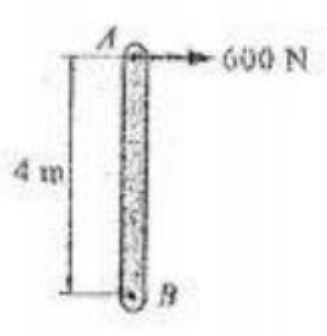



**CO 3: UNIT III – EQUILIBRIUM OF RIGID BODIES**

1. State Varignon"s theorem. **(Remember)**
2. Distinguish between couple and moment. **(Understand)**
3. Find the reactions at points A & B.(**Applying** )




**4.** Replace the force 600n from A as shown in figure by equivalent force and couple at B**(Analyse)**



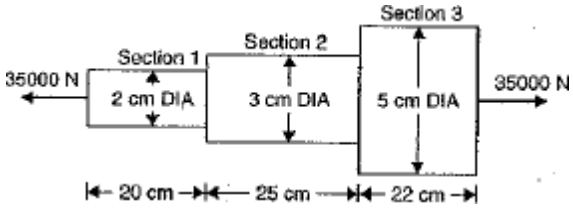

**CO 4: UNIT IV -MECHANICAL PROPERTIES & STRENGTH OF MATERIALS**

1.A steel rod 5m long and 30mm in diameter is subjected to an axial tensile load of 50KN.find the the change in length, diameter and volume of the rod. Take $E=200\times10^3$ N/mm$^2$&$\mu=0.25$. (Understand)

2. A bar of 30mm diameter is subjected to a pull of 60KN.The measured extension on gauge length of 200mm is 0.1mm and change in diameter is 0.004mm.find the E,K.(Remember)

3. An axial pull of 35000N is acting on a bar consisting of three length as shown in

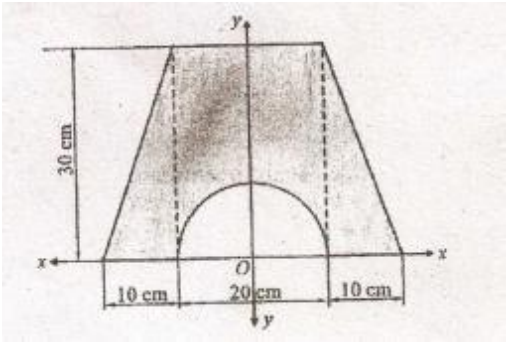
fig.E=2.1x105N/mm2. Stress in each section, total extension of the bar . (Apply)



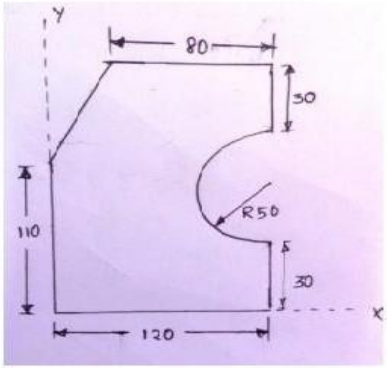

4.Find the minimum diameter of steel wire, which is used to raise a load of 4000N.if the stress in the rod is not exceed 95MN/mm$^2$
(Apply)

**CO 5: UNIT V – PROPERTIES OF SURFACES AND SOLIDS**.

1. State parallel axis theorem and perpendicular axis therorem. **(Remember)**
2. Differentiate Centroid and centre of gravity **(Understand)**
3. Find the moment of inertia of shaded area as shown in figure about Ixx axis and Iyy axis.(**Apply**)




4. Locate the centroid of the area shown in figure below. The dimensions are in mm**(Analyse)**



**Syllabus**

**UNIT I MATERIALS OF CONSTRUCTION FOR ENGINEERING MATERIALS 9**

Choice of materials – Chemical factors – Physical factors – Economic considerations – Fabrication – Generalized properties and Fields of Applications of metals – Ferrous metals – Cast Iron(CI) – Wrought Iron(WI), Plain Carbon Steels – Classification of Steels – Uses of Carbon Steels – Alloy Steels – Corrosion Resistance and Heat Resistance Steels – Non Ferrous Metals and Alloys – Generalized properties and Field of Applications of Non Metals.

**UNIT II STATICS OF PARTICLES 9**

**Equilibrium of Particles :** Fundamental concepts and principles of engineering mechanics – Forces on particles – vector addition – Concurrent forces in a plane – Resolution of forces – Resultant of several concurrent forces – Free Body diagram – Forces in spaces.

**UNIT III 9**

**Equilibrium of rigid bodies:** Principles of Transmissibility – Moment of a force – Varignon"s theorem – Equivalent system of forces – Reduction of system of forces into single force and couple-Equipollent system of forces – Types of supports and corresponding reactions – Equilibrium of rigid bodies in two dimensions.

**UNIT IVMECHANICAL PROPERTIES & STRENGTH OF MATERIALS 9**

Stress – Simple Tension – Stress-Strain relation – factors of safety – various physical prop Compression – Flexure – Shear & Torsion – Stress Analysis – Impact – Fatique – Stress conc stress concentration

**UNIT V PROPERTIES OF SURFACES AND VOLUMES 9**

Centre of Gravity:- Centroids of lines, areas and volumes – Determination of centroids by integration – Theorem of Pappus-Guldinus – **Moment of Inertia :** Second moment or Moment of Inertia of an area – Determination of moment of Inertia of area by integration – Radius of Gyration – Parallel and perpendicular axis theorems – Polar moment of inertia – Mass moment of Inertia.

` **TOTAL: 45 PERIODS**

**TEXT BOOK**

1. Beer,F.P and Johnson Jr. E.R, "Vector Mechanics for Engineers", McGraw-Hill Education (India) Pvt. Ltd. 10th Edition, 2013.
2. Hermant.C.Hesse, Henry Ruston.J., Process Equipment Design, Affiliated East West Press Pvt.Ltd, New Delhi.

**REFERENCES**


1. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
2. J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
3. P. Boresi & J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
4. Vela Murali, “Engineering Mechanics”, Oxford University Press (2010)

| 15UGS210 | BASIC SCIENCES LABORATORY –II<br>(Common for ALL Branches) | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 1 |

**OBJECTIVES:**

- To introduce the experimental procedure for the Band gap of a semiconductor, B-H curve and Potentiometer.
- To demonstrate the working of Spectrometer and Lee‟s Disc apparatus.

## PHYSICS LABORATORY

**(COMMON TO MECH, CHEMICAL& AGRICUTURAL ENGG..)**

### LIST OF EXPERIMENTS

1. Determination of band gap of a semiconductor.
2. B-H curve - Study of Hysteresis Loop.
3. Potentiometer - Measurement of Thermo e.m.f.
4. Torsion pendulum – Determination of Moment of inertia of a metallic disc and rigidity modulus of a given wire.
5. Spectrometer - Determination of wavelength of mercury spectrum using Grating.
6. Lee‟s Disc - Determination of thermal conductivity of a bad conductor.

• **A minimum of FIVE experiments shall be offered**

## PHYSICS LABORATORY

## CIVIL ENGINEERING

### LIST OF EXPERIMENTS

1. Uniform Bending – Determination of Young‟s modulus.
2. Non Uniform Bending – Determination of Young‟s modulus.
3. Torsion Pendulum – Determination of moment of inertia of disc and rigidity modulus of a wire.
4. Spectrometer – Determination of wavelength of merecury source using grating.
5. Newton‟s rings – Determination of radius of curvature of a convex lens.
6. B-H curve - Study of Hysteresis Loop.

- **A minimum of FIVE experiments shall be offered**

**TOTAL: 30 PERIODS**

## PHYSICS LABORATORY

a. COMPUTER SCIENCE ENGINEERING.
b. ELECTRONICS AND COMMUNICATION ENGINEERING.
c. ELECTRICAL AND ELECTRONICS ENGINEERING.
d. ELECTRICAL AND INSTRUMENTATION ENGINEERING.
e. INFORMATION TECHNOLOGY.

**LIST OF EXPERIMENTS**

1. Laser – Determination of numerical aperture and acceptance angle of an optical fibre.
2. Carey Foster‟s Bridge – Determination of specific resistance of the given coil.
3. Spectrometer – Determination of wavelength of mercury source using grating.
4. Newton‟s ring – Determination of radius curvature of convex lens.
5. B-H curve - Study of Hysteresis Loop
6. Determination of Band gap of a semiconductor.

**COURSE OUTCOMES:**

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

- Explain the concepts of Lasers,Newton‟s rings and B- H curve.
- Calculate the wavelength of Mercury source and thermal conductivity.

## CHEMISTRY LABORATORY

**OBJECTIVES:**

- Develop the practical skills to evaluate the quality parameters of water and industrial effluents
- Apply the theoretical principles and perform experiments**.**

**LIST OF EXPERIMENTS**
**(Common to All Branches)**

1. Estimation of hardness of water by EDTA method.
2. Estimation of alkalinity of water sample.
3. Estimation of Chloride in water sample (Argentometric method )
4. Determination of DO in water
5. Estimation of silver ion by Dichrometry
6. Determination of quality of Surface water (River/pond/lake) and Ground water (well/ bore well) with respect to Hardness, TDS, Chloride and pH.
7. Determination of acidity of industrial effluents.

**COURSE OUTCOMES**:

At the end of the course, the student will able to

1. Analyse the properties of water by applying the chemical concepts.
2. Determine the acid quality in the industrial effluents.

- **A minimum of FIVE experiments shall be offered**

**TOTAL: 30 PERIODS**

| 15UEE212 | BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY<br>(For CHEMICAL ENGINEERING ) | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 1 |

**COURSE OBJECTIVE:**

- To introduce the principles of DC and AC fundamentals
- To study the Construction and operations of Electrical machines & measuring instruments
- To attain basic knowledge on semi conductor devices and digital principles
- To introduce the basic concepts of communication engineering

**LIST OF EXPERIMENTS:**

1. Verification of Ohm‟s law and Kirchoff‟s voltage and current laws
2. Verification of Mesh and Nodal analysis
3. Characteristics of semiconductor Diode
4. Characteristics of Zener diode
5. Characteristics of Common Base Transistor
6. Characteristics of Common Emitter Transistor
7. Characteristics of Common Collector Transistor
8. Determination of Mutual Inductance and Co-Efficient of Coupling
9. Determination of Iron Losses

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

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

- Calculate the electrical parameters using Kirchoff‟s laws, mesh and nodal methods
- Sketch the characteristics of Diodes and Transistor
- Compute the Self and mutual inductance of the coil
- Calculate the Iron losses

**15UMA321** **TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS** **L T P C**

**(Common to MECH, ECE, EEE, CIVIL, CHEMICAL, AGRI, BIO MEDICAL)** **3 2 0 4**

## OBJECTIVES :

- To make the student knowledgeable in formulating certain practical problems in terms of partial differential equations, solve them and physically interpret the results.
- To familiarize the students to formulate and identify certain boundary value problems encountered in engineering practices, decide on applicability of the Fourier series method of solution, solve them numerically and interpret the results.
- To acquaint the student with the basics of Z - transform in its applicability to discretely varying functions, gained the skill to formulate certain problems in terms of difference equations and solve them using the Z - transform technique bringing out the elegance of the procedure involved.

**UNIT I FOURIER SERIES** **9 + 6**

Dirichlet‟s conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier Series – Parseval‟s identity – Harmonic analysis - Application of Fourier series - Gibb‟s Phenomenon.

**UNIT II FOURIER TRANSFORM** **9 + 6**

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval‟s identity - Application of Fourier Transform.

**UNIT III Z-TRANSFORM AND DIFFERENCE EQUATIONS** **9 + 6**

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and Final value Theorems - Formation of difference equations – Solution of difference equations.

**UNIT IV PARTIAL DIFFERENTIAL EQUATIONS** **9 + 6**

Formation of partial differential equations – Singular integrals -- Solutions of standard types of first order partial differential equations - Lagrange‟s linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

**UNIT V APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS** **9 + 6**

Introduction of Partial differential equations - Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

**TOTAL : 45 (L) + 30 (T) = 75 Periods**

## COURSE OUTCOMES:

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

- Write any periodic function as a combination of series of sine and cosine which are harmonically related to each other.
- Apply the acquired knowledge of Fourier transform and its properties which are used to transform signals between time and frequency domain.
- Apply finite difference concept to solve one dimensional wave, two dimensional Laplace and Poisson equations.
- Apply Fourier series to solve partial differential equations representing one dimensional and two dimensional heat and wave equations.
- Apply the acquired knowledge of Z transform and its properties for the analysis of linear discrete systems

**TEXT BOOKS:**


1. GREWAL B.S, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42nd Edition, (2012).
2. KANDASAMY.P, THILAGAVATHY.K, and GUNAVATHY.K, Engineering Mathematics III, S.Chand & Company Ltd., New Delhi, 3rd Edition, (1996).


**REFERENCE BOOKS:**


1. BALI N.P., MANISH GOYAL and WATAINS, "Advanced Engineering Mathematics", Firewall Media (An imprint of Laxmi Publication Private limited) New Delhi, 7th Edition, (2009).
2. RAMANA.B.V, "Higher Engineering Mathematics" Tata McGraw Hill, New Delhi, 11th Reprint (2010).
3. GLYN JAMES, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi, 3rd Edition, (2007).
4. ERWIN KREYSZIG, "Advanced Engineering Mathematics", Wiley India, 10th Edition, (2011).

**15UCH301 INTRODUCTION TO CHEMICAL ENGINEERING** **L T P C**

**3 0 0 3**

**Preamble**

This course provides the overview of chemical engineering, concepts of chemical engineering, concepts of unit operations and unit processes and modern view of chemical engineering accompanied with industrial visits.

**Prerequisite Nil**

**Course outcome**

On successful completion of the course the student will able to

| **Course Outcomes** | | **Bloom's Level** |
|---|---|---|
| **CO1:** | Attain knowledge on Principles of engineering, its history, achievements and role of chemical engineers in process industry | Understand |
| **CO2:** | Understand the components of chemical engineering and its relationship with other disciplines. | Understand |
| **CO3:** | Distinguish chemical processes, units and corresponding equipment. | Understand |
| **CO4:** | Familiarity with computer applications in process industries. | Understand |
| **CO5:** | Awareness of career options, potential job functions, contemporary and potential issues. | Understand |

**COURSE ARTICULATION MATRIX:**

| CO | Pos | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | b | c | d | e | f | g | h | i | j | K | l | l | ll |
| CO.1 | S | | | | | | | | | | | | | M |
| CO.2 | | | | | | | | M | | | | | | M |
| CO.3 | | M | | | | | | | | | | | | M |
| CO.4 | | | | | M | | | | | | | | | M |
| CO.5 | | | | | | | | | | | M | | | M |

**Assessment Pattern**

| Cognitive Level | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) | End semester (asmarks) |
|---|---|---|---|---|
| Remember | 20 | 30 | 25 | 40 |
| Understand | 30 | 20 | 25 | 50 |
| Apply | | | | 10 |
| Analyze | | | | |
| Evaluate | | | | |
| Create | | | | |
| **Total (50)** | 50 | 50 | 50 | 100 |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | Discuss the scope of chemical engineering and state the importance of chemistry in chemical engineering | Remember |
| 2 | Discuss the basic ideas, concepts and development of chemistry, chemical engineering and chemical technology | Remember |
| 3 | Write the major achievements of Chemical Engineering with year of finding | Understand |
| 4 | Explain any four important components of Chemical Engineering | Understand |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | Write about the application of Biology, Physics and Mathematics in Chemical Engineering. | Remember |
| 2 | Explain in detail about the dimensional analysis and the importance of dimensionless group in chemical engineering. | Remember |
| 3 | What is Process Control and explain in brief the terminologies and the variables used to control a process? | Understand |
| 4 | Discuss in detail the classification of pump and its applications in fluid transport | Understand |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | What is a PFD? Explain in brief the various flow sheet representations of process plants | Remember |

| | | |
|---|---|---|
| 2 | With a help of a neat process flow sheet, elaborate the various stages for the manufacture of Soda Ash by Solvay Process | Remember |
| 3 | With a help of a neat process flow sheet, elaborate the various stages for the manufacture of sulphuric acid by Contact process | Understand |
| 4 | Discuss elaborately the various unit operations of chemical engineering. | Understand |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Discuss briefly the role of computers in chemical engineering and the various chemical engineering softwares. | Remember |
| 2 | Explain in detail about relationship between chemical engineering and other engineering disciplines with suitable example | Understand |
| 3 | Explain the role of chemical engineer in the fields of food processing, energy and medical industry | Understand |
| 4 | Explain the role of chemical engineer in the fields of Environmental, Biochemical and Electronics industry. | Remember |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Explain in detail the range of scales in chemical engineering | Remember |
| 2 | Discuss briefly the paradigm shifts in chemical engineering | Remember |
| 3 | Discuss the various job functions and job opportunities for chemical engineers in India as well as abroad | Remember |
| 4 | Discuss the future of chemical engineering with the recent development of technologies. | Understand |

## Syllabus

**UNIT I** **5**

Chemistry, Chemical Engineering and Chemical Technology; Chemical process industries: History and their role in Society; Role of Chemical Engineer; History and Personalities of Chemical Engineering; Greatest achievements of Chemical Engineering.

**UNIT II** **12**

Components of Chemical Engineering: Role of Mathematics, Physics, Chemistry and Biology; Thermodynamics, Transport Phenomena, Chemical Kinetics and Process dynamics, design and control.

**UNIT III** **12**

Concept of Unit Processes and Unit Operations; Description of different Unit Processes and Unit Operations; Designing of equipments; Flow sheet representation of process plants,

Evolution of an Industry – Sulphuric acid and Soda ash manufacture. Demonstration of simple chemical engineering experiments; Plant visit to a chemical industry.

**UNIT IV** **12**

Role of Computer in Chemical Engineering; Chemical Engineering Software; Visit to Process Simulation Lab; Relation between Chemical Engineering and other engineering disciplines; Traditional vs. modern Chemical Engineering; Versatility of Chemical Engineering : Role of Chemical Engineers in the area of Food, Medical, Energy, Environmental, Biochemical, Electronics etc. Plant visit to an allied industry.

**UNIT V** **4**

Paradigm shifts in Chemical Engineering; Range of scales in Chemical Engineering; Opportunities for Chemical Engineers; Future of Chemical Engineering.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**


1. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 6th Edition, Tata McGraw Hill, 1997.
2. Dryden, C.E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, M. and M.Sittig, 2nd Edition, Affiliated East-West press, 1993.
3. Randolph Norris Shreve, George T. Austin, "Shreve‟e Chemical Process Industries", 5th Edition, McGraw Hill, 1984


**REFERENCE BOOKS**


1. McCabe, W.L., Smith, J. C. and Harriot, P. "Unit operations in Chemical Engineering", McGraw Hill, 7th Edition, 2001
2. Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006

**15UCH302** **ORGANIC CHEMISTRY** **L T P C**

**3 0 0 3**

**Preamble**

This course provides the basics of type of components in which organic reaction are taking place and also to know the preparation of the essential organic compounds.

**Prerequisite**

**Course outcome**

On successful completion of the course the student should able to

| **Course Outcomes** | | **Bloom's Level** |
|---|---|---|
| **CO1:** | Know and recall the fundamental principles of organic chemistry that include chemical bonding, nomenclature and structural isomerism | Understand |
| **CO2:** | Execute the concepts of hybridization and geometry of atoms and the three-dimensional structure of organic molecules | Apply |
| **CO3:** | Use knowledge of the organic chemistry language, concepts, and mechanisms to reason effectively qualitatively and quantitatively. | Apply |
| **CO4:** | Compare the properties such as, reactivity and stability of an organic molecule based on structure, including structural conformation. | Analyze |
| **CO5:** | Use sustainability ideas and tools to identify and assist green chemistry innovation. | Apply |

**Mapping with Programme Outcomes:**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | S | | M | M | | M | | | | M | M | | S | |
| CO.2 | S | | M | S | | | w | | | S | | | M | M |
| CO.3 | S | | M | S | | | | | | M | M | | M | M |
| CO.4 | S | | M | S | | M | | | | M | M | | S | M |
| CO.5 | S | | M | M | | | | | | M | | | M | |

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) | End Semester (as marks) |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 20 |
| Understand | 20 | 10 | 10 | 20 |
| Apply | 10 | 30 | 20 | 40 |
| Analyze | 10 | | 10 | 20 |
| Evaluate | | | | |
| Create | | | | |
| **Total (50)** | 50 | 50 | 50 | 100 |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | Memorize the mechanisms of nitration and halogenation of benzene. | Remember |
| 2 | Remember various catalysis and regents involved in substitution as well as in addition reactions. | Remember |
| 3 | Explain why benzene does not undergo addition reactions. | Understand |
| 4 | Execute the electrophilic substitution of benzene to other aromatic systems. | Apply |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | What do you know about Friedel craft reaction and Riemer Timenn Reaction? | Remember |
| 2 | What does when the addition HBR on Alkene in presence of peroxide? | Remember |
| 3 | Apply free radical mechanism on alkenes. | Apply |
| 4 | Illustrate the mechanisms of Aldol condensation, Benzion condensation. | Apply |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | Define the terms oxiadation, reducation and polymerization. | Remember |
| 2 | Study of alylic halogination using N-Bromo succinamide. | Remember |
| 3 | Estimation of some organic compounds such as phenol, aniline, acetone and glucose | Understand |
| 4 | Sketch the thermal halogenation of alkanes. | Apply |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | State and illustrate the synthesis mechanism of carboxylic acids and unsaturated acids. | Remember |
| 2 | Write short notes on methyl orange and congo dye. | Remember |
| 3 | Classify the dye according to its structure and method of application and illustrate the preparation of the following dyes. | Understand |
| | Give Reasons For The Presence Or Absence Of Colour In The Following<br>A) $C_6H_5N=NC_6H_5$ (Red) B) $C_6H_6$ (Colourless)<br>c) $NaO_3SC_6H_4N=NC_6H_4N(CH_3)_2$ (Orange) | Apply |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Define the terms protein and peptites. | Remember |
| 2 | Define basic amino acids and acidic amino acids. | Remember |
| 3 | How amino acids are classified based on their occurrence? Explain. | Understand |
| 4 | How the end group analysis of protein helped us to find the nature of bonded amino acids? Justify. | Apply |

**Syllabus**

**UNIT I UNIT PROCESS** **9**

Definitions – reagents- mechanism – catalyst – illustrations of the following unit process – nitration – halogenation – oxidation & reduction – esterification.

**UNIT II ORGANIC REACTIONS MECHANISM AND ESTIMATION** **9**

Electrophilic reaction - Friedel craft reaction, Riemer Timenn Reaction; Nucleophilic reactions - Aldol condensation, Benzion condensation; Free radical reaction - Halogenation of Alkane, Addition HBR on Alkene in presence of peroxide

**UNIT III** **9**

Alylic halogination using N-Bromo succinamide (NBS); Thermal halogination of Alkane (CH3-CH=CH); condensation and polymerization reaction – oxidation and reduction reactions; estimation of some organic compounds – phenol – aniline – acetone - glucose

**UNIT IV SYNTHETIC CHEMISTRY** **9**

Synthesis of different types of compounds like alcohol, aldehyde, acid, amine and synthesis of dicarboylic acids and unsaturated acids.

Synthesis of azodyes –methyl orange and congo dye.

Synthesis of triphenyl methane dyes – alizarin-melachite green

**UNIT V AMINO ACIDS AND PROTEINS** **9**

Amino acids and proteins- classification - synthesis of amino acids - reactions of carboxyl group and amino group - peptide linkage - end group analysis - colour reaction of proteins-denaturation.

**TOTAL: 45 PERIODS**

**TEXT BOOK**

1. Tiwari K.S. Vishnoi N.K. and Marhotra S.N., A text book of Organic Chemistry, II Edition, Vikas Publishing House Pvt.Ltd., (1998), New Delhi.

**REFERENCE BOOK**

1. P. H. Groggins Unit processes in organic synthesis. (Third Edition). McGraw-Hill, New York, 1947.

**15UCH303 FLUID MECHANICS FOR CHEMICAL ENGINEERING L T P C**

**3 0 0 3**

**Preamble**

To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium, flow measurement and fluid machineries.

## COURSE OUTCOMES

On completion of the course the student will be able to:

| COURSE OUTCOMES | | Bloom's Level |
|---|---|---|
| **CO 1** | Understand the basic principles of fluid mechanics | Understand |
| **CO 2** | analyze the fluid flow problems with the application of the momentum and energy equations | Analyze |
| **CO 3** | Know the importance of dimensional analysis and their application | Analyze |
| **CO 4** | Determine the concept of boundary layer, losses in pipe fittings and flow through fluidized beds. | Apply |
| **CO 5** | Calculate the coefficient of discharge in head and area meters and have knowledge in pumps. | Apply |

## COURSE ARTICULATION MATRIX

| CO | PEO | POs | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a | b | C | d | e | f | g | h | i | j | k | l | I | II |
| CO1 | I,II | S | S | | M | | | | | | | | | S | |
| CO2 | I,II,III | S | S | | M | | | | | | | | | S | |
| CO3 | I,II | M | S | | M | | | | | | | | | S | |
| CO4 | I,II | M | S | | M | | | | | | | | | S | |
| CO5 | I,II | M | S | | M | | | | | | | | | S | |

## ASSESSMENT PATTERN

| Cognitive Level | Periodical Test-I | Periodical Test-II | Periodical Test-III | End Semester |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 10 |
| Understand | 30 | 10 | 10 | 10 |
| Apply | 10 | 20 | 10 | 64 |
| Analyze | | 10 | 20 | 16 |
| Evaluate | | | | |
| Create | | | | |
| **Total** | **50** | **50** | **50** | **100** |

### Course Level Assessment Question

### Course Outcome 1(CO1):

| | | |
|---|---|---|
| 1 | Define density and specific weight. | Remember |
| 2 | Classify the types of viscosity and derive the units of viscosity | Remember<br>Understand |
| 3 | Illustrate the methods of analysis and description of fluid as Continuum. | |
| 4 | Two plates are placed at a distance of area 0.15mm,lower plate is fixed with upper plate having the surface area of 1m2 pulled at 0.3m/s. Find the force and power required to maintain the speed of fluid separating them having viscosity 1.5Poise. | Apply |

### Course Outcome 2 (CO2):

| | | |
|---|---|---|
| 1 | State Pascals Law. | Remember |
| 2 | Derive Bernoullis equation from Euler equation. | Understand |
| 3 | A Simple U tube manometer containing mercury which is in connected to a pipe in which a fluid of specific gravity 0.8 and having vaccum pressure is flowing. The other end of manometer is open to the atmosphere. Find the vaccum pressure in the pipe if the difference of mercury level in two limbs is 40cm and height of fluid in left from center of the pipe is 15cm below. | Apply |
| 4 | A right limb of a simple U tube manometer containing mercury is open to the atmosphere while left limb is connected to a pipe in which a fluid of specific gravity 0.9 is flowing. The center of pipe is 12cm below level of mercury in right | Apply |

limb. Find the pressure of the fluid in the pipe if the difference in mercury level in two limbs is 20cm.

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | State the principle of dimensional homogeneity | Remember |
| 2 | Illustrate the steps involved in Buckingham Pi theorem. | Remember |
| 3 | Write the application of Dimensional analysis for scale up industries. | Understand |
| 4 | Find an expression for the drag force on smooth sphere of diameter D,moving with a uniform velocity V in a fluid density ρ and dynamic viscosity μ. | Apply |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Define Reynolds number. | Remember |
| 2 | State the concept of Fluidization. | Remember |
| 3 | Derive the equation formed in major and minor losses. | Understand |
| 4 | Prove $V/V_{max}=0.5$ | Apply |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Define Pump and its classification | Remember |
| 2 | Compare Constant head and Variable head meters. | Remember |
| 3 | Sketch the characteristics curves of centrifugal pumps | Understand |
| 4 | A horizontal venturimeter with inlet diameter 20 cm and throat dia 10cm is used to measure the flow of water pressure at inlet is 17.658N/cm$^2$ and Vaccum pressure at throat is 30cm of mercury. Find the discharge of water through Venturimeter,take $C_d$=0.98. | Apply |

**SYLLABUS**

**UNIT-I BASICS OF FLUID MECHANICS 6**

Methods of analysis and description - fluid as continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion.

**UNIT-II FLUID STATICS 9**

Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometry – Differential analysis of fluid motion- continuity, equation of motions, Bernoulli equation and Navier- Stokes equation.

**UNIT III DIMENSIONAL ANALYSIS 9**

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations – similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies.

**UNIT-IV FLOW PAST IMMERSED BODIES 12**

Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.

**UNIT V METERING AND TRANSPORTATION 9**

Flow measurement - Constant and variable head meters; Velocity measurement

techniques; Types, characteristics and sizing of valves; Classification, performance

Characteristics and sizing of pumps, compressors and fans

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**

1. Noel de Nevers, “Fluid Mechanics for Chemical Engineers “, Second Edition, McGraw-Hill, (1991).

2. Munson, B. R., Young, D.F., Okiishi, T.H. “Fundamentals of Fluid Mechanics”, 5th Edition“, John Wiley, 2006 .

**REFERENCES:**

1. White, F.M., “Fluid Mechanics “, IV Edition, McGraw-Hill Inc., 1999.

2. James O Wilkes and Stacy G Bike, “Fluid Mechanics for Chemical Engineers‟ Prentice Hall PTR (International series in Chemical Engineering) (1999)

3.McCabe W.L, Smith, J C and Harriot. P “Unit operations in Chemical Engineering”, McGraw Hill, VII Edition, 2005.

**15UCH304** **CHEMICAL PROCESS INDUSTRIES - I** **L T P C**

**3 0 0 3**

**Preamble**

- The Course is designed to integrate various courses such as chemistry, unit operations, mechanical operation, stoichiometry etc., and to give the young chemical engineers some comprehension on various fields of production into which he will enter or with which he will be affiliated during the course of study or after completion of the study

**Prerequisite**

- None

**COURSE OUTCOMES**

On completion of the course the student will be able to:

| **COURSE OUTCOMES** | | **Bloom's Level** |
|---|---|---|
| **CO1 :** | Explain the manufacturing process of various inorganic and organic chemicals | Remember |
| **CO2 :** | Discuss the manufacturing process of Sulfur and Sulfuric Acid industries | Understand |
| **CO3 :** | Describe the manufacturing process of silicate industries | Understand |
| **CO4 :** | Analyze the manufacturing process of nitrogen and phosphorous industries | Analyze |
| **CO5 :** | Explain the manufacturing process of fertilizers industries | Understand |

**Assessment Pattern**

| **CognitiveLevel** | **Periodical Test – I (as marks)** | **Periodical Test– II (as marks)** | **Periodical Test – III (as marks)** |
|---|---|---|---|
| Remember | 20 | 10 | 10 |
| Understand | 20 | 30 | 20 |
| Apply | | | |
| Analyze | 10 | 10 | 20 |
| Evaluate | | | |
| Create | | | |
| **Total (50)** | 50 | 50 | 50 |

**Mapping with Programme Outcomes**

| CO | Pos | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | K | L | I | II |
| CO.1 | S | M | | | S | | | | | M | | M | S | |
| CO.2 | | | | | | | | S | | M | | | S | |
| CO.3 | S | | | S | | | | | | M | | | S | |
| CO.4 | S | | | | | S | | | M | | | | S | M |
| CO.5 | | M | | S | | | | | | S | | M | M | S |

**Ref: S- Strong M- Medium W- Weak**

**Course Level Assessment Questions**

**Course Outcome 1 (CO1):**

| | | |
|---|---|---|
| 1 | With the help of a neat process flow sheet, describe the various stages for the manufacture of Soda Ash by Ammonia - Soda Process | Understand |
| 2 | Discuss the Solvay Process with a neat flow sheet and mention major engineering problems related to them. | Remember |
| 3 | Explain in detail the electrolytic process for chlorine - caustic soda production | Understand |
| 4 | Compare and contrast the Electrolytic processes available for the manufacture of Chlorine and Caustic soda | Analyze |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | Explain the Production of sodium sulfate by the three- Stage Procedure | Understand |
| 2 | Discuss the manufacturing of sodium thiosulphate using block diagram and list out the major engineering problems | Remember |
| 3 | Describe with neat sketch about the manufacture of sulfur with contact process. | Understand |
| 4 | What are the raw materials sources for hydrochloric acid production? Explain the process with neat diagram | Remember |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | Describe the process of manufacture of Portland cement, indicating the chemical reactions involved with neat flow diagram | Understand |
| 2 | Explain the manufacture glass with the neat flow sheet. Write briefly about Special glasses | Evaluate |
| 3 | What are the various types of cements? Explain the manufacturing process of Portland cement with suitable diagram. | Remember |
| 4 | Briefly explain the manufacturing process of Fused silica glass and safety glass | Understand |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Discuss the various steps involved in the manufacture of Nitric Acid using Acid using Ammonia – Oxidation Process | Analyze |
| 2 | Briefly outline the effect of different variables affecting NH3 synthesis | Understand |
| 3 | Distinguish between the wet process and electric furnace process of phosphoric acid. | Analyze |
| 4 | What are the methods of production of phosphoric acid? Explain the mostly used manufacturing process in details with necessary diagrams. | Remember |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Starting from Phosphate rock, Describe the manufacture of single and triple superphosphate | Understand |
| 2 | With neat flow sheet, discuss in detail the manufacturing of potassium chloride. | Remember |
| 3 | Explain the manufacture of ammonium nitrate | Understand |
| 4 | Discuss briefly on NPK fertilizers. With the help of a flow sheet, explain the method of production of ammonium phosphates | Understand |

**Syllabus**

**UNIT I INTRODUCTION AND CHLORO- ALKALI INDUSTRIES 9**

The role of a chemical engineers in process industries, Introduction to common devices used in manufacturing processes, block diagrams, flow charts and standard symbols used for devices, industrial safety and pollution, outline of plant and equipment design. Manufacture of Soda ash and sodium bicarbonate, chlorine and caustic soda; bleaching powder and related bleaching agents, Sodium chloride, By-products of common salt industry.

**UNIT II SULPHUR AND SULPHURIC ACID INDUSTRIES 9**

Mining and manufacture of sulphur, recovery of sulphur from polluting gases, sulphur trioxide and sulphuric acid, hydrochloric acid, sodium sulphate, sodium thiosulphate, water treatment chemicals: Alum, Bleaching Agent

**UNIT III SILICATE INDUSTRIES 9**

Types and manufacture of Portland cement, Manufacture of glasses and special glasses, Ceramics and refractories. Paints and Varnishes ( Basic)

**UNIT IV NITROGEN AND PHOSPORUS INDUSTRIES 9**

Synthetic ammonia, Nitric acid, Urea, Phosphate rock beneficiation and phosphoric acid, Sodium Chloride, Gypsum and Snoenile from salt industries

**UNIT V FERTILIZER INDUSTRIES 9**

Growth elements, functions, ammonium sulphate, ammonium nitrate, ammonium phosphate, potassium chloride, potassium sulphate, single, triple super phosphate, introduction to pesticides, herbicides and bio-fertilizers.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

- Explain the manufacturing process of various inorganic and organic chemicals
- Discuss the manufacturing of sulphur and sulphuric acid industries
- Describe the manufacturing process of silicate industries
- Analyze the manufacturing of Nitrogen and Phosphorous Industries
- Explain the manufacturing process of fertilizer industries

**TEXT BOOKS**

1. Austin, G.T.,Shreve"s Chemical Process Industries, Fifth Edition, McGraw-Hill International Book Co, Singapore, 1984

2. Dryden, C.E., Outlines of Chemicals Technology, Edited and Revised by Gopala Rao, M. and M.Sittig, Second Edition, Affiliated East-West press, 1993.

**REFERENCES**

1. Shukla and G.N.Pandey “Text book on Chemical Technology”, Vikas Publishing Co 1997

2. Kirk and Othmer ,”Encyclopedia of Chemical Technology”, III Edition.

**Syllabus under Regulation 2015**
**III Semester**
**(Common to all Branches of Engineering)**
**15UGS331 – Value Education and Human Rights**

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | P/F |

**OBJECTIVES:**

• To inculcate the values of Humanism, Culture and to have an awareness of Human Rights

• To impart knowledge and develop a sensitivity to the diverse Indian culture

**Unit – I** **6**

Introduction – Value education - Definition - Why values? - need for inculcation - sources of values- Personal values, Social values, Professional values, Moral values and Behavioral values.

**Unit– II6**

Values needed for life - love & Compassion, Truth & Tolerance, Fairness & Obedience - Respect Empathy – Protection – Humility & Harmony – Principles of happy living – Stress management

**Unit–III6**

Social values and personality – Role models – National leaders – freedom fighters, Social reformers & Value based anecdotes

**Unit–IV6**

Social values-Five responsibilities: to self family, environment, society and universe- peace within, family & universe; Unethical standards in words and how to correct in deeds, in thought, its deleterious effects in society, deterioration of culture and traditional values- remediation for better understanding of such values and its implications

**Unit–V 6**

Human Rights – Universal Declaration of human rights - Human Rights violation - National Integration – Peace and non violence – the role of media in value building - Consumer awareness-**Case Study**

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

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

• Acquire a holistic vision and growth to become an integrated personality.

• Imbibe the essence of spirituality by which they will manifest the noble virtues of a universal brotherhood and benevolence

**TEXT BOOKS:**

1.S. Ignachimuthu, Values for Life, St.Paul Publications, Mumbai, 1994

**REFERENCE BOOKS:**

1. Frankena, W.K., “Ethics ”, Prentice Hall of India,,New Delhi, 1990.
2. Meron Theodor,“Human Rights and International Law Legal Policy Issues”, Oxford University Press, First Edition, New Delhi, 2000.
3. R.P.Shukla, “Value Education and Human Rights, Sarup and Sons Publishing, New Delhi, 2004.
4. Yogesh Kumar Singh and ReschikaNath.“Value Education”. APH Publishing Corporation, New Delhi, 2005.

**15UCH307** **ORGANIC CHEMISTRY LABORATORY** **L T P C**

**0 0 2 1**

**OBJECTIVE**

* To learn basic principles involved in analysis and synthesis of different organic derivatives.

**LIST OF EXPERIMENTS**

1. Analysis of nature of organic compounds – To identify aliphatic / aromatic, saturated / unsaturated compounds.
2. Identification and Characterization of various functional groups by their characteristic reactions: a). alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines h) amide i) nitro compounds.
3. Analysis of an unknown organic compound and preparation of suitable solid derivatives.
4. Analysis of Proteins.
5. Methodology of filtrations and recrystallization.
6. Introduction to organic Synthetic procedures:

i. Acetylation – Preparation of acetanilide from aniline.

ii. Hydrolysis – Preparation of salicylic acid from methyl salyciliate.

iii. Substitution – Conversion of acetone to iodoform.

iv. Nitration – Preparation of m-dinitrobenze from nitrobenzene.

v. Oxidation – Preparation of benzoic acid from benzaldehyde / benzy lalcohol.

**TOTAL :30 PERIODS**

**COURSE OUTCOMES**

1. Students are learning basic principles involved in analysis and nature of organized compounds by identifying it as aliphatic/aromatic, saturated/unsaturated and its functional groups

2. Students are learning the principles involved in the synthesis of organic compounds and preparing the suitable derivates which are mostly applied in chemical engineeirng

**REFERENCE BOOKS:**

1. Vogels"s Text Book of Practical Organic Chemistry, Fifth Edition, Longman Singapore Publishers Pte. Ltd., Singapore (1989).
2. Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Departemnt, A.C. Tech, Anna University (2007).

## Requirements for a batch of 30 students

| S.No | Description of Equipment | Quantity Required |
|---|---|---|
| 1. | Silica Crucible | 10 |
| 2. | Heating Mantle | 2 |
| 3. | Muffle Furnace | 1 |
| 4. | Hot Air Oven | 1 |
| 5. | Desiccator | 5 |
| 6. | Vaccum Pump | 1 |
| 7. | Condenser | 10 |
| 8 | Reflux Condenser | 10 |

**15UCH308 CHEMICAL ENGINEERING FLUID MECHANICS LABORATORY L T P C**

**0 0 2 1**

**AIM**

To determine experimentally the flow characteristics of fluids and also to determine the efficiency of the flow measuring devices and fluid transport machineries.

**OBJECTIVE:**

- To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.
- To gain practical knowledge on the measurement of Fluid Flow and theircharacteristics at different operating conditions

**LIST OF EXPERIMENTS**

1. Viscosity measurement of non Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps ( Centrifugal, Gear and Reciprocating Pumps)
10. Pressure drop studies in packed column
11. Drag coefficient of solid particle
12. Open drum orifice and draining time
13. Flow through annular pipe of horizontal concentric pipe

- Minimum of 10 Experiments

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

- Practical knowledge on the measurement of Fluid Flow and their characteristics at different operating conditions.

**Requirements for a batch of 30 students**

| Sl.No | Description of Equipment | Quantity Required |
|---|---|---|
| **1.** | Venturi meter | **1 No** |
| **2.** | Orifice meter | **1 No** |
| **3.** | Rota meter | **4 No** |
| **4.** | Open drum with orifice | **1 No** |

| | | |
|---|---|---|
| **5.** | Helical and spiral coils with different diameters | **1 No** |
| **6.** | Centrifugal pump | **1 No** |
| **7.** | Gear Pump | **1 No** |
| **8.** | Reciprocating Pump | **1 No** |
| **9.** | Packed Column | **1 No** |
| **10** | Viscometer (Redwood) | **2 No** |
| **11** | Weirs and Notches ( Circular ,V Type) | **1 Set** |
| **12** | Pipes, Valves and Fittings | **Sufficient** |
| **13** | U Tube manometer | **6Sets** |
| **14** | Pressure gauge | **4 No** |

| 15UMA422 | NUMERICAL METHODS<br>(Common to EEE, CIVIL & CHEMICAL) | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 2 | 0 | 4 |

## OBJECTIVES :

- To acquaint the student with the roots of nonlinear (algebraic or transcendental) equations, solutions of large system of linear equations and eigen value problem of a matrix can be obtained numerically where analytical methods fail to give solution.
- To familiarize the student with the methods discussed on interpolation which will be useful in constructing approximate polynomial to represent the data and to find the intermediate values, when huge amounts of experimental data are involved.
- To make the student acquire sound knowledge in applications of numerical methods in various fields, solving practical technical problems using scientific and mathematical tools when available in Engineering.

**UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9 + 6**

Bisection method – Method of False position – Iteration method – Newton-Raphson method – Ramanujan‟s method - Gauss Elimination method – Pivoting – Gauss Jordan methods – Iterative methods of Gauss Jacobi and Gauss Seidel - Matrix Inversion by Gauss Jordan method – Eigen values of a matrix by Power method – Jacobi‟s method for a real symmetric matrix.

**UNIT II INTERPOLATION AND APPROXIMATION 9 + 6**

Lagrangian Polynomials – Newton‟s divided difference interpolation – Newton‟s forward and backward difference interpolation – Interpolating with a cubic spline.

**UNIT III NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9 + 6**

Derivatives from difference tables – Divided differences and finite differences – Numerical integration by Trapezoidal and Simpson‟s 1/3 and 3/8 rules – Romberg‟s method – Two point and Three point Gaussian quadrature formulae - Double integrals using Trapezoidal and Simpson‟s rules.

**UNIT IV NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS 9 + 6**

Single step methods: Taylor series method – Euler method for first order equation – Fourth order Runge – Kutta method for solving first and second order equations – Multistep methods: Milne‟s and Adam‟s predictor and corrector methods.

**UNIT V NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9 + 6**

Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.

**TOTAL : 45 (L) + 30 (T) = 75 Periods**

## COURSE OUTCOMES:

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

- Employ a number of techniques to solve linear and nonlinear equations.
- Use Interpolation technique for equal and unequal intervals to find new data points within the range of known data points
- Find numerical integration for single and double integrals.
- Use the numerical methods to solve partial differential equations numerically.
- Apply numerical techniques to solve initial value and boundary value problems.

**TEXT BOOKS:**


1. SANKAR RAO.K, "Numerical Methods for scientists and engineers", Prentice Hall of India, New Delhi, 3rd Edition, (2007).
2. SASTRY S.S., "Introductory methods of Numerical Analysis", Prentice Hall of India, New Delhi, 4th Edition, (2008).


**REFERENCE BOOKS:**


1. KANDASAMY.P, THILAGAVATHY.K and GUNAVATHY.K, "Numerical Methods", S.Chand Co. Ltd., New Delhi, (2003).
2. GERALD C.F. and WHEATELEY P.O., "Applied Numerical Analysis", Pearson Education, New Delhi, 6th Edition, (2006).
3. GREWAL B.S. and GREWAL J.S., "Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, (2007).
4. CHAPRA S. C and CANALE R. P. "Numerical Methods for Engineers", Tata McGraw-Hill, New Delhi, 5th Edition, (2007).

**15UCH401 CHEMICAL ENGINEERING THERMODYNAMICS I** **L T P C**

**3 0 0 3**

**Preamble**

This course provides the basic concept of law of thermodynamics, PVT behaviour of fluids, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

**Prerequisite**

15UCH303:FLUID MECHANICS FOR CHEMICAL ENGINEERING

**Course outcomes**

On successful completion of the course the student should able to

| Course Outcome | | Bloom"s Level |
|---|---|---|
| CO1: | Apply fundamental concepts of concepts of Thermodynamics and solve the heat and work calculations for closed and open system. | Remember |
| CO2: | Evaluate the PVT behavior of ideal and real gases. | Apply |
| CO3: | Apply thermodynamics concepts and the laws of thermodynamics to various systems process. | Apply |
| CO4: | Analysis the thermodynamic properties by using of partial differentiation and Jacobians method. | Apply |
| CO5: | Applying the Refrigeration concerts and various refrigeration used in chemical process industries | Apply |

**Mapping with Programme Outcomes:**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | S | | M | M | | M | | | | M | M | | S | |
| CO.2 | S | | M | S | | | w | | | S | | | M | M |
| CO.3 | S | | M | S | | | | | | M | M | | M | M |
| CO.4 | S | | M | S | | M | | | | M | M | | S | M |
| CO.5 | S | | M | M | | | | | | M | | | M | |

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I (asmarks) | Periodical Test– II (asmarks | Periodical Test – III (asmarks) | End Semester |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 20 |
| Understand | 10 | 10 | 10 | 20 |
| Apply | 30 | 30 | 20 | 40 |
| Analyze | | | 10 | 20 |

| | | | | |
|---|---|---|---|---|
| Evaluate | | | | |
| Create | | | | |
| **Total (50)** | 50 | 50 | 50 | 100 |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | What is the number of degrees of freedom when a binary mixture is in equilibrium with its vapour | Remember |
| 2 | State Zeroth law of thermodynamics. | Remember |
| 3 | Write the phase rule as applicable to a non-reacting system. | Understand |
| 4 | A spherical balloon of diameter 0.5 m contains a gas at 1 bar and 300 K. the gas is heated and the balloon is allowed to expand. The pressure inside the balloon is found to vary linearly with the diameter. What would be the work done by the gas when the pressure inside reaches 5 bar? | Apply |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | Define compressibility factor. | Remember |
| 2 | State the principle of corresponding states. | Remember |
| 3 | Mention any two limiting conditions that should be satisfied by any equation of state in general. | Understand |
| 4 | An ideal gas is undergoing a series of three operations: the gas heated at constant volume from 300 K and 1 bar to a pressure of 2 bar . It is expanded in a reversible adiabatic process to a pressure of 1 bar. It is cooled at constant pressure of 1 bar to 300 K. Determine the heat and work effect for each step. Assume CP= 29.3 KJ/kmol K. | Apply |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | State Carnot‟s theorem. | Remember |
| 2 | What do you understand by the term „Internal Energy‟? | Remember |
| 3 | Why is the specific heat at constant pressure $C_p$ always greater than that at constant volume $C_v$? | Understand |
| 4 | It required to freeze 1 kg water at 273 K means of a refrigeration machine which operates in the surroundings at 300 K. the latent heat of fusion of ice at 273 K is 334.11 kJ/kg. Determine the minimum amount of work required and the heat | Apply |

given up to the surroundings.

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Define Helmholtz function. | Remember |
| 2 | Express the coefficient of thermal expansion and isothermal compressibility in terms of measurable properties | Understand |
| 3 | Derive the following relation between $C_P$ and $C_V$ using method of Jacobians $C_P - C_V = (\beta^2 VT/K)$ | Apply |
| 4 | Convert the Maxwell‟s relations using the method of Jacobians. | Analyze |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Define Clearance volume in a compressor. | Remember |
| 2 | What do you understand from the term “throttling process”. | Understand |
| 3 | Air at 600K and 2000 kPa enters a convergent-divergent nozzle whose throat area is one half that of the discharge of the divergent section. Assuming 4 . 1 = γ for air, determine the following.<br>(a) The pressure, temperature, velocity and density at the throat when the Mach number is 0.8 at the throat<br>(b) The critical pressure corresponding to the reservoir | Apply |
| 4 | Derive an expression for the pressure drop and maximum velocity at the pipe for the flow of fluid through. | Analyze |

**Syllabus**

**UNIT I** **6**

Scope of thermodynamics; Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work and heat. zeroth law; temperature scales

**UNIT II** **7**

PVT behaviour of fluids; Mathematical representation of PVT behaviour; Generalized compressibility factor correlation; Generalized equations of state

**UNIT III** **12**

Joule‟s experiment, internal energy, first law, energy balance for closed systems, mass and energy balance for open systems Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

**UNIT IV** **12**

Thermodynamic potentials – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams

**UNIT V** **8**

Duct flow of compressible fluids, Compression and expansion processes, steam power plant, internal combustion engines, jet and rocket engines.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**


1. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VI edition, 2003
2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004


**REFERENCES:**


1. Kyle, B.G., "Chemical and Process Thermodynamics III Edition", Prentice Hall of India Pvt. Ltd., 1999.
2. Elliott J.R., Lira, C.T., "Introductory chemical engineering thermodynamics", Prentice Hall, 1998
3. Rao, Y.V.C., "Chemical Engineering Thermodynamics" Universities Press, 2005
4. Pradeep ahuja," Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).
5. Gopinath Halder," Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).

**15UCH402 CHEMICAL PROCESS CALCULATIONS L T P C**

**3 0 0 3**

**Preamble**

This course aims to acquire a concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units.

**Prerequisite**

15UCH301-Introduction to Chemical Engineering
15UCH303-Fluid Mechanics for Chemical Engineers

**Course outcome**

On successful completion of the course the student will able to

| Course Outcome | | Bloom's Level |
|---|---|---|
| **CO1:** | Understand the fundamentals of units and stoichiometric equations | Understand |
| **CO2:** | Write material balance for different chemical processes with chemical reaction and without chemical reaction | Apply |
| **CO3:** | Perform calculations on vapor gas systems and use humidity charts | Apply |
| **CO4:** | Determine the composition of the production of combustion. | Analyze |
| **CO5:** | Write energy balance for different chemical processes with and without chemical reactions | Apply |

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) | End Semester |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 10 |
| Understand | 10 | 10 | 10 | 20 |
| Apply | 30 | 20 | 10 | 40 |
| Analyze | | | 10 | 20 |
| Evaluate | | 10 | 10 | 10 |
| Create | | | | |
| **Total (50)** | 50 | 50 | 50 | 100 |

**Syllabus**

**UNIT I UNITS AND GAS CALCULATIONS 9**

Basic and derived units, use of model units in calculations,Methods of expression,Compositions of mixture and solutions.

Ideal and real gas laws - Gas constant - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation and Stoichiometric principles

**UNIT II MATERIAL BALANCE 9**

Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

**UNIT III HUMIDITY AND SATURATION 9**

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

**UNIT IV COMBUSTION AND THERMOPHYSICS 9**

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds.

Heat capacity of solids, liquidsgases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy,.

**UNIT V THERMOCHEMISTRY 9**

Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems with and without chemical reaction. - Unsteady state energy balances.

**Total : 45 periods**

**TEXT BOOKS**


1. Bhatt, B.L., Vora, S.M., “Stoichiometry”, Tata McGraw-Hill, 1976.
2. Himmelblau, D.M., “Basic Principles and Calculations in Chemical Engineering”, EEE Sixth Edition, Prentice Hall Inc.,2003

**REFERENCES**


1. Process Calculation for Chemical Engineering, Second Revised Edition, Chemical Engg Education Development Centre, I.I.T., Madras, 1981.
2. Process Calculations, Venkataramani, V and Anantharaman, N, Prentice Hall of India Pvt. Ltd., 2003.

**15UCH403** **MECHANICAL OPERATIONS** **L T P C**

**3 0 0 3**

**Preamble**

The course is designed to the impart knowledge in identifying the important physical mechanisms occurring in processes involving principles of size reduction, particle dynamics, filtration, mixing of different components and separation of particles.

**Prerequisite**

**Nil**

**COURSE OUTCOMES**

On completion of the course the student will be able to:

| **COURSE OUTCOMES** | | **Bloom's Level** |
|---|---|---|
| CO1 | To know Characteristics of particulate solids, Principles of size reduction, crushing and grinding equipment. | Remember |
| CO2 | Understanding the working principles of thickeners, gravity settling tanks, cyclone separators, flotation and other mechanical operation devices | Understand |
| CO3 | Apply the principles of filtration techniques used for the separation in chemical process industries | Remember |
| CO4 | To analyze the fluid dynamics involved in mixing of different components and the need of agitation. | Analyze |
| CO5 | To understand the different storage methods and transportation equipments used for handling of solids in chemical process industries | Understand |

**Mapping with Programme Outcomes:**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | S | | | M | M | M | | | | M | M | | S | |
| CO.2 | M | | | M | M | | | | | M | M | | M | M |
| CO.3 | S | | M | S | | | | | w | M | M | | M | M |
| CO.4 | S | | M | S | | M | | | | M | M | | S | M |
| CO.5 | S | | M | M | | | | | | M | M | | M | |

**Assessment Pattern**

| CognitiveLevel | Continuous Assessment Tests (as marks) | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Remember | 30 | 20 | 30 |
| Understand | 10 | 10 | 10 |
| Apply | 10 | 20 | 10 |
| Analyze | | | |
| Evaluate | | | |
| Create | | | |

**Course Level Assessment Questions**

**Course Outcome 1 (CO1):**

| | | |
|---|---|---|
| 1. | How increase in surface area can be achieved | Understand |
| 2. | Discuss the different components involved in size reduction equipment. | Remember |
| 3. | Explain the laws of size reduction and methods of size reduction. | Remember |
| 4. | Which works on the principle of impact and attrition? Explain it. | Understand |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1. | Explain the various characteristics of screening | Understand |
| 2. | Discuss the various types of screening equipments involved in process industries | Understand |
| 3. | Describe the techniques involved in centrifugal separation | Remember |

| | | |
|---|---|---|
| 4. | Explain various industrial dust removing equipments with special reference to electrostatic separator | Remember |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1. | Describe the theory of filtration with reference to compressible and uncompressible cakes. | Understand |
| 2. | How scraper effectively used in rotary vacuum filters | Remember |
| 3. | Explain the centrifugation operation and different centrifuges in chemical industry. | Remember |
| 4. | Discuss the special filtration operations in special reference to membrane and ultra filtration. | Understand |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1. | How turbulence enhance the mixing of liquids in the reactor vessel. | Understand |
| 2. | Which impeller creates currents parallel with the axis of impeller. | Understand |
| 3. | Derive the power factor of agitation for dispersion of liquids. | Understand |
| 4. | Explain various correlations involved in mixing of liquids | Understand |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1. | How can we achieve transport of solids in process industries | Understand |
| 2. | Explain pneumatic conveyers and elevators for conveying solids | Remember |
| 3. | Discuss the storage of solids in process industries | Remember |
| 4. | Different methods involved in storage of solids. | Understand |

**Syllabus**

**UNIT I PARTICLE CHARACTERISTICS AND SIZE REDUCTION 9**

General characteristics of solids, their behaviour under different external forces, agglomeration, techniques for size analysis.

Laws of size reduction, classification of equipment, methods of size reduction, disintegration, preparation of colloids.

**UNIT II MECHANICAL SEPARATIONS 9**

Screening and Screening equipment, effectiveness of screens, gravity settling, sedimentation, thickening, centrifugal separation, impingement methods, industrial dust removing equipment

with special reference to electrostatic and magnetic separators, heavy media separations, floatation.

**UNIT III FILTRATION** **9**

Theory of filtration, Batch and continuous filters, centrifuges, membrane and ultra filtration.

**UNIT IV MIXING AND AGITATION** **9**

Equipment for blending and kneading, dispersion, power for agitation, correlations.

**UNIT V STORAGE AND CONVEYING OF SOLIDS** **9**

Conveyors, Elevators, Pneumatic conveying, Different methods for storage of solids.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**


1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Fourth Edition, 1984.
2. Coulson, J.M., Richardson, J.F., "Chemical Engineering", Volume 2, Third Edition, Pergamon Press, 1977.


**Reference**


1. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
2. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B.,"Principles of Unit Operations", 2nd Edn., John Wiley & Sons, 1994.

**15UCH404** **PHYSICAL CHEMISTRY** **L T P C**
**3 0 0 3**

**Preamble**

This course provides the basic concept of kinetics and mechanisms of chemical reactions, fundamentals of electrochemistry and its Applications. It includes phase rule, distribution law and surface Chemistry .

**Prerequisite**

**Course outcome**

On successful completion of the course the student should able to

| | **Course Outcome** | **Bloom's Level** |
|---|---|---|
| **CO1:** | Understand order of reaction, concept of activation energy and rate of reactions. | Understand |
| **CO2:** | Gaining the knowledge about the fundamentals of electrochemistry and its Applications | Apply |
| **CO3:** | Perform calculations about phase rule and distribution law | Apply |
| **CO4:** | Use knowledge about the surface chemistry of different processes | Analyze |
| **CO5:** | Apply the knowledge of polymers and macromolecules in chemical engineering | Apply |

**Mapping with Programme Outcomes:**

| **CO** | **Pos** | | | | | | | | | | | | **PSOs** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** | **l** | **I** | **II** |
| **CO.1** | S | | M | M | | M | | | | M | M | | S | |
| **CO.2** | S | | M | S | | | w | | | S | | | M | M |
| **CO.3** | S | | M | S | | | | | | M | M | | M | M |
| **CO.4** | S | | M | S | | M | | | | M | M | | S | M |
| **CO.5** | S | | M | M | | | | | | M | | | M | |

**Assessment Pattern**

| **CognitiveLevel** | **Periodical Test – I (asmarks)** | **Periodical Test– II (asmarks)** | **Periodical Test – III (asmarks)** |
|---|---|---|---|
| Remember | 10 | 10 | 10 |
| Understand | 30 | 10 | 10 |
| Apply | 10 | 30 | 20 |
| Analyze | | | 10 |

| | | | |
|---|---|---|---|
| Evaluate | | | |
| Create | | | |
| **Total (50)** | 50 | 50 | 50 |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | Study of first order, second order, third order, zero order and pseudo order reactions | Remember |
| 2 | Chain reactions, branched chain reactions | Remember |
| 3 | Concept of activation energy and influence of ionic strength in rates of reactions. | Understand |
| 4 | Derive the kinetics of First order unimolecular reactions. | Apply |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | To remember the definitions of Electrolytic conductance, specific conductance, equivalent conductance, molar conductance | Remember |
| 2 | State kohlrausch‟s law, ostwald dilution law | Remember |
| 3 | Interpret the Debye – Huckel theory of mean ionic activity coefficient | Apply |
| 4 | Apply the applications of kohlrausch‟s law | Apply |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | Definition of terms of Phase rule. | Remember |
| 2 | How the reduced phase rule works? | Remember |
| 3 | Relate the concepts of distribution and chemical combinations of solutions | Understand |
| 4 | Applications of distribution law-Raoults law-Henry‟s law | Apply |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Remember the terms adsorptions and catalysis | Remember |
| 2 | Select suitable theory for monolayer adsorption. | Remember |
| 3 | To Understand one component system of Water and Sulphur and their phase transitions. | Understand |
| 4 | Concern the concepts of Vapour pressure & boiling point on ideal and non-ideal solutions | Apply |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Define the terms coagulation and flocculation | Remember |
| 2 | State the following terms surfactants, emulsions, emulsifiers and gels. | Remember |
| 3 | Summarize the Classifications of polymerization reactions | Understand |
| 4 | Calculate molar masses of polymers by using weight average molecular mass method. | Apply |

**SYLLABUS**

**UNIT I CHEMICAL KINETICS** **9**

Rate equations – order of reaction – I order – II order – III order – zero order – pseudo order reactions – effect of temperature on reaction rate – concept of activation energy- chain reactions – branched chain reactions – reactions in solutions – influence of ionic strength in rates of reactions.

**UNIT II ELECTROCHEMISTRY** **9**

Electrolytic conductance –specific conductance- equivalent conductance – molar conductance- variation with dilution – kohlrausch‟s law- applications of kohlrausch‟s law – molar ionic conductance – conductometric titrations – ostwald dilution law – Debye – Huckel theory of mean ionic activity coefficient.

**UNIT III PHASE RULE AND DISTRIBUTION LAW** **9**

Definition of terms- one component system – water – sulphur – two component system – simple eutectic system – reduced phase rule. Distribution-chemical combinations- applications- applications of distribution law-Raoults law-Henry‟s law-ideal and non-ideal solutions-vapour pressure & boiling point

**UNIT IV SURFACE CHEMISTRY** **9**

ADSORPTION

Definition – types – isotherms – theories of adsorption – BET method – applications.

CATALYSIS

Homogeneous catalysis – acid –base – enzyme catalysis autocatalysis mechanism and kinetics – Michaelis-Menten equation – Heterogeneous catalysis – kinetics – effect of temperature on surface reactions

**UNIT V MACRO MOLECULES** **9**

COLLOIDS

Classification – preparations – coagulation – flocculation – determination of size of particles- surfactants – emulsions – emulsifiers –gels – applications.

POLYMERS

Classification – polymerization reactions – molar masses of reactions – determination of molar

masses- kinetic study.

**TEXT BOOKS**

1. Puri B.H and Sharma L.R. Principles of Physical Chemistry, S.Nagin Chand & Co, Delhi 1994)

2. P.L.Soni , O.P.Dharmarha & U.N. Dash,Textbook of Physical Chemistry, Sultan Chand & Sons.

**REFERENCES:**

1. Kund and Jain, Physical Chemistry, S.Chand and Company, Delhi (1996)

2. Kuriakose, J.C. and Rajaram J, Chemistry in Engineering and Technology Vol. I,

TataMcGraw

**15UCH405** **CHEMICAL PROCESS INDUSTRIES - II** **L T P C**

**3 0 0 3**

**Preamble**

- The Course is designed to impart the knowledge on various aspects of production engineering and enable the students to understand the practical methods of production in a chemical factory. Also aims at facilitating the students to understand the various industries applications and needs.

**Prerequisite**

- 15UCH304 Chemical Process Industries - I

**COURSE OUTCOMES**

On completion of the course the student will be able to:

| **COURSE OUTCOMES** | | **Bloom's Level** |
|---|---|---|
| **CO1 :** | Describe the manufacturing process of paper, pulp, sugar and starch industries | Remember |
| **CO2 :** | Discuss the manufacturing process of oils, soap and detergent industries | Understand |
| **CO3 :** | Evaluate the manufacturing process of Petroleum and petrochemical industries with applications | Evaluate |
| **CO4 :** | Analyze the manufacturing process of rubber and polymer industries | Analyze |
| **CO5 :** | Explain the manufacturing process of synthetic fiber and film industries | Understand |

**Assessment Pattern**

| **CognitiveLevel** | **Periodical Test – I (as marks)** | **Periodical Test– II (as marks)** | **Periodical Test – III (as marks)** | **End Semester** |
|---|---|---|---|---|
| Remember | 20 | 10 | 10 | 20 |
| Understand | 20 | 20 | 20 | 40 |
| Apply | | | | |
| Analyze | 10 | 10 | 10 | 20 |
| Evaluate | | 10 | 10 | 20 |
| Create | | | | |
| **Total (50)** | 50 | 50 | 50 | 100 |

**Mapping with Programme Outcomes**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | b | c | d | e | f | g | h | i | j | k | L | I | II |
| CO.1 | S | M | | | S | | | | | M | | M | S | |
| CO.2 | | | | | | | | S | | M | | | S | |
| CO.3 | S | | | S | | | | | | M | | | S | |
| CO.4 | S | | | | | S | | | M | | | | S | M |
| CO.5 | | M | | S | | | | | | S | | M | M | S |

**Ref: S- Strong M- Medium W- Weak**

**Course Level Assessment Questions**

**Course Outcome 1 (CO1):**

| | | |
|---|---|---|
| 1 | Describe the manufacturing of sugar from sugarcane with a neat process diagram | Understand |
| 2 | What is paper? With a neat flow chart discuss in detail about the various unit operations involved in the production of paper. | Remember |
| 3 | Outline the manufacturing of chemical pulp by Kraft process with a neat diagram. | Understand |
| 4 | List the various applications of starch and with a neat sketch describe the starch production. | Analyze |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | Summarize the process of extracting Vegetable Oils by Mechanical and Solvent Extraction methods. | Analyze |
| 2 | Discuss in detail the manufacture of fatty alcohols by Ziegler catalytic process | Remember |
| 3 | Explain the solvent extraction process for obtaining soya bean oil with a neat sketch. | Understand |
| 4 | With relevant flow sheets explain the methods of manufacture of Soaps & Detergents. | Understand |

| | | |
|---|---|---|
| 5. | Explain the hydrogenation process of vegetable oils with a flow sheet and the major engineering problems associated with this processes | Remember |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | List out the various chemicals obtained in aromatics classification, their properties, uses and the unit processes by which they are obtained? | Understand |
| 2 | Discriminate about the various chemical intermediates and products obtained from methane and synthesis gas | Evaluate |
| 3 | With the help of process flow diagram, explain the process of naphtha cracking for the production of Olefins and also give the typical operating conditions of naphtha cracking | Understand |
| 4 | What are the different products obtained by the Atmospheric Distillation of Crude Petroleum? Explain with a flow sheet the Refinery Process. | Remember |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Differentiate LDPE and HDPE. Examine with one manufacturing method of each. | Evaluate |
| 2 | Analyze and classify elastomers and their characteristics and appraise on processing of rubber | Analyze |
| 3 | Illustrate the manufacturing process of styrene-butadiene rubber with relevant flow diagram | Understand |
| 4 | Derive the properties and modes available for polymerization. | Remember |
| 5. | Compare the general properties and applications of synthetic resins and plastics. | Analyze |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Explain in detail the production of 6,6 - nylon. Also explain the reactions. | Understand |
| 2 | Identify the pertinent properties of PVC and infer on manufacturing process of vinyl polymer. | Evaluate |
| 3 | How does polyester fibers manufacturing takes place? Explain it with a neat sketch | Understand |
| 4 | What are different routes of nylon manufacturing? Explain any one method with a neat sketch. | Remember |
| 5. | Explain in detail on the manufacture of viscose rayon. State the uses of rayon and acetate | Understand |

**SYLLABUS**

**UNIT I PULP AND PAPER INDUSTRIES AND SUGAR AND STARCH INDUSTRIES 9**

Wood and Wood extracts – Wood Chemicals - Cellulose derivatives, Manufacture of pulp – different processes of pulping – Manufacture of paper – Manufacture of Boards - Raw and refined sugar, by products of sugar industries, Starch and starch derivatives.

**UNIT II OILS, FATS, SOAPS AND DETERGENT INDUSTRIES 9**

Vegetable oils and animal fats, their nature, analysis and extraction methods, hydrogenation of oils, fatty acids and alcohols, waxes, soaps, synthetic detergents.

**UNIT IIIPETROLEUM AND PETROCHEMICAL INDUSTRIES 9**

Petroleum refining, physical and chemical conversion products, lubricating oils, petrochemical precursors, methane, olefines, acetylenes and aromatics and products obtained from them by various unit processes.

**UNIT IVRUBBER AND POLYMERS 9**

Monomers – Thermosetting and Thermoplastic materials – General properties and Applications of Resins – Polymerization processes – different types - Natural rubber; Synthetic rubber such as SBR, NBR, CR - Fundamental methods of processing of synthetic Rubbers.

**UNIT VSYNTHETIC FIBRE AND FILM INDUSTRIES 9**

Natural and synthetic fibres – properties of - Poly amides – manufacture of Nylon 6. 6. Polyesters Fibres – manufacturer of – Cellulosic Fibres – Viscose Rayon production manufacture of films - cellulose Acetate, PVC, Polyesters - polyethylene

**TOTAL : 45 PERIODS**

**TEXTBOOKS:**


1. “Shreve's Chemical Process Industries Handbook”, Fifth Edition, McGraw-Hill 1998.
2. Dryden, C.E., “Outlines of Chemical Technology”, Edited and Revised by Gopala Rao. M. and M.Sittig, Second edition, Affiliated East-West press, 1993.


**REFERENCES:**


1. “Kent and Riegel's Hand Book of Industrial Chemistry and Biotechnology”, Springer , XI Edition, 2007.
2. Srikumar Koyikkal,”Chemical Process Technology and Simulation”,PHI Learning Ltd (2013).

**15UGS431 REASONING AND QUANTITATIVE APTITUDE L T P C**

**1 0 0 1**

## OBJECTIVES :

- To make the student acquire sound knowledge of the characteristic of quantitative and qualitative aptitude.
- To familiarize the student with various principles involved in solving mathematical problems.
- To develop an understanding of the basic concepts of reasoning skills.

## UNIT I QUANTITATIVE APTITUDE 8

Numbers – HCF and LCM - Arithmetic and Geometric Progression – Averages –Percentages – Problems on ages – Profit and Loss – Simple and Compound Interest - Ratio and Proportion – Time – Speed –Distance- Work – Pipes and Cistern - Problems on Trains – Permutation and Combination – Clocks – Calendars.

## UNIT II VERBAL AND NON VERBAL REASONING 7

Analytical Reasoning – Circular and Linear arrangement – Direction problems – Blood relations – Analogy – Odd Man Out – Venn Diagrams – Statement and Conclusion, Statement and Implications – Letter series & arrangement – Alpha Numeric Series – Syllogism - Coding – Decoding.

**TOTAL = 15 PERIODS**

## COURSE OUTCOMES:

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

- Solve the problems on commercial mathematics.
- Solve problems on Ratio and Proportions.
- Choose appropriate statistical tools for data analysis.
- Interpret the graphical and numerical data.
- Solve many Brain Teasers problems.

## TEXT BOOKS:


1. Dr. R.S.AGARWAL, “Quantitative Aptitude”, S. Chand Publications, New Delhi, 17th Edition, (2010).
2. TRISHNA KNOWLEDGE SYSTEMS, “Quantitative Aptitude”, Pearson Education, South Asia, 2nd Edition, (2009).


## REFERENCE BOOKS:


1. ABIJIT GUHA, “Quantitative Aptitude for Competitive Examinations”, Tata McGraw Hill Publication, New Delhi, 4th Edition, (2011).
2. Dr. V.A.SATHGURUNATH“S “A Guide for Campus Recruitment”, Sagarikka Publications, Thiruchirapalli, 3rd Edition, (2011).
3. NISHIT K.SINHA “Quantitative Aptitude for CAT”, Pearson Publication, New Delhi, 2nd Edition, (2009).
4. Dr. N.K.SINGH, “Quantitative Aptitude Test”, Upkars Prakashan Publications, Agra, Revised Edition, (2013).

**15UCH407** **PHYSICAL CHEMISTRY LABORATORY** **L T P C**

**0 0 2 1**

**AIM**

To determine experimentally various properties of the chemical compounds and to determine and estimate kinetics values, and other properties of chemicals.

**OBJECTIVE**

- To improve the practical knowledge on the properties and characteristics of solvents and mixtures.

**LIST OF EXPERIMENTS**

1. Determination of molecular weight of a polymer by viscosity method.
2. Determination of partition co-efficient of iodine between two immiscible solvents
3. Determination of partition co-efficient of benzoic acid between two immiscible solvents
4. Determination of Ka of the weak acid
5. Conductometric experiments- Verification of Oswald‟s Dilution Law
6. Titration of Strong Acid Vs Strong Base
7. Titration of mixture of Strong Acid Weak Acid Vs Strong Base
8. Titration of Weak Acid Vs Weak Base
9. Determination of Rate Constant (K)
10. Determination of Activation Energy (ΔE)
11. Estimation of Ferrous ion concentration by Potentiometric Titration
12. Determination of standard electrode potential (Zn, Cu, Ag)
13. Adsorption studies
14. To study the adsorption of Acetic acid on charcoal and construct the isotherm.
15. Determination of pH metric titration of Strong Acid Vs Strong Base
16. Enzyme catalytic reaction by varying pH.
17. Application of Phase Rule to Phenol-Water system
18. To study the inversion of cane sugar by polarimeter.
    a. Polarimeter-Inversion of cane sugar
    b. Refractometer

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES;**

Students are able to determine experimentally various properties of the chemical compounds and to determined also estimate kinetics values etc and other properties of chemicals

**REFERENCE BOOK**:

1. Physical Chemistry experiments by Alexander Findley, McGraw-Hill IV Edition, (1976)

## Requirements for a batch of 30 students

| SI.NO | DESCRIPTION OF EQUIPMENT | QUANTITY REQUITRED |
|---|---|---|
| 1. | Micro Calorimeter | 1 |
| 2. | Beckman Thermometers. Glassware"s | 3 |
| 3. | Thermometers 0 to 110 °C | 5 |
| 4. | Bottle Shakers | 2 |
| 5. | pH meters | 3 |
| 6. | Pressure Glass bottles | 2 |
| 7. | Standard Cells | 2 |
| 8. | Multi meters | 2 |
| 9. | Viscometers | 5 |
| 10. | Ostwald | 5 |
| 11. | Canaan Ubbelholde | 5 |
| 12. | Voltage Stabilizer | 2 |
| 13. | Stalalmometer | 1 |
| 14. | Surface Tension Meter .Tape Heaters | 1 |
| 15. | Mantle Heaters | 5 |
| 16. | DC Power Supply | 2 |
| 17. | Thermostat | 1 |
| 18. | Cryostats | 1 |
| 19. | Conductometer | 5 |
| 20. | Potentometer | 5 |
| 21. | Polarimeter | 1 |
| 22. | Refractometer | 3 |

**15UCH408 MECHANICAL OPERATIONS LABORATORY L T P C**
**0 0 2 1**

**OBJECTIVE:**

- To enable the students to develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

**LIST OF EXPERIMENTS**

1. Study of crushing strength of solid materials using jaw crusher
2. Study of crushing strength of solid materials using crushing rolls
3. Study of crushing strength of solid materials using ball mill
4. Taylor sieves
5. Layer sieves
6. Study of characterization of filtration using to Filter Press.
7. Study of characterization of solid materials using leaf Filter.
8. Study of separation of fine particles using cyclone separator.
9. Study of separation of fine particles using sedimentation
10. Study of separation of fine particles using Elutriator.
11. Study of separation of solid particles using drum Filter.
12. Study of separation of fine particles using screens and determination of effectiveness of factor.

**TOTAL : 30 PERIODS**

**OUTCOME:**

- Estimate crushing characteristics, power requirements and constants of crushing laws using Jaw Crusher, Roll Crusher and Ball mill
- determine average particle size and specific surface area by conducting Sieve Analysis
- Estimate specific cake and filter medium resistance using Filter press and Leaf filter and calculate minimum area require using batch sedimentation

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

| S.No | Name of the Equipment | Required |
|---|---|---|
| 1. | Sieve shaker | 1 No |
| 2. | Leaf filter | 1 No |
| 3. | Plate and Frame Filter Press | 1No |
| 4. | Sedimentation Jar | 1No |
| 5. | Jaw Crusher | 1No |
| 6. | Ball Mill | 1No |
| 7. | Cyclone Separator | 1No |
| 8. | Roll Crusher | 1No |

| | | |
|---|---|---|
| 9. | Elutriator | 1No |
| 10. | Drop Weight Crusher | 1No |
| 11. | Sieves. | 1No |
| 12. | Rotary Drum Filter | 1 No |
| 13. | 2 Lit Glass Jar | 2 No |
| 14. | 1Lit Glass Jar | 2 No |
| 15. | Stop Watch | 8 No |
| 16. | Screens of Various sizes | 2 Sets |
| 17. | Taylor and Layer Sieves | 2 Sets |
| 18. | Physical Balance with all Weights 10Kg capacity | 1 Set |

**15UCH409** **TECHNICAL ANALYSIS LABORATORY** **L T P C**

**0 0 2 1**

**AIM**

To determine experimentally the various elements and compounds used in chemicalengineering

**OBJECTIVE**

- To train the students on basic principles involved in estimation and characterization of industrially important materials.

**LIST OF EXPERIMENTS**

1. Analysis of water
2. pH meter
3. Nephelometer
4. pH measurements
5. Estimation of Residual chlorine in water
6. Estimation of Glucose
7. Estimation of purity of Calcium Carbonate
8. Analysis of Nitrogen in fertilizer sample
9. Biological Oxygen Demand (BOD)
10. Chemical Oxygen Demand (COD)
11. Soap Analysis
12. Oil Analysis
13. Cement Analysis
14. Analysis of Bleaching powder
15. Analysis of Glycerol
16. Analysis of fuels
17. Conductivity Measurement of an Electrolyte Solution
18. Potentiometric Titrations

**TOTAL :30 PERIODS**

**COURSE OUTCOMES:**

- At the end of this practical course, the student would have a thorough understanding on the of estimation and analysis chemical compounds.

**REFERENCES**

1. Technical Analysis Manual, Chemistry Division, Chemical Engineering Department, A.C. Tech. Anna University (2007).

2. Hand book of Chemical Analysis by Griffin

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

| S.No | Description of the Equipment | Required Quantity |
|---|---|---|
| 1. | Silica Crucible | 20 |
| 2. | Heating Mantle | 3 |
| 3. | Muffle Furnace | 1 |
| 4. | Hot air oven | 1 |
| 5. | Desiccators | 5 |
| 6. | Vacuum pump | 1 |
| 7. | Condenser | 10 |
| 8. | Reflux Condenser | 10 |
| 9. | Pensky martens closed cup apparatus | 1 |
| 10 | Cleveland open cup apparatus | 1 |
| 11. | Cloud point apparatus | 1 |
| 12. | Aniline point apparatus | 1 |
| 13. | Saybolt Viscometer | 1 |
| 14. | Redwood viscometer | 1 |
| 15. | Bomb Calorimeter | 1 |
| 16. | Junkers gas Calorimeter | 1 |
| 17. | Conductivity meter | 5 |
| 18. | pH meter | 5 |
| 19. | BOD and COD apparatus set | 1+1 |

**15UCH501 CHEMICAL ENGINEERING THERMODYNMICS II L T P C**

**3 0 0 3**

**Preamble**

In this course, more emphasis is given to the treatment of properties of solution, phase equilibria, Chemical reaction equilibria and refrigeration Cycles.

**Prerequisite**

15UCH401: Chemical Engineering Thermodynamics-I

**Course outcomes**

On successful completion of the course the student should able to

| | Course Outcome | Bloom's Level |
|---|---|---|
| **CO1:** | To examine the terminologies such as chemical potential, fugacity, fugacity coefficient, activity and activity coefficient | Understand |
| **CO2:** | To apply equations of state and activity coefficient models to describe VLE. | Apply |
| **CO3:** | Carry out calculations and develop relations to phase equilibrium and apply them to solve chemical engineering problems. | Analyze |
| **CO4:** | To determine reaction equilibrium constants and predict the effects of temperature, pressure, and composition on equilibrium conversion. | Analyze |
| **CO5:** | To apply and solve mass, energy and entropy balances to flow processes | Apply |

**Assessment Pattern**

| Cognitive Level | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) | End Semester |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 20 |
| Understand | 30 | 10 | 10 | 30 |
| Apply | 10 | 20 | 20 | 30 |
| Analyze | | 10 | 10 | 20 |
| Evaluate | | | | |
| Create | | | | |
| **Total (50)** | 50 | 50 | 50 | 100 |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | What are Partial Molar properties? Explain with an example. | Remember |
| 2 | What do you mean by Activity? Give the importance of activity. | Remember |
| 3 | Clearly distinguish between ideal and non-ideal solutions? | Understand |
| 4 | The enthalpy at 300 K and 1 bar of a binary liquid mixture is $H=400x_1+600x_2+x_1x_2(40x_1+20x_2)$, where H is in J/mol. For the stated temperature and pressure, Calculate<br>(i) Expressions for $H_1$ and $\overline{H_2}$ in terms of x1.<br>(ii) Numerical values for the pure component enthalpies $H_1$ and $H_2$.<br>(iii) Numerical values for the partial molar enthalpies at infinite dilution $H_1^{\infty}$ and $\overline{H_2^{\infty}}$ | Apply |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | What type of phase equilibrium problem that are frequently encountered in chemical industries? | Remember |
| 2 | State the phase rule as applicable to a non-reacting system. | Remember |
| 3 | For a heterogeneous multicomponent system, what is the general criterion of phase equilibrium?( | Understand |
| 4 | Show that for a stable liquid phase, the fugacity of each component in a binary mixture always increases with increase in concentration at constant temperature and pressure. | Apply |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | State the Van-Laar Equation. | Remember |
| 2 | Write the significance of Co-existence equation. | Understand |
| 3 | Water (1) – hydrazine (2) system forms an azeotropes containing 58.5% (mol) hydrazine at 393 K and 101.3 Kpa. Calculate the equilibrium vapour composition for a solution containing 20 % (mol) hydrazine. The relative volatility of water with reference to hydrazine is 1.6 and may be assumed to remain constant in the temperature range involved. The vapour pressure of hydrazine at 393 K is 124.76 Kpa? | Apply |
| 4 | Explain about the Zero Area Method for checking/analyze the thermodynamics consistency of VLE data | Analyze |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Define Standard Free Energy and how it is related to equilibrium constant? | Remember |
| 2 | Explain Equilibrium constant | Understand |
| 3 | Estimate the standard free energy change and equilibrium constant at 700 K for the reaction $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ given that the standard heat of formation and standard free energy of formation of ammonia at 298 K to be -46,000 J/mol and -16,500 J/mol respectively. The specific heat (J/molK) data are given below as function of temperature(K). $C_p=27.27+4.93*10^{-3}$ T for $N_2$, $C_p=27.01+3.51*10^{-3}$ T for $H_2$, $C_p=29.27+25.11*10^{-3}$ T for $NH_3$? | Apply |
| 4 | Derive an expression for the effect of temperature and pressure on equilibrium constant and compare the expression. | Analyze |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | What do you mean by capacity of a refrigerator? | Remember |
| 2 | Why the efficiency of actual refrigeration cycle is less than the Carnot‟s cycle efficiency? | Remember |
| 3 | Ammonia as a refrigerant- Give your comments. | Understand |
| 4 | An air-refrigeration machine rated at 10 ton is used to maintain the temperature of a cold room at 261 K when the cooling is available at 293 K. The machine operates between pressures of 1.013 bar and 4.052 bar. Assume a 5 K approach in the Cooler and the refrigerator. The specific heat of air may be taken as 1.008 kJ/kg and $\gamma$=1.4. Calculate the COP and air-circulation rate.(6) | Apply |

**Syllabus**

**UNIT I PROPERTIES OF SOLUTIONS 9**

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice,

Gibbs-Duhem equation, excess properties of mixtures.

**UNIT II PHASE EQUILIBRIA 9**

Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapour-liquid equilibrium, phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

**UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 9**

Activity coefficient-composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

**UNIT IV CHEMICAL REACTION EQUILIBRIA 9**

Definition of standard state, standard free energy change and reaction equilibrium constant, evaluation of reaction equilibrium constant, prediction of free energy data, equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors, thermodynamic analysis of simultaneous reactions.

**UNIT V REFRIGERATION 9**

Principles of refrigeration, methods of producing refrigeration, liquefaction process, co-efficient of performance, evaluation of the performance of vapour compression and gas refrigeration cycles.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**


1. Smith, J.M., VanNess, H.C., & Abbot M.C, “Introduction to Chemical Engineering Thermodynamics”, McGraw Hill VII Edition 2004.
2. Narayanan K.V “A Text Book of Chemical Engineering Thermodynamics” Prentice Hall of India Pvt. Ltd. 2001.


**REFERENCES:**


1. Hougen, O.A., Watson, K.M., and Ragatz, R.A., “Chemical Process Principles Part II”, Thermodynamics, John Wiley, 1970.
2. Dodge, B.F., “Chemical Engineering Thermodynamics”, McGraw-Hill, 1960.
3. Sandler, S.I., “Chemical and Engineering Thermodynamics”, 2nd Edition, Wiley, 1989.

**15UCH502** **MASS TRANSFER I** **L T P C**

**3 0 0 3**

**Preamble**

This course provides the basic concept of mass transfer coefficient and theories of mass transfer. It includes design of cooling tower, Dryer and crystallization.

**Prerequisite**

15UCH402: Chemical Process Calculation

**Course outcomes**

On successful completion of the course the student should able to

| | Course Outcome | Bloom's Level |
|---|---|---|
| **CO1:** | Describe the concepts of diffusion in gas, liquid and solid phase for single and multi-compound systems. | Understand |
| **CO2:** | Apply fundamentals of mass transfer coefficient using different transport analogies to find the individual and overall mass transfer coefficients. | Apply |
| **CO3:** | Design the cooling tower using Humidification principle | Apply |
| **CO4:** | Determine the length of dryer and time of drying for batch and continuous process using rate concept. | Analyze |
| **CO5:** | Design the crystallizer by understating of kinetics and population balance model of crystallization. | Apply |

**Mapping with Programme Outcome**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | C | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | S | | | | | W | | | | | | | W | |
| CO.2 | | | M | | | | | | W | | | | | S |
| CO.3 | | S | | | | | W | | W | | | | | W |
| CO.4 | | S | | | | | | | | M | | | M | |
| CO.5 | | | | | | | M | | | W | | | S | |

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I | Periodical Test– II (asmarks) | Periodical Test – III | End Semester |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 20 |
| Understand | 30 | 10 | 10 | 20 |

| | | | | |
|---|---|---|---|---|
| Apply | 10 | 30 | 20 | 40 |
| Analyze | | | 10 | 20 |
| Evaluate | | | | |
| Create | | | | |
| **Total (50)** | 50 | 50 | 50 | 100 |

**Course Level Assessment Question**

**Course Outcome 1 (CO1):**

| | | |
|---|---|---|
| 1 | State and explain Fick‟s law of diffusion. | Remember |
| 2 | Develop an expression for steady state diffusion of „A‟ through a stagnant gas film „B‟ | Remember |
| 3 | Distinguish between molecular and eddy diffusion. | Understand |
| 4 | Benzene is stored in a tank of dia 10m and open at the top. A stagnant air film 10mm thick is covering the surface liquid beyond which benzene is absent. If the atm temp. is $25^0$C &the corresponding pressure is 150 mm Hg. Find the rate of loss of benzene. Diffusivity of benzene is 0.02 $m^2$/hr. Total pressure is 1.0 atm. | Apply |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | According to penetration theory, what is the relation between mass transfer coefficient „k‟ and diffusivity „D‟? | Remember |
| 2 | Define the terms NTU and HTU. | Remember |
| 3 | In an experimental study of absorption of ammonia by water in a wetted wall column the overall gas phase mass transfer coefficient, $K_G$ was estimated as $2.72x10^{-4}$ kmol/$m^2$s.atm. At one point in the column the gas contained 10 mol% ammonia and the liquid phase concentration was $6.42x10^{-2}$ kmol $NH_3/m^3$ of solution. Temperature is 293K and the total pressure is 1 atm. 85% of the resistance to mass transfer lies in gas phase. If Henry‟s law constant is $9.35x10^{-3}$ atm.$m^3$/kmol, calculate the individual film coefficient and the interfacial composition. (E) | Apply |
| 4 | Starting from fundamental expressions for molecular and turbulent transport of mass, momentum and energy, determine the Reynold‟s analogy equation. | Apply |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | Give any four major type of cooling tower | Remember |
| 2 | Define equilibrium moisture content. | Remember |
| 3 | Explain the design of cooling towers and the steps involved in the design of cooling towers. | Understand |

| | | |
|---|---|---|
| 4 | Air-water vapour sample has a DBT of $55^0$C with an absolute humidity 0.03 Kg $H_2O$ vapour/Kg dry air at 1 atm pressure. Calculate (i) Percentage humidity (ii) Absolute molal humidity (iii) Relative humidity (iv) Humid volume (v) Enthalpy | Apply |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Recommend a suitable dryer for drying peas and milk | Remember |
| 2 | Explain the theories of moisture movement in solids | Remember |
| 3 | By deriving all the necessary analytical expressions, describe the step by step procedure for designing a rotary dryer. | Understand |
| 4 | A wet slab material is drying in a laboratory the following relation for the falling rate period was obtained,<br><br>$dX/d\theta = -0.8 ( X - 0.05 )$<br><br>Where X is moisture content on dry basis and θ is the time in hours. The critical moisture content is 1.4 Kg moisture/Kg dry solid. Calculate the time required for drying the material from $X_1$=4.0 to $X_2$=0.1 and the equilibrium moisture content. | Apply |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | State ΔL law of crystal growth. [R] | Remember |
| 2 | List the methods of producing super saturation. | Remember |
| 3 | Write a note on Mixed Suspension- Mixed Product Removal (MSMPR) model in the design of crystallizer | Understand |
| 4 | A solution of $K_2Cr_2O_7$ in water contains 13% by wt. $K_2Cr_2O_7$. From 1000 Kg of this solution, 640 Kg of water is evaporated. The remaining solution is cooled to $20^0$C. Calculate the weight crystals formed. Estimate the % yield of $K_2Cr_2O_7$. | Apply |

**Syllabus**

**UNIT I** **9**

Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion.

**UNIT II** **9**

Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors.

**UNIT III** **9**

Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

**UNIT IV** **9**

Drying- Equilibrium; classification of dryers; batch drying – Mechanism and time of cross through circulation drying, continuous dryers – material and energy balance; determination of length of rotary dryer using rate concept.

**UNIT V** **9**

Crystallization - Equilibrium, classification of crystallizers, mass and energy balance; kinetics of crystallization - nucleation and growth; design of batch crystallizers; population balance model and design of continuous crystallizers.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**


1. Treybal, R.E., “Mass Transfer Operations”, 3rd Edn, McGraw-Hill, 1981.
2. Geankoplis, C.J., “Transport Processes and Unit Operations”, 4th Edition, Prentice Hall Inc., New Jersey, 2003.


**REFERENCES:**


1. McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”, 7th Edn., McGraw-Hill, 2005.
2. Coulson, J.M. and Richardson, J.F., “Chemical Engineering” Vol. I and II, 4th Edition,Asian Books Pvt. Ltd., India, 1998.
3. J.D. Seader and E.J. Henley, “Separation Process Principles”, 2nd Ed., John Wiley, 2006.
4. Binay K.Dutta,”Principles of Mass Transfer and Seperation Processes”,PHI Learning Ltd,2013.

**15UCH503** **HEAT TRANSFER** **L T P C**

**3 0 0 3**

**Preamble**

To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger.

**Prerequisite**

15UCH402: Chemical Process Calculation

**Course outcomes**

On successful completion of the course the student should able to

| Course Outcome | | Bloom"s Level |
|---|---|---|
| CO1: | Understand the fundamental principles of conduction and their Laws | Understand |
| CO2: | Acquire knowledge in convection and radiation heat transfer | Apply |
| CO3: | Familiarize with the fundamentals of boiling and condensation | Apply |
| CO4: | Apply the knowledge of heat transfer in the design of evaporators | Apply |
| CO5: | Design and analyze the performance of heat exchangers | Apply |

**COURSE ARTICULATION MATRIX**

| CO | PEO | POs | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO1 | I,II | S | S | | | | | | | | | | | | S |
| CO2 | I,II | S | S | | | | | | | | | | | | S |
| CO3 | I,II | M | S | | | | | | | | | | | | S |
| CO4 | I,II,III | M | S | S | | | | | | | | | | | S |
| CO5 | I,II | M | S | S | | | | | | | | | | | S |

**Assessment Pattern**

| Cognitive Level | Periodical Test-I | Periodical Test-II | Periodical Test-III | End Semester |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 10 |
| Understand | 30 | 10 | 10 | 10 |
| Apply | 10 | 30 | 30 | 64 |
| Analyze | | | | 16 |
| Evaluate | | | | |
| Create | | | | |
| **Total** | **50** | **50** | **50** | **100** |

## Course Level Assessment Question

### Course Outcome 1(CO1):

| | | |
|---|---|---|
| 1 | Define Conduction.. | Remember |
| 2 | Illustrate the requirements of Insulating materials. | Remember |
| 3 | Derive the one dimensional steady state conduction through One Plane Wall and Composite wall. | Understand |
| 4 | A 50 mm diameter pipe of Cross sectional area and with walls 3mm thick covered with two concentric layers of lagging,innerlayer having thickness 25mm and k=0.08W/m.K and outer layer having thickness of 40mm and k=0.04W/m.K. Estimate the rate of heat loss per meter length of pipe,if the temperature inside the pipe 550K and outside surface temperature is 330K.Thermal conductivity for pipe is 45W/m.K | Apply |

### Course Outcome 2 (CO2):

| | | |
|---|---|---|
| 1 | State Newton"s Law of Cooling. | Remember |
| 2 | List out the some Dimensional numbers used in Heat Transfer. | Remember |
| 3 | Derive the overall Heat Transfer Coefficient when the metal wall resistence is very small in comparison with the resistence of fluid films. | Apply |
| 4 | Determine the inside heat transfer coefficient for a oil flowing at a rate of 0.5kg/sec through a tube of 19mm inside diameter is heated from 311 to 327K by condensing steam at 373K. | Apply |

### Course Outcome 3 (CO3):

| | | |
|---|---|---|
| 1 | State Stefan Boltzman Law in radiation. | Remember |
| 2 | Define Kirchoffs law and Plancks law. | Remember |
| 3 | Explain the concept of Black body | Understand |
| 4 | A 50mm i.d iron pipe at 423K passing through a room in which surrounding are at temperature 300K. If the emissivity of the pipe metal is 0.8,what is the next interchange of radiation energy per meter length of pipe? The outside dia of pipe is 60mm. | Apply |

### Course Outcome 4 (CO4):

| | | |
|---|---|---|
| 1 | List out the effects of properties of solution on Evaporation operation. | Remember |
| 2 | State Capacity and Economy of Evaporators. | Remember |
| 3 | Explain with a neat sketch about Horizontal tube Evaporator.. | Understand |
| 4 | An Evaporator operating at atmosphere pressure 101.325kPa is fed at the rate of 10000kg/hr of weak liquor containing 4% Caustic soda. Think Liquor leaving the evaporator contains 25% caustic soda. Find the Capacity of Evaporator. | Apply |

### Course Outcome 5 (CO5):

| | | |
|---|---|---|
| 1 | Compare between Single Pass and Multi pass shell and tube heat exchanger. | Remember |
| 2 | List the equipments of heat Exchanger. | Remember |
| 3 | Explain in detail about Shell and Tube heat exchanger. | Understand |
| 4 | It is require to cool 250kg/hr of hot liquid with inlet temperature of 399K using a parallel flow arrangement. 1000kg/hr cooling water is available for cooling purpose at temperature of 283K.Calculate the outlet temperature of hot liquid and water at effectiveness of heat exchanger,if the U is 1160W/$m^2$K and Heat transfer surface is 0.25$m^2$ | Apply |

**Syllabus**

**UNIT – I Conduction** **9**

Nature and Modes of heat transfer. Concept of heat conduction - Fourier's law, thermal conductivity of materials, one dimensional steady state heat conduction equation for flat plate, hollow cylinder, and hollow sphere, Heat conduction through a series of resistances. Relationship between Individual and overall heat transfer coefficients; critical thickness of insulation; fundamental concepts in extended surfaces heat transfer; Transient heat conduction.

**UNIT – II Convection** **9**

Natural and forced convection – Application of dimensional analysis for convection and dimensionless numbers, Reynolds and Colburn analogy – jH factor, Equations for forced convection under laminar and turbulent flow conditions in pipes, Equations for natural convection in vertical plates and vertical and horizontal cylinders.

**UNIT – III Radiation** **9**

Concept and nature of thermal radiations - Concept of Black and grey bodies; Stefan Boltzmann, Kirchhoff„s, Planck„s and Wien laws; Radiation between surfaces – configuration factor; radiation shield.

**UNIT – IV Heat Transfer with Phase Change** **9**

Introduction to boiling and condensation, condensers-vertical and horizontal types, Evaporator-Types and method of feed - steam economy and surface area calculations for single effect evaporator.

**UNIT – V Heat Exchangers** **9**

Types of heat exchangers; LMTD; use of correction factor charts; Fouling factors; surface area calculations for double pipe and shell and tube heat exchangers; effectiveness and number of transfer units - Wilson„s plot.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. McCabe W.L., Smith J.C. and Harriot P.," Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill International Edition , New York , 2006

2. Yunus A.Cengel., " Heat Transfer: A Practical Approach", 2nd Edition , McGraw Hill, 2003.

**REFERENCE BOOKS:**

1. Dutta Binay K., " Heat Transfer Principles and Application", Prentice Hall of India, New Delhi,2001.
2. Coulson J.M. and Richardson J.F., " Chemical Engineering", Volume I, 4th Edition, Asian Books Pvt.Ltd.,1998.

**15UCH504 INSTRUMENTAL METHODS OF ANALYSIS L T P C**

**3 0 0 3**

**Preamble**

This course provides basic knowledge on various analytical instruments and methods for accurate chemical analysis.

**Course outcome**

On successful completion of the course the student should able to

| | Course Outcomes | Bloom's Level |
|---|---|---|
| **CO1:** | Describe the properties of electromagnetic radiation- wave properties - components of optical instruments | Understand |
| **CO2:** | Interpret the structure of unknown compounds by using UV-Vis, IR and Raman spectroscopy | Apply |
| **CO3:** | An approach to identify the skeleton of an unknown moiety. | Apply |
| **CO4:** | Analyze the compound by quantitative methods | Analyze |
| **CO5:** | Select suitable chromatographic method to analyse the given compound | Apply |

**Assessment Pattern**

| Cognitive Level | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) | End Semester |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 20 |
| Understand | 30 | 10 | 10 | 20 |
| Apply | 10 | 20 | 10 | 30 |

| | | | | |
|---|---|---|---|---|
| Analyze | | 10 | 20 | 30 |
| Evaluate | | | | |
| Create | | | | |
| **Total** | 50 | 50 | 50 | 100 |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | Define wave number. Mention the relation between wavelength and frequency. | Remember |
| 2 | What is wavelength selector? Describe the different selectors in detail. | Remember |
| 3 | Discuss the properties for electromagnetic radiation. | Understand |
| 4 | What are the components of Optical Instruments? Mention their role in spectroscopy analysis. | Apply |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | Define the theory of Raman spectroscopy | Remember |
| 2 | State the theory of fluorescence and Phosphorescence | Remember |
| 3 | Measurement of transmittance and absorbance by using Beer"s law. | Apply |
| 4 | Construct the applications of IR spectroscopy. | Apply |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | State Electron paramagnetic resonance and g values | Remember |
| 2 | Define chemical shift and its consequences | Remember |
| 3 | Discuss the methods of expressing the accuracy in NMR spectroscopy. | Understand |
| 4 | Explain the application of NMR - Spectroscopy | Apply |

Course Outcome 4 (CO4):

| | | |
|---|---|---|
| 1 | List of the general description of chromatography | Remember |
| 2 | State the terms band broadening and optimization of column | Remember |

| | | |
|---|---|---|
| 3 | Explain the principles of various chromatography techniques. | Understand |
| 4 | Implementation of HPLC to quantize the presence of particular element in a whole solution. | Apply |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | State and write electrochemical series. | Remember |
| 2 | Classify reference electrode, ion selective and molecular selective electrodes. | Remember |
| 3 | Discuss. How "Scanning probe microscopes" gives information about the properties of unknown compound by surface analysis? | Understand |
| 4 | Comprehend the principles of AFM and STM. | Apply |

**SYLLABUS**

**UNIT I INTRODUCTION OF SPECTROMETRY ` 9**

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

**UNIT II MOLECULAR SPECTROSCOPY 9**

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer‟s law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence – Instrumenation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation Applications – Theory of Raman spectroscopy – Instrumentation – applications.

**UNIT III MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY 9**

Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applicatons of 1H and 13C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values – instrumentation.

**UNIT IV SEPARATION METHODS 9**

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography - Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography principles of GC and applications – HPLC- Capillary electrophoresis – Applications.

**UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9**

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**


1. Willard H.H., Merritt I., Dean J.A. and Settle F.A., ¯Instrumental Methods of Analysis‖, 7th Edition, CBS Publishers, New Delhi, 1986.
2. Ewing, Galen W., ¯Instrumental Methods of Chemical Analysis‖, 7th Edition, McGraw-Hill Company, New Delhi, 1985.


**REFERENCE BOOKS:**


1. Skoog D.A. and West D.M., ¯Fundamentals of Analytical Chemistry‖, 7th Edition, Saunders College Publishing, New York,1996.
2. Banwell. G. C., ¯Fundamentals of Molecular Spectroscopy‖, Tata McGraw-Hill, New Delhi, 2006.

**15UCH507 PROCESS EQUIPMENT DESIGN AND DRAWING I L T P C**

**0 0 2 1**

**AIM**

To integrate the various courses such as Chemistry, Engineering mechanism,Engineering Graphics, unit operation, Mechanics of solids, Materials Technology for acomprehension approach to the design of the process equipments.

**OBJECTIVES**

- To develop skill to design and install process equipments used widely in a chemical industry.
- All Tables/ Chemical Engineers‟ Handbook/Data Books/Graph Sheets are permitted during the Examination

**LIST OF DESIGN AND DRAWINGS**

1. Design and drawing of bolt,nut and Screws
2. Design and drawing of welded and riveted joints
3. Design and Drawing of Flanged joints, nozzles and reinforcements
4. Design and Drawing of Pipe fittings
5. Design and Drawing of Pressure Vessels
6. Design and Drawing of Vessel Support ( Bracket, saddle skirt)
7. Design and Drawing of cyclone separator
8. Design and Drawing of Centrifuge
9. Design and Drawing of Filtration equipments
10. Design and drawing of Crystallizers
11. Design and drawing of agitated Vessels.
12. Design and drawing of coil heated vessels

**(Minimum of any 10 design)**

**COURSE OUTCOMES**

The student will demonstrate the ability

1. To make student understand the principles and theories combined with a practical knowledge of the limits imposed by environmental, safety and health concerns to design of new process and expansion and revision of the existing process.
2. Understand to various mechanical properties of materials to be used as material of construction, resistance of metals to corrosion under varying conditions of temperature and pressure.
3. Conveniently use various codes and standards in design and their application in designing new processes.

4. Design various equipments such as tall vessel, unfired pressure vessels internal or external pressure and with various heads and closures including nozzles, openings and reinforcements, Bolts, flanges, gaskets
5. Process and mechanical design of selected equipment like crystallizers, Agitated Vessel, Jacketed and heated coil heated vessels.

**TEXT BOOKS**


1. R.S. Khurmi, “Textbook of Machine design”. S. Chand & Company , XXV Edition, 2005.
2. M.V. Joshi and V.V. Mahajan, “Design of Process Equipment Design”, McMillan India III Edition 1994.


**REFERENCES**


1. S.D. Dawande, “Process Design of Equipments”, Central Techno Publications, Nagpur, 2000.
2. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
3. R.H. Perry, “Chemical Engineers‟ Handbook”, McGraw-Hill.
4. W.L. McCabe, J.C. Smith and P. Harriot, “Unit Operation of Chemical Engineering”, McGraw-Hill, 2001.
5. Robert Treybal, “Mass Transfer Operations”, McGraw-Hill.
6. J.M. Coulson and J.Richardson, “Chemical Engineering”, Vol. 6, Asian Books Printers Ltd.

**15UCH508** **HEAT TRANSFER LABORATORY** **L T P C**

**0 0 2 1**

**AIM**

To determine experimentally the heat transfer coefficient of different fluid in different equipments.

**OBJECTIVE:**

- To enable the students to develop a sound working knowledge on different types of heat transfer equipments.
- To have a wide knowledge on the conductive, convective and radioactive type of heat transfer under different operative conditions and also the selection of instruments to measure the heat

**LIST OF EXPERIMENTS**

1. Performance studies on Cooling Tower
2. Batch drying kinetics using Tray Dryer
3. Heat transfer in Open Pan Evaporator
4. Stefan-Boltzmann Experiment
5. Heat Transfer through Packed Bed
6. Heat Transfer in a Double Pipe Heat Exchanger
7. Heat Transfer in Shell and Tube Heat Exchanger
8. Heat Transfer by Natural Convection
9. Heat Transfer by Forced Convection
10. Heat Transfer in a Condenser
11. Heat Transfer in Helical Coils
12. Heat Transfer in Agitated Vessels
13. Heat Transfer in a Bare and Finned Tube Heat Exchanger

**TOTAL : 30 PERIODS**

*** Minimum 10 Experiments shall be offered**

**COURSE OUTCOMES**

On completion of the course the students will be able to

- determine Stefan Boltzmann constant at different temperatures
- assess the heat transfer coefficient for natural and forced convection systems, double pipe heat exchanger / shell and tube heat exchanger and condensers
- develop temperature profile in unsteady state heat transfer system
- evaluate the convective and radiative heat transfer coefficients using radiation experiment
- appraise the fin efficiency and estimate the steam economy in an evaporator

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

| S.No | Name of the Equipment | Required |
|---|---|---|
| 1. | Cooling Tower | 1 No |
| 2. | Tray Dryer | 1 No |
| 3. | Open Pan Evaporator | 1 No |
| 4. | Packed Bed | 1 No |
| 5. | Double Pipe Heat Exchanger | 1 No |
| 6. | Bare and Finned Tube Heat Exchanger | 1 No |
| 7. | Condenser ( Vertical, Horizontal) | 1 No each |
| 8. | Helical Coil | 1 No |
| 9. | Agitated Vessel | 1 No |
| 10. | Mini Boiler | 1 No |
| 11. | Natural Convection | 1 No |
| 12. | Forced Convection | 1 No |
| 13. | Transient Heat Conduction | 1 No |
| 14. | Stefan Boltzmann experiment - Radiation | 1 No |
| 15. | Laminar Flow | 1 No |
| 16. | Characteristics of Temperature measuring | 1 No |
| 17. | Jacketed Kettle | 1 No |
| 18. | Convective Heat Transfer | 1 No |
| 19. | Controllers of Temperature | 1 No |
| 20. | Data Logger | 1 No |

**15UGS531 SOFTSKILLS AND COMMUNICATIONLABORATORY**

**(CIVIL, MECH, CHEMICAL, EIE)**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

## COURSE OBJECTIVES:

- To develop a requisite knowledge in communication skills and soft skills .
- To enhance the students‟ acumen in sharpening the skills to meet the global challenges and industrial needs.

**Unit –I** **6**

Communication – Types of communication – Communication network – Communication Techniques- Barriers of Communication.

**Unit–II** **6**

Listening – Types of listening – Listening & Note Talking – Listening strategies – Barriers of Listening – Conversation & Oral skills – Improving fluency & self expression- Good Pronunciation.

**Unit–III** **6**

Reading comprehension – Enriching Vocabulary (restricted to 1000 words) – Error analysis – Visual perception – Transcoding – Formal and Informal letters – Resume writing – Report writing.

**Unit-IV** **6**

Attitude – Self Confidence – Leadership Qualities – Effective Time Management – Surviving stress (Emotional Intelligence) – Overcoming failure- Professional Ethics – Interpersonal Skills.

**Unit–V** **6**

Body Language – Types of Interview: Online interview, Mock Interview, Telephonic interview – GD - Presentation.

**TOTAL: *30* (L) = 30 PERIODS**

## COURSE OUTCOMES:

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

- Present ideas and in a flexible manner and differentiate & eliminate the ambiguity
- Write well-structured and easily readable reports, e-mails and articles on complex topics in an appropriate style

- Comprehend any address in English face to face and through different media like telephone and public announcement

**LAB MANUAL**:

To be compiled by the Department

**REFERENCE BOOKS:**

1. Allan Pease, Body Language, New Delhi, Sudha Publications (P) Ltd, 2005

2. Dr.Rathan Reddy, Team Development & Leadership, Mumbai, Jaico Publishing House, 2006

3. Chand.S, Soft Skills, New Delhi, S.Chand& Company Ltd, 2011

4. Career Press Editors, 101 Great Resumes, Mumbai, Jaico Publishing House, 2006

**Evaluation Pattern**

| | | |
|---|---|---|
| I. | Career Lab | 25 Marks |
| II. | English Lab(System Based) | 25 Marks |

**15UCH601** **MASS TRANSFER II** **L T P C**

**3 0 0 3**

**Preamble**

This course on Mass transfer II aims to emphasize the need for and provide an in depth coverage of various unit operationlike Absorption, Distillation, Extraction, Leaching and adsorption. This course also discovers the latest separation process like Ion exchange and Membrane separation technology.

**Prerequisite**

15UCH502: Mass Transfer I

**Course outcome**

On successful completion of the course the student will able to

| | **Course Outcome** | **Bloom's Level** |
|---|---|---|
| **CO1:** | Apply the knowledge of equilibrium and operating line to calculate the HTU and NTU for the Absorption tower. | Apply |
| **CO2:** | Design the distillation tower with the knowledge of vapor liquid equilibria concepts. | Apply |
| **CO3:** | Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid mixtures | Apply |
| **CO4:** | Understand the solid liquid equilibria and different type of leaching equipments used for solid – liquid mixture separation. | Understand |
| **CO5:** | Understand the adsorption operation and Membrane separation process. | Understand |

**Mapping with Programme Outcome**

| **CO** | **POs** | | | | | | | | | | | | **PSOs** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **a** | **b** | **C** | **d** | **E** | **f** | **g** | **h** | **i** | **j** | **k** | **L** | **I** | **II** |
| **CO.1** | **S** | | | | | **W** | | | | | | | **W** | |
| **CO.2** | | | **M** | | | | | | **W** | | | | | **S** |
| **CO.3** | | **S** | | | | | **W** | | **W** | | | | | **W** |
| **CO.4** | | **S** | | | | | | | | **M** | | | **M** | |
| **CO.5** | | | | | | | **M** | | | **W** | | | **S** | |

**Assessment Pattern**

| **CognitiveLevel** | **Periodical Test – I** | **Periodical Test– II** | **Periodical Test – III** | **End Semester Examination** |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 10 |
| Understand | 10 | 10 | 30 | 50 |

| | | | | |
|---|---|---|---|---|
| Apply | 30 | 30 | 10 | 40 |
| Analyze | | | | |
| Evaluate | | | | |
| Create | | | | |
| **Total** | 50 | 50 | 50 | 100 |

**Syllabus**

**UNIT I ABSORPTION** **9**

Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process.

**UNIT II DISTILLATION** **9**

Vapour-liquid equilibria, Raoult's law and deviations from ideality, methods of distillation; fractionation of binary and multicomponent system; design calculations by McCabe- Thiele and ponchon-Savarit, methods; continuous contact distillation tower (packed tower) design; extractive and azeotropic; distillation low pressure distillation; steam distillation.

**UNIT III LIQUID-LIQUID EXTRACTION** **9**

Equilibrium in ternary systems; equilibrium stage wise contact calculations for batch and continuous extractors, differential contact extraction equipment - spray, packed and mechanically agitated contactors and their design calculations; pulsed extractors, centrifugal extractors.

**UNIT IV SOLID-LIQUID EXTRACTION (LEACHING)** **9**

Solid-liquid equilibria; leaching equipment-batch and continuous types; calculation of number of stages.

**UNIT V ADSORPTION AND OTHER ION EXCHANGE SEPARATION PROCESSES** **9**

Theories of adsorption of gases and liquids; industrial adsorbents, adsorption equipment for batch and continuous operation; design calculation of ion-exchange resins; principle of ion-exchange; industrial equipment.

Membrane separation process; solid and liquid membranes; concept of osmosis; reverse osmosis; electrodialysis; their applications; foam separation process; Thermal and sweep /diffusion process.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**


1. R.E.Treybal, “Mass Transfer Operations”, McGraw-Hill, III Edition 1980.
2. W.L McCabe J.C.Smith, and Harriot. P., “Unit Operations of Chemical Engineering”,VI edn McGraw-Hill, International Edition, 2001.


**REFERENCES**


1. 1 . C.Judson King “Separation Processes”, McGraw-Hill II Edition 1980.
2. A.H.P.Skelland, “Diffusional Mass Transfer”, Krieger, Malapur, FL (1985).
3. Roman Zarfyki and Andrzej Chacuk, “Absorption Fundamentals and Applications", Pergamon Press, 1993.
4. P.Wankat “Separation Process Engineering ”, Prentice Hall, II Edition 2006.
5. R.F.Strigle (jr), Packed Tower Design and Application, 2nd Edn. Gulf Publishing Company U.S.A. 1994. 6

**15UCH602** **CHEMICAL REACTION ENGINEERING I** **L T P C**

**3 0 0 3**

**Preamble**

Chemical Reaction engineering (CRE) course is for Graduate students with a background in Chemical Engineering. The course entails design of chemical reactors for complex reaction systems. It presents reaction kinetic principles, performance equations, size comparison, and non ideality of different types of reactors.

**Prerequisite:**

Basic knowledge of material and energy balances in chemical engineering applications, laws of thermodynamics.

**COURSE OUTCOMES**

The student will demonstrate ability to

**COURSE OUTCOMES** **Blooms level**

**CO 1**: To analyze and interpret batch and differential reactors data to obtain reaction rate expressions . **Understand**

.

**CO 2**: Derive performance equations and size the batch and flow reactors. **Apply**

**CO 3**: Develop skills to choose the right reactor among single, multiple, recycle reactors etc. **Apply**

**CO 4**: Apply the concepts of heat capacity, latent heat, heat of reaction, heat of combustion, and heat of formation. **Apply**

**CO 5**: Perform non ideal reactor analysis. **Apply**

**Mapping with program outcomes**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | S | M | | | S | | | | | M | | M | S | |
| CO.2 | | | | | | | | S | | M | | | S | |
| CO.3 | S | | | S | | | | | | M | | | S | |
| CO.4 | S | | | | | S | | | M | | | | S | M |
| CO.5 | | M | | S | | | | | | S | | M | M | S |

**Ref: S- Strong M- Medium W- Weak**

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) | End Semester |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 20 |
| Understand | 30 | 10 | 10 | 20 |
| Apply | 10 | 30 | 20 | 40 |
| Analyze | | | 10 | 20 |
| Evaluate | | | | |
| Create | | | | |
| **Total** | 50 | 50 | 50 | 100 |

**Syllabus**

**UNIT I** **9**

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

**UNIT II** **9**

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, size comparison of reactors.

**UNIT III** **9**

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

**UNIT IV** **9**

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

**UNIT V** **9**

The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors

**TOTAL: 45 PERIODS**

**TEXT BOOKS**


1. Levenspiel.O, “Chemical Reaction Engineering”, John Wiley, III Ediition, 1998.
2. Smith.J.M., “Chemical Engineering Kinetics”, McGraw-Hill Third Edition, 1981.
3. Fogler .S “Fundamental Chemical Reaction Engg”, Prentice Hall of India. 7


**REFERENCES**


1. Froment. G.F. & K.B.Bischoff, “Chemical Reactor Analysis and Design”, John Wiley and Sons, 1979.

| 15UCH603 | PROCESS INSTRUMENTATION | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | DYNAMICS AND CONTROL | PC | 3 | 0 | 0 | 3 |

**Preamble**

This Course provides an in depth knowledge of various open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation. Also emphasize on mathematical techniques and tools to control the system based on applications

**Prerequisite**

- **None**

**COURSE OUTCOMES**

On completion of the course the student will be able to:

| COURSE OUTCOMES | | Bloom's Level |
|---|---|---|
| **CO1 :** | Describe the principles involved in the measurement and control of industrial processes, instruments and devices available for designing process control systems. | Remember |
| **CO2 :** | Derive the Laplace domain, frequency domain in various systems and its application in process control | Apply |
| **CO3 :** | Evaluate dynamic modeling, behavior and system stability | Evaluate |
| **CO4 :** | Explain the frequency response methods and controllers design | Understand |
| **CO5 :** | Illustrate the knowledge of advanced control strategies | Analyze |

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I (as marks) | Periodical Test– II (as marks) | Periodical Test – III (as marks) | End Semester |
|---|---|---|---|---|
| Remember | 30 | 10 | 10 | 10 |
| Understand | 20 | 10 | 20 | 20 |
| Apply | | 10 | 10 | 40 |
| Analyze | | | 10 | 20 |
| Evaluate | | 20 | | 10 |
| Create | | | | |
| **Total** | 50 | 50 | 50 | 100 |

**Mapping with Programme Outcomes**

| CO | Pos | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | S | | M | S | | W | W | | | | M | | S | |
| CO.2 | S | | | | | M | | M | | | M | | S | |
| CO.3 | S | | | M | | | M | | | | | W | S | |
| CO.4 | S | | S | | | W | | | | M | S | | S | M |
| CO.5 | S | M | S | S | | | | W | | | S | M | M | S |

**Ref: S- Strong M- Medium W- Weak**

**Course Level Assessment Questions**

**Syllabus**

**UNIT I INSTRUMENTATION 9**

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

**UNIT II OPEN LOOP SYSTEMS 9**

Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

**UNIT III CLOSED LOOP SYSTEMS 9**

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

**UNIT IV FREQUENCY RESPONSE 9**

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion – Routh Array, tuning of controllers Z-N tuning rules, C-C tuning rules.

**UNIT V ADVANCED CONTROL SYSTEMS 9**

Introduction to advanced control systems, cascade control, feed forward control, Smith predictor, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**

1. D. SCoughnowr and Koppel, “Process Systems Analysis and Control”, McGraw-Hill, New York, 1991.

2. George Stephanopoulos,“Chemical Process Control”,Prentice-Hall of India Pvt. Ltd., New Delhi, 2012.

3. Patranabis.D, Principles of Process control, II edition, Tata McGraw-Hill Publishing Co. Ltd., 1981.

4. Peter Harriott, Process control, Tata McGraw-Hill Publishing Co., Reprint 2004.

5. Kulkarni P.D and Dhone D.B, "Chemical Process Instrumentation and Control". Nirali Publications, 2011.

**REFERENCES**

1. Thomas, E.Marlin, Process Control, 2nd Edn, McGraw-Hills International Edn. 2000.

2. Norman H.CEAGLSKE, Automatic process control for chemical engineers, John Wiley & Sons, Japan.

3. Emenule, S.Savas, “Computer Control of Industrial Processes”, McGraw-Hill, London, 1965.

4. Eckman, D.P., “Industrial Instrumentation”, Wiley, 1978.

**15UCH607** **MASS TRANSFER LABORATORY** **L T P C**

**0 0 2 1**

**AIM**

To determine experimentally certain physical properties of fluids and solids

**OBJECTIVES**

- To gain knowledge on the determination of important data for the design and operation of the process equipments.

**LIST OF EXPERIMENTS**

1. Simple distillation.
2. Steam distillation.
3. Packed column distillation.
4. Bubble cap distillation.
5. Diffusivity measurements.
6. Liquid-liquid extraction.
7. Vacuum Dryer.
8. Tray dryer.
9. Rotary dryer.
10. Surface Evaporation.
11. Adsorption.
12. Leaching.

*** Minimum 10 experiments shall be offered.**

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES**

- To study the complete design calculation for equilibrium stage separation processes of distillation and the experiment concepts of diffusion
- To study the separation principles of Liquid-liquid equilibrium and solid-liquid equilibrium
- To familiarize students with equipments commonly used in drying and characteristics curve

**Requirements for a batch of 30 students**

| Sl. No. | Description of Equipment | Quantity required | |
|---|---|---|---|
| 1. | Simple distillation setup | 2 | |
| 2. | Steam distillation setup | 2 | |
| 3. | Packed column | 1 | |
| 4. | Liquid-liquid extractor | 1 | |
| 5. | Vacuum Dryer | 1 | |
| 6. | Tray dryer | 1 | |
| 7. | Rotary dryer | 1 | |
| 8. | Ion exchange column | 1 | |
| 9. | Rotating disc contactor | 1 | |
| 10. | Cooling tower | 1 | |
| 11. | Absorption column | 1 | |

| 15UCH608 | TECHNICAL PROJECT | L T P C |
|---|---|---|
| | | 0 0 6 3 |

**OBJECTIVES**

The objective of the project is to enable the students to work in groups of not more thanfour members in each group on a project involving analytical, experimental , design orcombination of these in the area of Chemical Engineering.

Each project shall have a guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem. The evaluation is based on continuous internal assessment by an internal assessment committee for 100marks.

**Course outcomes**

1. Build and work in a team and gather information pertained to the project work.

2. Review the literature, formulate the problem and form a methodology to arrive a solution to the problem.

3. Design and analyze the various unit operation and process in chemical engineering.

**15UCH701** **TRANSPORT PHENOMENA** **Category L T P Credit**

**PC 3 0 0 3**

**Preamble**

The Course is designed to impart the knowledge on various types of fluids, their flow characteristics and different mathematical models applied to actual situations in shell balance approach in laminar flow. Also aims at facilitating the students to understand the various mechanisms of fluids in motion under different conditions.

**Prerequisite**

15UCH502 – Mass Transfer – I
15UCH 503 – Heat Transfer

**COURSE OUTCOMES**

On completion of the course the student will be able to:

| **COURSE OUTCOMES** | | **Bloom's Level** |
|---|---|---|
| CO1 | understand the principles of momentum, heat and mass transport by developing mathematical models to determine respective fluxes | **Remember** |
| CO2 | Apply the shell momentum balances and velocity distribution in laminar flow and understand equation of continuity and motion. | **Apply** |
| CO3 | Establish the shell energy balances and temperature distributions in solids. | **Apply** |
| CO4 | Determine the shell mass balance and concentration distributions in systems involving diffusion and reactions | **Analyze** |
| CO5 | Analyze the analogy between the transports processes of heat, momentum and mass transfer | **Understand** |

**Mapping with Programme Outcomes:**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | S | | M | M | | M | | | | M | M | | S | |
| CO.2 | S | | M | S | | | w | | | S | | | M | M |
| CO.3 | S | | M | S | | | | | | M | M | | M | M |
| CO.4 | S | | M | S | | M | | | | M | M | | S | M |
| CO.5 | S | | M | M | | | | | | M | | | M | |

**Assessment Pattern**

| CognitiveLevel | Continuous Assessment Tests (as marks) | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Remember | 20 | 20 | 10 |
| Understand | 10 | 10 | 10 |
| Apply | 10 | 10 | 15 |
| Analyze | 10 | 5 | 10 |
| Evaluate | | 5 | 5 |
| Create | | | |

**Course Level Assessment Questions**

**Course Outcome 1 (CO1):**

1. Explain the Importance of Transport Phenomena and Analogous nature of transfer processes. — Understand
2. Develop the concept of Viscosity for the Newtonian Fluids and the corresponding rheological property terms for the Newtonian fluids. — Understand
3. Explain the rheological behavior of Non- Newtonian fluid with different models. — Remember
4. Compute the viscosity of $CO_2$ at 300 K and 1 atm pressure — Evaluate

   Given: $\varepsilon$ / R= 190 K; $\sigma$ = 3.996 A$^o$ and $\Omega_\mu$ = 1.286

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1. | Explain the procedure for Shell momentum balance and boundary conditions for solving viscous flow problems. | Understand |
| 2. | Consider a inclined plate at an angle β, on which the fluid is flowing. Derive the expression for maximum velocity, average velocity and volumetric flow rate. | Analyze |
| 3. | Arrive the equation $Q = \pi (P_0 - P_L) R^4 / 8\mu L$ for a flow of a fluid in a cylinder whose length "L", radius "r" and thickness "Δr" and the end effects may be neglected. | Analyze |
| 4. | Two immiscible incompressible fluids are flowing in the z-direction in a horizontal thin slit of length „L" and width W under the influence of a pressure gradient. The fluid rates are so adjusted that the slit is half filled with Fluid I (the more dense phase) and half filled with Fluid II (the less dense phase). Analyze the system in terms of the distribution of velocity and momentum flux. | Analyze |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1. | Discuss Fourier"s law of heat conduction and and the analogy between heat and momentum transfer. | Understand |
| 2. | Find the heat of conduction with an electrical heat source for a cylindrical shell of radius "r" thickness "Δr" and length "L" | Analyze |
| 3. | In a nuclear reactor the fission reactions taking place with a nuclear fuel rod of radius $R_f$. Express the equation of temperature distribution for nuclear fuel rod. | Analyze |
| 4. | Develop an equation for heat conduction through composite cylindrical walls. | Analyze |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1. | Express the definitions of concentrations, velocities and mass fluxes | Understand |
| 2. | Find the expression for diffusion of liquid "A" is evaporating in to a stagnant gas "B".. | Analyze |
| 3. | In a catalytic converter the reaction $2A \rightarrow A_2$ is carried our on a catalyst surface. Find the expression for $N_{AZ.}$ | Analyze |
| 4. | Derive the expression for absorption of gas "A" by a laminar falling film of liquid "B". | Analyze |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1. | Discuss the development and applications of analogies between momentum, heat and mass transfer | Understand |
| 2. | Describe the Von Karman hypothesis in respect of analogy between the different transport operations. | Remember |
| 3. | Write in detail about Prandtl Analogy. | Remember |
| 5. | Find the expression for Chilton-Colburn J factor analogy for gases and liquids under laminar and turbulent flow regions. | Evaluate |

**Syllabus**

**UNIT – I** **9**

**Fundamentals of Transport Phenomena:** Importance of Transport Phenomena; Analogous nature of transfer processes; Conservation laws; Newtonian and Non-Newtonian fluids- Rheological models; Transport properties of gases and liquids- theories, pressure and temperature effects.

**UNIT – II** **9**

**Shell Momentum Balances and Velocity Distribution in Laminar Flow:** Shell balance and boundary conditions; Momentum flux and velocity distribution in flow of a falling film, flow through circular tube, Hagen poiseuille law, flow through an annulus and adjacent flow of two immiscible fluids. Time derivatives and vector notation, Equation of continuity, Equation of Motion, Navier- stokes equation.

**UNIT – III** **9**

**Shell Energy Balances and Temperature Distributions in Solids and Laminar Flow:** Fourier‟s law of heat conduction**,** Analogy between heat and momentum transfer,Shell heat balance and boundary conditions to heat transport**,** Heat Conduction with Electrical heat source, Heat conduction with Nuclear heat source and Viscous Heat Sources; Heat Conduction - Composite Walls and Cooling Fin and effectiveness of Fin; Forced and Free Convection.

**UNIT – IV** **9**

**Shell Mass Balance and Concentration Distributions in Solids and Laminar Flow:** Fick‟s law of diffusion**,** Definitions of concentrations, velocities and mass fluxes. Boundary conditions in mass transfer,Diffusion - Stagnant Gas Film, Heterogeneous and Homogeneous Chemical Reactions, Falling Liquid Film (Gas Absorption).

**UNIT – V** 9

**Analogies of Transport Process:** Development and applications of analogies between momentum, heat and mass transfer- Reynolds, Prandtl, Von Karman and Chilton-Colburn analogies.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**


1. R.B. Bird, W.E. Stewart and E.W. Lightfoot, “Transport Phenomena”, John Wiley, II Edition 2006.
2. B. M . Suryavanshi and L. R. Dongre, “Transport Phenomena”, Nirali Prakashan, 6th edition 2015.
3. Robert, S Brodkey, Harry C. Hershey, “Transport Phenomena A Unified Approach”, Brodkey Publishing 2003.


**REFERENCES:**


1. L.S.Sissom, and D.R.Pitts, “Elements of Transport Phenomena”, McGraw-Hill, New York, 1972.
2. R.W.Fahien, “Elementary Transport Phenomena”, McGraw-Hill, New York, 1983.
3. J.R.Welty., R.W Wilson and C.W wicks, Roger.G.E ., Wilson R.W, Fundamental of Momentum, Heat and Mass Transfer V th edn, John Wiley, New York, 2007.

**15UCH702 CHEMICAL ENGINEERING PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT** **L T P C 3 0 0 3**

**Preamble**

This course provides the basic concept of cost estimation, feasibility analysis, management, organization and quality control that will enable thestudents to perform as efficient managers.

**Prerequisite**

15UCH402: Chemical Process Calculation

**Course outcome**

On successful completion of the course the student should able to

| **Course Outcome** | | **Bloom's Level** |
|---|---|---|
| **CO1:** | Describe the basic management function with respect to production and effective utilization of materials in manufacturing and service organization, | Understand |
| **CO2:** | Calculate the economic evaluation, including accounting techniques taxes, investment, interest, discounted cash flows | Apply |
| **CO3:** | Classify the profitability, Investment, alternative and replacement policiesof chemical process industries. | Apply |
| **CO4:** | Analysis the annual report like balance sheet, income statement and financial ratios, and also analysis the performance and growth | Analyze |
| **CO5:** | Prepare the essential economics balance for industrial equipment like evaporator, heat exchanger. | Apply |

**Assessment Pattern**

| **CognitiveLevel** | **Periodical Test – I (asmarks)** | **Periodical Test– II (asmarks)** | **Periodical Test – III (asmarks)** |
|---|---|---|---|
| Remember | 10 | 10 | 10 |
| Understand | 30 | 10 | 10 |
| Apply | 10 | 30 | 20 |
| Analyze | | | 10 |
| Evaluate | | | |
| Create | | | |
| **Total (50)** | 50 | 50 | 50 |

**Syllabus**

**UNIT IPRINCIPLES OF MANAGEMENT AND ORGANISATION 12**

Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations. Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control, Microeconomics.

**UNIT II INVESTMENT COSTS AND COST ESTIMATION 8**

Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, capital budgeting and project feasibility.

**UNIT III PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT 9**

Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

**UNIT IV ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 8**

Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

**UNIT V ECONOMIC BALANCE 8**

Economic decisions in Chemical Plant - Economics of size - Essentials of economic balance – Economic balance approach, economic balance for insulation, evaporation, heat transfer.

TOTAL : 45 PERIODS

**TEXT BOOKS:**


1. Peters, M. S. and Timmerhaus, C. D. RE West , “Plant Design and Economics for Chemical Engineers”, III Edn, McGraw Hill, 2003.
2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., "Introduction to process Economics", 2nd Edn, John Wiley, 1983.
3. Narang, G.B.S. and Kumar, V., “Production and Costing”, Khanna Publishers, New Delhi.
4. Banga T.R., and Sharma S.C., Industrial organisation and engineering economics, Khanna Publishers, New Delhi.


**REFERENCES:**


1. Allen, L.A., “Management and Organization”, McGraw Hill.
2. Perry, R. H. and Green, D., “Chemical Engineer"s Handbook “, 7th Edition, McGraw Hill.

**15UCH703** **CHEMICAL REACTION ENGINEERING II** **L T P C**

**3 1 0 4**

**PREAMBLE**

In this subject emphasis is on heterogeneous reaction engineering and catalysis, leading finally to design considerations. The first part of this subject deals with Catalysis . Kinetics and design of reactors for non-catalytic fluid-fluid and fluid-particle reactions follows.

**COURSE PREREQUISTE**

15UCH602 CHEMICAL REACTION ENGINEERING I

**COURSE OUTCOMES**

On successful completion of the course the students can able to

**COURSE OUTCOMES** **Blooms level**

**CO 1** Classify catalysts and predict physical properties of catalyst, surface area, void volume, solid density pore volume distribution. **Understand**

**CO2** Develop rate laws for heterogeneous reaction and predict the rate controlling stepfor the fluid - particle reactions. **Apply**

**CO3** Derive expressions for diffusion of reactants in catalyst, also the reactions involved in fixed bed reactors. **Apply**

**CO4** Design of reactors for gas solid non catalytic reactions. **Apply**

**CO5** Demonstrate expressions for gas - liquid reactors involving mass transfer coefficients. **Apply**

**Mapping with program outcomes**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | I | II |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO.1** | **S** | **M** | **S** | | | | | | **M** | | | | **S** | **M** |
| **CO.2** | **S** | **M** | **S** | | | | | **S** | | **M** | | | **S** | **M** |
| **CO.3** | **S** | | | **S** | | | | | | **M** | | | **S** | **M** |
| **CO.4** | **S** | | | | | **S** | | | **M** | | | | **S** | **M** |
| **CO.5** | | **M** | | **S** | | | | | | **S** | | **M** | **M** | **S** |

**Ref: S- Strong M- Medium W- Weak**

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) | End Semester |
|---|---|---|---|---|
| Remember | 10 | 10 | 10 | 20 |
| Understand | 30 | 10 | 10 | 20 |
| Apply | 10 | 30 | 20 | 40 |
| Analyze | | | 10 | 20 |
| Evaluate | | | | |
| Create | | | | |
| **Total** | 50 | 50 | 50 | 100 |

**SYLLABUS**

**UNIT I CATALYSTS 7**

Nature of catalysts, surface area and pore-volume distribution, catalyst preparation.

**UNIT II HETEROGENEOUS REACTIONS 10**

Rate equations for heterogeneous reactions, adsorption isotherms, rates of adsorption and desorption, surface reaction analysis of rate equation and rate controlling steps,

**UNIT III GAS-SOLID CATALYTIC REACTORS 10**

Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets, effectiveness factor, Thiele Modulus, fixed bed reactors.

**UNIT IV GAS-SOLID NON-CATALYTIC REACTORS 9**

Models for explaining kinetics; volume and surface models; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes, fluidized and static reactors.

**UNIT V GAS-LIQUID REACTORS 9**

Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants; application of film, penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction, tower reactor design.

**TOTAL: 45 (L) + 30 (T)= 75 periods**

**TEXT BOOKS:**


1. Levenspiel, O., "Chemical Reaction Engineering ", III Edition, John Wiley, 1999.
2. Fogler. H. S. "Elements of Chemical Reaction Engineering ", III Edition., Prentice Hall of India, 1999.


**REFERENCES:**


1. Smith J.M., "Chemical Engineering Kinetics ", III Edition, McGraw-Hill, New York, 1981.
2. Froment G.F & K.B. Bischoff, "Chemical Reaction Analysis and Design", John Wiley and Sons, 1979.

**15UCH707 CHEMICAL REACTION ENGINEERING LABORATORY L T P C**

**0 0 2 1**

**AIM**

To determine experimentally the kinetics and rate constants of reactions in differenttypes of reactors.

**OBJECTIVES**

- To gain knowledge in the design of reactors.

**LIST OF EXPERIMENTS***

1. Kinetic studies in a batch reactor
2. Kinetics in a plug flow reactor
3. Kinetics in a PFR followed by a CSTR
4. RTD in a PFR
5. RTD in a packed bed
6. RTD in CSTRs in series

***Minimum 10 experiments shall be offered.**

**XOURSEOUTCOMES**

On successful completion of the course the students can able to

- Ability to know the kinetics of Batch Reactor and Plug Flow Reactor.
- Describe the mechanisms of PFR followed by CSTR.
- Examine the residence time distributions in plug flow reactor.
- Explain the residence time distributions in Packed bed reactor.
- Design and examine the residence time distributions in CSTR"s in series

**REQUIREMENTS FOR A BATCH OF 30 STUDENTS**

| Sl. No | Description of Equipment | Quantityrequired |
|---|---|---|
| 1. | Batch Reactor | 3 |
| 2. | Plug Flow Reactor | 2 |
| 3. | CSTR | 2 |
| **4.** | Sono-Chemical Reactor | 2 |
| **5.** | Photochemical Reactor | 2 |
| **6.** | Packed Bed Reactor | 2 |

**15UCH708 PROCESS EQUIPMENT DESIGN AND DRAWING II L T P C**

**0 0 2 1**

(All Tables/Chemical Engineers‟ Handbook/Data Books/Graph Sheets are permitted during the Examination.)

**AIM**

To gain practical knowledge on the shape and drawing of the process equipments

**OBJECTIVES**

- To become a design engineers on process equipments design and drawing consideration of the following

**LIST OF DESIGN AND DRAWINGS**

1. Design and drawing of cooling towers
2. Design and drawing of Evaporators
3. Design and drawing of driers
4. Design and drawing of Heat Exchangers
5. Design and drawing of condensers
6. Design and drawing of reboilers
7. Design and drawing of Distillation columns
8. Design and drawing of sieve tray
9. Design and drawing of bubble tray columns and packed columns
10. Design and drawing of absorption towers
11. Design of liquid -liquid extraction

Minimum any 10 designing must be drawn

.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES**

On successful completion of the course the students can able to

- Ability to design of evaporators, cooling towers, driers.
- Design of heat exchangers, Condenser, Reboilers.
- Develop design procedure for Distillation Columns.
- Design procedure for packed column with sieve plate and bubble cap.
- Compose design procedure for Liquid- Liquid Extraction

**TEXT BOOKS**


1. M.V.Joshi and V.V. Mahajan, “Process Equipment Design”, MacMillan India Ltd.
2. S.D.Dawande, “Process Design of Equipments”, Central Techno Publications, Nagpur, 2000.


**REFERENCES**

1. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
2. R.H. Perry, “Chemical Engineers‟ Handbook”, McGraw-Hill.
3. W.L.McCabe, J.C.Smith and Harriet, “Unit Operation of Chemical Engineering”, McGraw-Hill.
4. Robert Treybal, “Mass Transfer Operations”, McGraw-Hill.
5. J.M. Coulson and J.Richardson, “Chemical Engineering”, vol. 6, Asian Books Printers Ltd.

**15UCH709** **PROCESS CONTROL LABORATORY** **L T P C**

**FOR CHEMICAL ENGINEERS** **0 0 2 1**

**OBJECTIVE:**

- To determine experimentally the methods of controlling the processes including measurements using process simulation techniques.

**LIST OF EXPERIMENTS**

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a level system
10. Tuning of a pressure system
11. Tuning of a thermal system
12. Flow co-efficient of control valves
13. Characteristics of different types of control valves
14. Closed loop study on a pressure system
15. Tuning of pressure system
16. Closed loop response of cascade control system *Minimum 10 experiments shall be offered.

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

On successful completion of the course the students can able to

- Estimate the response of first and second order systems
- Ability to interpret the response forInteracting and Non-interacting systems.
- Distinguish various controllers like flow, Level and Thermal controllers.
- Tuning of various controllers like flow, Level and Thermal controllers.
- Design the closed loop Cascade controller

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

| S.No | Name of the Equipment | Required |
|---|---|---|
| 1. | U tube manometer with controller | 1 |
| 2. | Interacting Tank | 2 |
| 3. | Non Interacting Tank | 2 |
| 4. | Open loop control system | 1 |
| 5. | Closed loop control system | 1 |
| 6. | ON/OFF controller | 1 |
| 7. | Control valve characteristics | 1 |
| 8. | Pressure Tuner | 1 |
| 9. | Temperature Tuner | 1 |
| 10. | Proportional Controller | 1 |
| 11. | Flow Transmitter | 1 |
| 12. | Level Transmitter | 1 |
| 13. | Cascade control system | 1 |

| 15UME801 | PROFESSIONAL ETHICS<br>(Common to ALL Branches) | L<br>2 | T<br>0 | P<br>0 | C<br>2 |
|---|---|---|---|---|---|

**OBJECTIVES :**

- To impart knowledge on a values-based approach and provide a method of thinking about and dealing with ethical issues in the work place.
- To explain what a profession is and what it means to act professionally.

**UNIT I ENGINEERING ETHICS 9**

Senses of „Engineering Ethics‟ - Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg‟s theory – Gilligan‟s theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

**UNIT II ENGINEERING AS SOCIAL EXPERIMENTATION 10**

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Assessment of safety and risk – Risk Benefit analysis – Professional Rights – Employee rights – Intellectual Property Rights

**UNIT III GLOBAL ISSUES 11**

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Engineers as Managers – Consulting Engineers – Honesty – Moral Leadership – Sample Code of Conduct.

**TOTAL : 30 PERIODS**

**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

1. Illustrate the basic perception of profession, professional ethics and various m issues.(Understand)
2. Describe the code of ethics and role of professional ethics in engineering field. (Understand)
3. Apply ethical principles to resolve global and cross cultural issues that arise in professio career.(Apply)

**TEXT BOOKS:**


1. Subramanian. R , “Professional Ethics”, Oxford University press India, New Delhi First edition, 2013.
2. Dhinesh Babu.S, “Professional Ethics and Human Values”, Laxmi Publications, New Delhi, Reprint, 2016.

**REFERENCE BOOKS:**


1. Jayakumar.V, “Professional Ethics in Engineering”, Lakshmi Publications, Chennai.
2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, 2003.
3. Edmund G Seebauer, Robert L Barry “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, 2001.
4. David Ermann, Michele S Shauf “Computers, Ethics and Society”, Oxford University Press, 2003.


## COURSE ARTICULATION MATRIX:

### CO/PO/PEO MAPPING

| CO | PEO | POs | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | I, II | | | | | | M | | S | M | | | M | M | M |
| CO.2 | I, II | | | | | | M | | S | | | | M | S | M |
| CO.3 | I, II | | | | | | M | | S | M | | | M | S | M |

| Subject | PEO | POs | | | | | | | | | | | | PSO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| 15UME801 | I, II | | | | | | M | | S | M | | | M | S | M |

**Ref: S- Strong M- Medium W- Weak**

## Assessment Pattern

| Cognitive Level | Periodical Test – I (as marks) | Periodical Test – II (as marks) | Periodical Test – III (as marks) | End semester Examination (as marks) |
|---|---|---|---|---|
| **Remember** | 18 | 18 | 10 | 40 |
| **Understand** | 32 | 32 | 16 | 44 |
| **Apply** | - | - | 16 | 8 |
| **Analyze** | - | - | 8 | 8 |
| **Evaluate** | - | - | - | - |
| **Create** | - | - | - | - |
| **Total (50)** | **50** | **50** | **50** | **100** |

## Assessment Questions

**CO 1:**

1. Explain the levels of moral development proposed by Kohlberg and Gilligan. Also bring out the drawbacks of Kohlberg theory? (**Understand)**
2. Describe the professional roles played by an engineer? (**Understand)**
3. What is meant by Moral Autonomy? Discuss the factors influencing person concern and the skills required to improve more Autonomy? **(Remember)**
4. Where and how do moral problems arise in engineering practice? Give the safety and other obligations of professional engineers for appropriate problems. (**Apply)**

**CO 2:**

1. How can an engineer become a responsible experimenter? Explain in detail? **(Remembering)**
2. Discuss on the roles played by the codes of ethics set by professional societies? (**Understanding)**
3. In the challenger disaster, Examine if and how the principal actors behaved as responsible experimenters? **(Analyze)**
4. Make use of codes of ethics in engineering practice? **(Apply)**

**CO 3:**

1. List out some most common conflicts that may arise for an engineering project manager? **(Remember)**
2. Construct the sequence of events which lead to the Bhopal disaster **(Apply)**
3. Compare ethical relativism and descriptive relativism with some examples. **(Analyze)**
4. Explain engineers as Expert witness and Advisors **(Understand)**

| 15UCH801 | PROJECT WORK | L T P C |
|---|---|---|
| | | 0 0 24 12 |

**OBJECTIVES**

The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.

Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry. Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment.

**15UCH901** **FOOD SCIENCE AND TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To enable the students to learn to design processing equipments for Food Industries.

**UNIT I AN OVERVIEW** **5**

General aspects of food industry; world food needs and Indian situation

**UNIT II FOOD CONSTITUENTS, QUALITY AND DERIVATIVE FACTORS** **9**

Constituents of food; quality and nutritive aspects; food additives; standards deteriorative factors and their control.

**UNIT III GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS** **9**

Preliminary processing methods; conversion and preservation operations

**UNIT IV FOOD PRESERVATION METHODS** **9**

Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.

**UNIT V PRODUCTION AND UTILISATION OF FOOD PRODUCTS** **13**

Cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

On successful completion of the course the students can able to

- Explain the general aspects of food industries, food products, and economic value and food demand of our country.
- Identify the food constituents and their nutritive value in terms of quality standards and detractive factors and their control.
- Know about the engineering aspects of food processing and preservation methods.
- Analysis the various kinds of food products, Production and utilization to the standard.
- Design the food processing equipment for food industries.

**TEXT BOOKS:**


1. Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, The AVI publishing Co., West port 1967.
2. Potter N.N., Food Science, The AVI publishing Co., Westport, 1963.
3. Food Industry – Chemical Engineering Edn. Development Centre


**REFERENCES:**


1. Heldman D.R., Food Process Engineering, The AVI publishing co., 1975.
2. Charm S.E., The Fundamentals of Foods Engineering, The AVI Publishing Co., Westport, 1963.

**15UCH902** **FLUIDIZATION TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVE**

- To enable the students to learn the design aspects of fluidized beds.

**UNIT I BASICS OF FLUIDIZATION 9**

Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozney karman – On set of fluidization – Properties of fluidized beds – Development of fluidization from fixed bed.

**UNIT II FLUIDIZED BED TYPES 9**

Minimum fluidization conditions, correlations for Minimum fluidization velocity- Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

**UNIT III DESIGN ASPECTS 9**

Channeling – Bed expansion in liquid – Solid and gas – Solid fluidizations and correlations. Design aspects of fluidized bed systems.

**UNIT IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS 9**

Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

**UNIT V OTHER TYPES OF FLUIDIZATION 9**

Single stage and multistage fluidization – Collection of fines – Use of cyclones.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will have the knowledge on

- Fluidization phenomenon, behavior of fluidized beds and industrial applications.
- Understanding of fluidization behaviour
- To estimate pressure drop, bubble size, TDH, voidage, heat and mass transfer rates for the fluidized beds
- Ability to write model equations for fluidized beds
- capability to design gas-solid fluidized bed reactors

**TEXT BOOKS:**


1. Levenspiel, “Fluidization Engineering”, 2nd Edition, Butterworth – Heinmann, 1991.
2. Robert H. Perry and Don W. Green, “Perry‟s Chemical Engineer‟s Hand Book”, 7th Edition, Mc Graw Hill – International, 1997.


**REFERENCES:**


1. Rowe and Davidson, “Fluidization”, Academic Press, 1971.
2. Leva, M., “Fluidization”, McGraw Hill Book Co, 1959.
3. Wen-Ching Yang. “Handbook of Fluidization and Fluid-Particle Systems”, Marcel Dekker Inc, 2003.
4. Kunii and Levenspiel, “Fluidization Engineering” .John Willey and Sons,New York

**15UCH903** **PETROLEUM REFINERY ENGINERING** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To make the students understand petroleum engineering principles, their application to petroleum and natural gas manufacturing problems.

**UNIT – I** **9**

**Formation and Composition of Petroleum:** Origin and formation of petroleum; composition; types and classification; Petroleum reserves.

**UNIT – II** 9

**Properties and Testing Methods**: Physical properties and testing methods – crude and petroleum products;

**UNIT– III** **9**

**Treatment Techniques:** Desalting of crudes, dehydration and fractionation methods; Thermal and catalytic cracking processes – vis-breaking, Dubbs two coil process, coking, FCC, Hydro cracking processes.

**UNIT– IV** **9**

**Upgrading Processes:** Solvent extraction; hydro treatment processes; Reforming and Alkylation; Isomerization; polymerization; finishing and purification processes.

**UNIT – V** **9**

**Material and Energy Balances:** Material and Energy balances calculation; controlling hydrocarbon losses in refinery; application of pollution control techniques.

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students will be able to

- understand the formation and composition of petroleum
- familiarize with properties and testing methods for crude and petroleum products
- understand the various treatment techniques of petroleum
- familiarize with upgrading process of petroleum products
- demonstrate the material and energy balance

**TEXT BOOKS:**


1. BhaskaraRao B.K., "Modern Petroleum Refining Processes", 5th Edition, Oxford and IBH Publishing Company, New Delhi, 2008.
2. Nelson W.L., ¯Petroleum Refinery Engineering‖, 4th Edition, McGraw Hill Publishing Company Limited, 1958.


**REFERENCE BOOKS:**


1. Watkins R.N., ¯Petroleum Refinery Distillation‖, 2nd Edition, Gulf Publishing Company, Texas, 1979.
2. Hobson G. D., ¯Modern Petroleum Technology", Part 1&2, 5th Edition, Wiley Publishers, 1984.

**15UCH904** **PROCESS OPTIMIZATION** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To expose the students with various mathematical methods for numerical analysis and use of software tools.

**UNIT – I** **9**

**Developing Models for Optimization**: Scope and hierarchy of optimization, Essential features of Optimization problems, Classification of Models, Building a model, Factorial experimental designs,Degree of freedom

**UNIT – II** **9**

**Basic Concepts**: Formation of objective function, continuity of functions, NLP problem statement,convexity and applications, Interpretation of objective function based on its Quadratic approximation

**UNIT – III** **9**

**Optimization of Unconstrained Functions**: Methods for one dimensional search, Newton„s method and Quasi – Newton methods for uni-dimensional search. Polynomial approximation methods

**UNIT – IV** **9**

**Unconstrained Multivariable Optimization**: Methods using function value only, methods using first derivative, Newton„s method, Quasi – Newton methods.

**UNIT – V** **9**

**Linear Programming**: Simplex method, Barrier method, sensitivity analysis, Linear mixed integer programs, Examples

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students will be able to

- design experiments and formulate optimization models of chemical processes/equipment
- gain knowledge on the basic concepts of process optimization techniques
- solve different uni-dimensional search methods and polynomial approximations
- understand the principles of unconstrained multivariable Optimization techniques
- familiarize the methods of linear programming

**TEXT BOOKS:**


1. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes", McGraw-Hill II Edition 2001.
2. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation", John Wiley, II Edition 2006


**REFERENCES:**


1. Biles, W.E., Swain, J.J.; "Optimisation and Industrial Experimentation", Inter Science, New York, 1980.
2. Seinfeld, J.H.; Lapidus, L; "Process Modelling, Estimation and Identification", Prentice Hall, Englewood Cliffs, New Jersey, 1974.
3. Beveridge, C.S.; Schechter, R.S.; "Optimisation: Theory and Practice", McGraw-Hill Book Co., New York, 1970.

**15UCH905** **PULP AND PAPER TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- Focused on papermaking science and technology and is intended to be especially valuable to students majoring in programs leading to careers in corporate or government positions which would interface with the paper related industries.

**UNIT – I** **9**

**Wood Preparation and Pulping:** Basics of pulp and paper technology- Wood as raw material- Pulpwood harvesting, handling and storage- Mechanical pulping, Chemical pulping and Semi-chemical pulping- Chemical recovery.

**UNIT – II** **9**

**Processing and Bleaching of Pulp: Processing of pulp-** Cooking, Defibering, Deknotting ,Washing,Screening and Thickening- Bleaching- Oxygen bleaching, Chlorine-dioxide bleaching, Hydrosulfite bleaching, Peroxide bleaching, Ozone bleaching - Stock preparation.

**UNIT – III** **9**

**Paper Manufacture Operations:** Secondary Fiber Processing- Paper making process- Wet and Dry end operations- Surface treatments andfinishing operations -Specific paper and Board grades.

**UNIT – IV** **9**

**Properties and Testing of Pulp and Paper:** Properties of pulp and paper- Testing of pulp and paper –Paper end uses- Process control- Quality assurance.

**UNIT – V** **9**

**Emissions and Pollution Control:** Emissions from pulp and paper industry – Solid, liquid & gaseous wastes- Water pollution control- Air pollution control.

**TOTAL: 45 hours**

**COURSE OUTCOMES:**

On completion of the course the students will be able to

- understand various methods for wood preparation and pulping
- familiar with the processing and bleaching of pulp
- understand the finishing and surface treatment of various grades of paper
- demonstrate various methods for testing of pulp and paper
- demonstrate control measures relevant to solid , liquid and gaseous pollution from pulp and paper industry

**TEXT BOOKS:**

1. Kenneth W. Brittt, ¯Handbook of Pulp and Paper Technology‖, 2nd Revised Edition, John Wiley & Sons, 1971.

2. Smook G.A., ¯Handbook for Pulp & Paper Technologists‖, 3rd Edition, Angus Wilde Publications, Incorporation, 2003.

**REFERENCE BOOKS:**

1. Austin, G.T., ¯Shreve's Chemical Process Industries‖, 5th Edition, McGraw-Hill International Book Company, Singapore, 1984.

2. Kent J.A., ¯Riggel's Hand Book of Industrial Chemistry‖, Van Nostrant Reinhold, 1974.

**15UCH906** **POLYMER TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVE**

- To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers.

**UNIT – I Introduction to Polymerization: 9**

Monomer; functionality and degree of polymerizations; polymers and their classification; Types of polymerization and mechanisms: addition; condensation and copolymerization, bulk, solution, emulsion and suspension polymerizations.

**UNIT – II Structure and Properties of Polymers: 9**

Structure of polymers: linear, branched and cross linked;Characterization of polymers: molecular weight, crystallinity, glass transition and mechanical propertiesUltrasonic waves; Photodegradation, High energy radiation, Oxidative and hydrolytic.

**UNIT – III Plastics and Methods: 9**

Introduction to plastics: Anti-oxidants and stabilizers, polymer additives;fillers, plasticizers; colorants. Moulding methods: Injection; compression transfer and Blow moulding, Processing techniques: Calendaring; casting; extrusion; thermoforming; foaming.

**UNIT – IV Characterization Techniques: 9**

Chemical analysis of polymer; X-ray diffraction, Microscopic technique: Light scattering, SEM; Spectroscopic methods: IR, NMR. Thermal analysis: DSC, DTA and TGA.

**UNIT – V Preparation, Properties and Industrial Uses of Polymers: 9**

Polyethylene; poly propylene;polystyrene, polymethylmethacrylate; polyvinyl chloride; polytetrafluoroethylene; polyacrylate; nylon6, nylon 6,6 and polyesters; Phenol formaldehyde, urea formaldehyde, and melamine formaldehyde; epoxy; urethanes and silicones, ion exchange polymers.

**TOTAL: 45 Hours**

**COURSE OUTCOMES:**

**On completion of the course the students will be able to**

- understand the principles and types of polymerization processes
- gain insight into the structure and properties of polymers
- grasp the methods of preparation and moulding of plastics
- develop the knowledge to characterize the plastics by using different instruments
- comprehend the properties and manufacturing processes of polymers

**TEXT BOOKS:**

1. Gowarikar V.R., Viswanathan N.V., and Jayadev Sreedhar, ―Polymer Science‖, 9th Reprint,New Age International Pvt. Ltd., India, 1996.

2. Rodriguez. F., Cohen, C., Ober, C, Archer, L.A., ―Principles of Polymer Systems‖, 5th Edition, Taylor and Francis, Great Britain, London, 2003.

**REFERENCE BOOKS:**

1. Williams D.J., ―Polymer Science and Engineering‖, Prentice Hall, New York, 1971.

2. Arora M.G. and Singh M., ―Polymer Chemistry‖, Anmol Publications Pvt. Limited, 2003.

**15UCH907** **FERTILIZER TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.

**UNIT I NITROGENOUS FERTILISERS 9**

Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

**UNIT II PHOSPHATIC FERTILISERS 9**

Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

**UNIT III POTASSIC FERTILISERS 9**

Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.

**UNIT IV COMPLEX AND NPK FERTILISERS 9**

Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitrophosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

**UNIT V MISCELLANEOUS FERTILISERS 9**

Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the students would be able to understand

- The need for synthetic fertilizer for plant growth
- Understand the need of Phosphate fertilizers in plant growth
- Ability to realize the properties of potassic fertilizers‟
- Knowledge about NPK fertilizers
- Biofertilizers and their advantages compared to synthetic fertilizers

**TEXT BOOKS:**


1. “Handbook of Fertilizer Technology”, Association of India, New Delhi, 1977.
2. Menno, M.G.; “Fertilizer Industry - An Introductory Survey”, Higginbothams Pvt. Ltd., 1973.


**REFERENCES:**


1. Sauchelli, V.; “The Chemistry and Technology of Fertilizers”, ACS MONOGRAPH No. 148, Reinhold Publishing Cor. New York, 1980.
2. Fertiliser Manual, “United Nations Industrial Development Organisation”, United Nations, New York, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, New York, 1966.

**15UCH908** **FERMENTATION TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To enable the students to understand the role of fermentation microorganisms and (bio) chemical activities and conversions that takes place during fermentations, and their impact on quality.

**UNIT I INTRODUCTION TO FERMENTATION PROCESSES** 9

Microbial biomass – Microbial Engymes – Microbial metabolites – Recombinant products – Transformation Process – Microbial growth binetus – Isolation and preservation and improvement of industrially important micro organism.

**UNIT II INSTRUMENTATION AND CONTROL.** **9**

Measurement of process variables – Temperature and its control – Flow measurement and control – Gases and Liquids – Pressure measurement and control – Cenline analysis – Control System – Combination of Control Systems – Computer application in fermentation technology.

**UNIT III RECOVERY AND PURIFICATION OF FERMENTATION PRODUCTS** **9**

– Removal of Microbial cells – Foam Separation – Precipitation Filtration – Different Filtration process – Centifugation – Different centrifuge cell description

– Different methods – Solvent recovery – Superfluid extraction – Chromatography – Membrane processes – Drying – Crystallization Whole growth processing.

**UNIT IV EFFLUENT TREATMENT** **9**

Strength of fermentation effluent – Treatment and disposal – Treatment Processes – Physical, chemical and biological – Aerobic process – Anareobic treatment.

**UNIT V FERMENTATION ECONOMICS** **9**

Introduction – Isolation of micro organisms of industrial interest – Strain improvement – Market potential – Plant and equipment – Media – Air sterilization – Heating and cooling – Recovery costs.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the students should able to

- Understand the basic concepts of fermentation processes, Isolation and preservation of micro organism‟s growth in industrial.
- Measure the process variables like Temperature, pressure & flow and also know about the instrumentation control.
- Examine the recovery and purification of fermentation product.
- Analysis the fermentation effluent and its and also understand the treatment and disposal methods.
- Analysis and predict the least cost method for fermentation process.

**TEXTBOOKS:**


1. Principles of Fermentation Technology P.Stanbury Buttuworth Hanman – 1999.
2. Fermentation and Biochemical Engineering Handbook – C.C Haber. William Andrew II Edition 2007.
3. Bioprocess Engineering Hydersen B.K Nancy A.dela K.L.Nelsen Wiley Interscience,1994.

**15UCH909 BIO CHEMICAL ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVE**

- This course mainly discusses the role of enzymes and microbes in biotechnology sectors.

**UNIT I INTRODUCTION 6**

Industrial biochemical processes with typical examples, comparing chemical and biochemical processes, development and scope of biochemical engineering as a discipline. Industrially important microbial strains; their classification; structure; cellular genetics.

**UNIT II KINETICS OF ENZYME ACTION 9**

Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, modulation and regulation of enzyme activity, types of inhibition. Immobilized enzyme technology: enzyme immobilization, Immobilized enzyme kinetics: effect of external mass transfer resistance.

**UNIT III KINETICS OF MICROBIAL GROWTH 9**

Kinetics of cellular growth in batch and continuous culture, models for cellular growth unstructured,structured and cybernetic models , medium formulation. Thermal death kinetics of cells and spores, stoichiometry of cell growth and product formation , Design and analysis of biological reactors.

**UNIT IV TRANSPORT PHENOMENA 9**

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

**UNIT V DOWN STREAM PROCESSING 12**

Down stream processing: Strategies to recover and purify products; separation of insoluble products, filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra filtration and reverse osmosis),chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification –crystallization and drying.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of the course the students should able to**

- **Understanding the basics of Biochemical Engineering**
- **Understand the enzyme kinetics and immobilized enzyme technology**
- **Understand the kinetics of microbial growth and design of bioreactor**
- **Understand the transport phenomena in bio-process systems.**
- **Understand the transport phenomena in bio-process systems.**

**TEXT BOOKS:**


1. Biochemical engineering fundamentals by J.E.Bailey and D.F.Ollis, 2nd ed, 1986, McGraw Hill.
2. Bioprocess Engineering by Michael L. Shuler and Fikret Kargi, 2nd edition, Pearson education.


**REFERENCES:**


1. Biochemical engineering by James M.Lee – Prentice-Hall-1992.
2. Bioprocess engineering principles, Pauline M. Doran, Academic Press.
3. Biochemical Engineering, H.W. Blanch and D.S. Clark, Marcel Dekker, 1997.

**15UCH910** **ENERGY ENGINEERING** **L T P C**

**3 0 0 3**

**Preamble**

- The Course is designed to impart the various sources of Energy, such as conventional and non conventional etc., and to give knowledge for the young chemical engineers on various fields in production of energy, which they will enter or with which they will be affiliated during the course of study or after completion of the study.

**Prerequisite**

Nil

**COURSE OUTCOMES**

| On completion of the course the student will be able to: | | **Bloom's Level** |
|---|---|---|
| CO1 | Understand the sources, applications and conversion technologies of fossil fuels | **Remember** |
| CO2 | Gain knowledge on the relevance and applications of nuclear and biomass energy | **Apply** |
| CO3 | Comprehend the principles of power generation using hydro, wind and solar energy | **Apply** |
| CO4 | Grasp the principles and applications of geothermal, ocean energy and fuel cells | **Analyze** |
| CO5 | Appreciate the importance of energy management and conduct energy audit in chemical and process industries. | **Understand** |

**Mapping with Programme Outcomes:**

| CO | POs | | | | | | | | | | | | PSOs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | l | I | II |
| CO.1 | M | | M | M | | | M | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO.2** | M | | M | S | S | M | M | W | M | S | S | M | S | M |
| **CO.3** | M | | M | S | M | M | M | | M | M | S | M | M | M |
| **CO.4** | M | | M | S | M | M | M | | M | M | S | M | M | M |
| **CO.5** | M | | M | M | | | M | | | | | | M | m |

**Course Level Assessment Questions**

**Course Outcome 1 (CO1):**

| | | |
|---|---|---|
| 1. | What are primary and secondary energy sources? | Understand |
| 2. | Which energy sources may play an important role for future development in India? | Understand |
| 3. | Discuss various types of coal in the increasing order of their carbon content. | Remember |
| 4. | Explain in brief the theories for origin of petroleum. | Understand |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1. | What are nuclear fission and nuclear fusion? | Understand |
| 2. | Give a detail note on types of Nuclear reactors | Remember |
| 3. | Compare floating drum and fixed dome type biogas plant in rural applications. | Remember |
| 4. | What are the techniques suggested for gasification from biomass? Explain. | Understand |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1. | Discuss different hydro power projects in India. | Understand |
| 2. | Explain different types of hydroelectric projects. | Analyze |
| 3. | What are the classifications of solar air collectors? | Understand |
| 4. | What is the basic principle of wind energy conversion? Draw a neat sketch of wind mill and discuss its design aspects for power generation. | Understand |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1. | Mention the applications of geothermal energy. What are the advantages and disadvantages of Geothermal Energy forms? | Understand |

| | | |
|---|---|---|
| 2. | Discuss a detail note on tidal energy. | Understand |
| 3. | Classify fuel cells. With the help of a neat sketch, explain the working and construction of any one type of fuel cells. | Understand |
| 4. | Enumerate the advantages and disadvantages of the fuel cells. | Remember |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1. | Explain Energy forecasting and planning | Understand |
| 2. | Discuss about Energy Audit in Chemical process industries | Remember |
| 3. | How Waste heat recovery is possible in chemical industries | Remember |
| 4. | Discuss the Cogeneration practices in industries. | Understand |

**Syllabus**

**UNIT – I** **9**

**Fossil Fuels:** Coal -types and classification –Conversion technologies, Petroleum- products and properties, shale oil and gas, Oil and tar sand, Natural gas-CNG and LNG.

**UNIT – II** **9**

**Nuclear and Biomass Energy:** Nuclear energy-Fission and fusion-Types of nuclear reactors.

Biomass energy-Resources and conversion processes.

**UNIT – III** **9**

**Renewable Energy Sources-I:** Fundamentals of Power generation systems-Hydro, Wind and solar energy.

**UNIT – IV** **9**

**Renewable Energy Sources-II:** Fundamentals of Power generation systems –Geothermal and ocean energy; fuel cells.

**UNIT – V** **9**

**Energy Conservation and Management:** Energy forecasting and planning; Energy conservation: Waste heat recovery and heat pipes, Energy Audit in Chemical process industries; Cogeneration practices in industries.

**TOTAL: 45 hours**

**TEXT BOOKS:**

1. Twidell John and Weir Tony, ¯Renewable Energy Sources‖, 2nd Edition, Taylor and Francis, New York, 2006.

2. Rao S. and Dr. B.B. Parulekar, ‖Energy Technology ‖, 4th Edition, Khanna Publishers, 2005.

**REFERENCE BOOKS:**

1. Beggs Clive, ¯Energy: Management Supply and Conservation‖, Butterworth-Heinemann, Oxford, 2002.

2. Fay James A. and Golomb Dan S., ¯Energy and the Environment‖, Oxford University Press Inc. New York, 2002.

**15UCH911** **AIR POLLUTION AND CONTROL** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To enable the students to learn about Air Pollution, effects of air pollution, Global effects, Sampling of pollutants, Meteorology and air pollution, Atmospheric stability, Plume rise and dispersion and Prediction of air quality.

**UNIT I INTRODUCTION** **9**

Air Pollution Regulatory Framework Histroy – Air Pollution Regulatory Framework - Regulatory System – Laws and Regulations – Clean air Act – Provisions for Recent Developments.

**UNIT II AIR POLLUTION GASES** **9**

Measurement fundamentals – chemicals and physical properties – Phase Equelbonem consecoation laws – Incinerators – Design and Performance – Operation and Maintainance - Absorbers – Design operation and improving performances Absorbers.

**UNIT III PARTICULATE AIR POLLUTION** **9**

Particle Collection mechanisms- Fluid particle. Dynamics- Particle size, Distribution-Efficiency Distribution – Efficiency – Gravity Setling chambers Cyclones- Electrostatic precepators Bannouses

**UNIT IV HYBRID SYSTEM** **9**

Heat electrostatic precepitation – Genizing Heat Scrubbers – Dry Scrubbers – Electrostatically Augmented Fabric Fillration

**UNIT V AIR POLLUTION CONTROL EQUIPMENT** **9**

Introduction – Installation – Cost Model.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the student will be able to

- understand the evolution of air pollution regulation and different laws related to air pollution and control
- apply the skill in measurement of gas properties and design of incinerator
- assess the performance of absorbers and understand the different particle collection mechanisms
- perform the design of gas cleaning equipments and evaluate their performance
- understand the concepts involved in hybrid systems and its cost modeling

**TEXT BOOKS:**

1. Air Pollution Control Equipment Louis Theodore, Burley Intuscence 2008.
2. Air Pollution Control CD Cooper and FC.Alley Wairland Press III Edition 2002.
3. Air Pollution Control Engg, Noel de nevey – McGraw Hill.

**REFERENCE BOOK:**

1. Kirk and Othmer, Chemical Technology Hand Books, IV Edn, (1994

**15UCH912** **MODERN SEPARATION PROCESS** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To enable the students to learn the principle and technical concept of advanced separation processes.

**UNIT I BASICS OF SEPARATION PROCESS 9**

Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

**UNIT II MEMBRANE SEPARATIONS 9**

Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.

**UNIT III SEPARATION BY ADSORPTION 9**

Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

**UNIT IV INORGANIC SEPARATIONS 9**

Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

**UNIT V OTHER TECHNIQUES 9**

Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to

- Ability to about the modern separation operation.
- Explain the modern separation technique in Membrane technology
- Illustrate the modern separation methods by using adsorption techniques.
- Describe about the inorganic separation techniques.
- Analysis and design of suitable membrane for waste water treatment by using ROSA software.

**REFERENCES:**


1. King, C. J., “Separation Processes”, Tata McGraw Hill, 1982.
2. Roussel, R. W., “Handbook of Separation Process Technology”, John Wiley, New York, 1987.
3. Nakagawal, O. V., “Membrane Science and Technology”“ Marcel Dekkar, 1992.

**15UCH913 PROCESS MODELING AND SIMULATION L T P C**

**3 0 0 3**

**OBJECTIVE:**

To give an overview of various methods of process modeling, different computational techniques for simulation.

**UNIT I INTRODUCTION 7**

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations, computational methods in chemical engineering.

**UNIT II STEADY STATE LUMPED SYSTEMS 9**

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

**UNIT III UNSTEADY STATE LUMPED SYSTEMS 9**

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

**UNIT IV STEADY STATE DISTRIBUTED SYSTEM 7**

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

**UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES 13**

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations. Empirical modeling, parameter estimation, population balance and stochastic modeling.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to

- Classify the mathematical models and conservation equations for process modeling.
- Solve the steady state lumped systems problems by using linear and non-linear algebraic equations.
- Describe the unsteady state lumped systems by using ordinary differential equation initial value problems.
- Analysis of steady state distributed system like compressible flow, heat exchanger, packed columns, plug flow reactor, using ordinary differential equation boundary value problems .
- Analysis of unsteady state distributed system & other modeling approaches by using Empirical modeling equation

**TEXT BOOKS:**


1. Ramirez, W.; “Computational Methods in Process Simulation “, 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., “ Process Modelling Simulation and Control “,2nd Edn, McGraw-Hill Book Co., 1990

**REFERENCES:**


1. Felder, R. M. and Rousseau, R. W., “Elementary Principles of Chemical Processes “, John Wiley, 2000.
2. Franks, R. G. E., “Mathematical Modelling in Chemical Engineering “, John Wiley, 1967.
3. Amiya K. Jana,”Process Simulation and Control Using ASPEN”, 2nd Edn,PHI Learning Ltd (2012).
4. Amiya K. Jana,”ChemicalProcess Modelling and Computer Simulation” 2nd Edn,PHI Learning Ltd,(2012).

**15UCH914** **PINCH TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVES**

Understanding on Pinch concept, Application to Process Heat Exchange Networking, Identification of Energy Minimization in the Process, Retrofitting Concepts and Setting up Targets for Energy Minimization.

**UNIT I** **7**

Thermodynamical review of the process, Pinch Concept, significance of pinch, pinch in grid representation, Threshold problems, capital cost implication of the pinch.

**UNIT II** **7**

Targeting: Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, continuous targeting.

**UNIT III** **9**

Pinch Methodology: Problem representation, temperature enthalpy diagram, simple match matrix. Heat content diagram, Temperature interval diagram.

**UNIT IV** **11**

Pinch Design and Optimization: Networks for maximum energy recovery, Pinch design method, Flexibility criteria of the pinch, cp table, the tick of heuristic, case studies, optimization of heat exchanger network optimality for a minimum area network, Sensitivity analysis.

**UNIT V** **11**

Energy and Resource Analysis of various processes, Batch process, flexible process, distillation process, evaporation process, reaction process, process using mass separating agent. Heat pipes and Heat pumps,

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to

- Understand the basic fundamental behind in pinch technology and energy maximization.
- Targeting the energy, area, unit, shell, and cost for heat exchanger.
- List out the pinch methodology and its enthalpy -temperature relation diagram
- Design and optimization of Pinch networks for maximum energy recovery.
- Analyze the various processes like, Batch process, flexible process, distillation process, evaporation process, reaction process for energy and its resources.

**TEXT BOOKS:**

1. V. UdayShenoy" Heat Exchanger network synthesis" Gulf Publishing Co, USA, 1995
2. D.W. Linnhoff et al., "User Guide on Process Integration for the efficient use of Energy", Institution of Chemical Engineers, U.K., 1994.

**REFERENCES:**

1. James M.Douglas “Conceptual Design of Chemical Process”, McGraw Hill, New York, 1988.
2. Anil Kumar, “Chemical Process Synthesis and Engineering Design”, Tata McGraw Hill New Delhi, 1977

**15UCH915 NANO SCIENCE AND ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To enable the students to learn about basis of nanomaterial science, preparation method, types and application

**UNIT I INTRODUCTION 8**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials.

Length Scales involved and effect on properties : Mechanical, Electronic, Optical, Magnetic and Thermal Properties. Introduction to properties and motivation for study (qualitative only).

**UNIT II GENERAL METHODS OF PREPARATION 9**

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

**UNIT III NANOMATERIALS 12**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays- functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications

**UNIT IV CHARACTERIZATION TECHNIQUES 9**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

**UNIT V APPLICATIONS 7**

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to

- Define the basic fundamentals behinds in Nano science and technology and also know about the Nano structure of the particles.
- Understand about the preparation methods
- Synthesis of Nano composite materials and doped Nano composite materials.
- Characterize the synthesized Nano composite materials and doped Nano composite materials by using X-ray diffraction technique, Scanning Electron Microscopy, AFM, SPM, STM, SNOM, ESCA, SIMS
- Identify the application of nanotechnology in various fields.

**TEXT BOOKS:**


1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nanoscale charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000


**REFERENCES:**


1. G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia (Editor),"The Hand Book of Nano Technology,Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

**15UCH916** **PILOT PLANT AND SCALE UP** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To understand scale up in chemical engineering plants.
- To apply dimensional analysis technique for scale up problems.
- To scale up of chemical reactors.
- To Scale up mixers and heat exchangers, distillation columns and packed towers.

**UNIT I** **9**

Principals of Similarity, Pilot Plants & Models: Introduction to scale-up methods, pilot plants, models and principles of similarity, Industrial applications.

**UNIT II** **9**

Dimensional Analysis and Scale-Up Criterion: Dimensional analysis, regime concept, similarity criterion and scale up methods used in chemical engineering, experimental techniques forscale-up.

**UNIT III** **9**

Scale-Up of Mixing and Heat Transfer Equipment: Typical problems in scale up of mixing equipment and heat transfer equipment.

**UNIT IV** **9**

Scale-Up of Chemical Reactors: Kinetics, reactor development & scale-up techniques for chemical reactors, Furnaces, Filters and Mechanical operations equipments.

**UNIT V** **9**

Scale-Up of Distillation Column & Packed Towers: Scale-up of distillation columns and packed towers for continuous and batch processes.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to

- Understand scale up in chemical process industries.
- Apply dimensional analysis technique for scale up problems.
- Scale up of equipments like heat transfer equipments and mixer.
- Scale up of chemical reactors, furnaces, and mechanical operation equipment.

- Scale up of distillation columns and packed towers for continuous and batch processes.

**TEXT BOOKS:**


1. Johnstone and Thring, Pilot Plants Models and Scale-up Methods in Chemical Engg., McGraw Hill, New York, 1962.
2. W. Hoyle, Pilot Plants and Scale-Up, Royal Society of Chemistry, 1st Edition, 1999.
3. Marko Zlokarnik, Dimensional Analysis and Scale-up in Chemical Engineering, Springer Verlag, Berlin, Germany,1991.
4. E. Bruce Nauman, Chemical Reactor Design, Optimization and Scale-up, McGraw Hill, New York, 2002.


**REFERENCES:**


1. Pilot Plants Models and Scale-up Methods in Chemical Engg., Johnson and Thring, McGraw Hill, New York, 1987.
2. Stage-wise Process Design, Henley & Staffin, John Wiley, New York.
3. Scale-Up of Chemical Process, Bisio and Kabel, John Wiley, Singapore, 1985.

| 15UCH917 | WASTE WATER TREATMENT | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**Preamble**

• To focus on the wastewater transport system and the theory and design technique for the wastewater treatment process.

**Course outcomes**

On successful completion of the course the student should able to

| Course Outcome | | Bloom's Level |
|---|---|---|
| **CO1:** | Understand the Regulations, Health and Environment Concerns in waste water management | Understand |
| **CO2:** | Acquire knowledge in process and choosing the reactors. | Apply |
| **CO3:** | Familiarize with the fundamentals of storage of chemicals and their treatment methods. | Apply |
| **CO4:** | Apply the knowledge of Biological Treatment | Apply |
| **CO5:** | Study about the advance technology in waste water treatment | Apply |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | Explain the regulation used for the waste water treatment disposal. | Remember |
| 2 | Draw layout of conventional water treatment plant and explain the function of each in detail. | Remember |
| 3 | List out the Constituents in waste water inorganic. | Understand |
| 4 | Discuss the relative merits and demerits of Batch and continuous processes for treatment of waste water. How will you proceed to formulate the design criteria for a continuous biological reactor | Understand |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | With neat sketch show and explain the settling characteristics of particles at different zone during sedimentation operation with a sample of waste | Remember |

| | | |
|---|---|---|
| 2 | List out the types of reactors used in waste water treatment and explain any one in detail. | Remember |
| 3 | Write the Mass Balance Analysis. | Apply |
| 4 | Determine the modeling of ideal and non ideal flow in Reactors | Apply |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | Discuss the phenomenon of discrete sitting of particles in primary treatment process. | Remember |
| 2 | State the factors affecting coagulation. | Remember |
| 3 | Write short note on „Coagulation Aid" | Understand |
| 4 | Determine the Role of unit processes in waste water treatment. | Apply |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Write a short note on classification of filter.. | Remember |
| 2 | State the function and importance of two stage anaerobic sludge digestion (High rate process) for production of Biogas.. | Remember |
| 3 | Discuss the working principle of Trickling filter which acts as attached growth biological reactor. | Understand |
| 4 | What are the problems in Filter and Explain the theory of filtration. | Apply |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | List out the Classification of technologies for Removal of Colloids and suspended particles. | Remember |
| 2 | Write a short note on Surface and Membrane filteration. | Remember |
| 3 | With a neat sketch Explain in detail about the Ion-Exchange process | Understand |
| 4 | State oxidation process. | Remember |

**Syllabus**

**UNIT – I Waste Water Treatment an Overview** **9**

Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water inorganic – Organic and metallic constituents.

**UNIT – II Process Analysis and Selection** **9**

Components of waste water flows – Analysis of Data – Reactors used in waste water treatment – Mass Balance Analysis – Modeling of ideal and non ideal flow in Reactors – Process Selection.

**UNIT – III Chemical Unit Processes** **9**

Role of unit processes in waste water treatment chemical coagulation – Chemical precipitation for improved plant performance chemical oxidation – Neutralization – Chemical Storage.

**Unit – IV Biological Treatment** **9**

Overview of biological Treatment – Microbial metabolism – Bacterial growth and energatus – Aerobic biological oxidation – Anaerobic fermentation and oxidation – Trickling filters – Rotating biological contractors – Combined aerobic processes – Activated sludge film packing

**Unit – V Advanced Waste Water Treatment** **9**

Technologies used in advanced treatment – Classification of technologies Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. Waste water Engineering Treatment and Reuse: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.

2. Industrial Waste Water Management Treatment and Disposal by Waste Water Mc Graw Hill III Edition 2008.

**REFERENCE BOOKS:**

2. Mackenzie L Davis, Water and Wastewater Engineering", Prentice Hall of India, New Delhi,2010.
3. David A Cornwell and Mackenzie L Davis., "Introduction to Environmental Engineering", Volume I, 4th Edition, Asian Books Pvt.Ltd.,1985.

**15UCH918** **ELECTROCHEMICAL ENGINEERING** **L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To solve problems related to the production, storage, distribution and utilization of electrochemical energy and the associated environmental issues.

**UNIT I** **9**

Review basics of electrochemistry: Faraday"s law -Nernst potential -Galvanic cells – Polarography, The electrical double layer: It"s role in electrochemical processes -Electro capillary curve –Helmoltz layer –Guoy –Steven"s layer – fields at the interface.

**UNIT II** **9**

Mass transfer in electrochemical systems: diffusion controlled electrochemical reaction -the importance of convention and the concept of limiting current. over potential, primary-secondary current distribution -rotating disc electrode.

**UNIT III** **9**

Introduction to corrosion, series, corrosion theories derivation of potential-current relations of activities controlled and diffusion controlled corrosion process. Potential-pH diagram, Forms of corrosion- definition, factors and control methods of various forms of corrosion-corrosion control measures-industrial boiler water corrosion control -protective coatings -Vapor phase inhibitors -cathodic protection, sacrificial anodes -Paint removers.

**UNIT IV** **9**

Electro deposition -electro refining -electroforming -electro polishing – anodizing -Selective solar coatings, Primary and secondary batteries -types of batteries, Fuel cells.

**UNIT V** **9**

Electrodes used in different electrochemical industries: Metals-Graphite -Lead dioxide – Titanium substrate insoluble electrodes -Iron oxide -semi conducting type etc. Metal finishing-cell design. types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, Swiss roll cell, plug flow cell, design equation, figures of merits of different type of electrochemical reactors.

**TOTAL : 45 PERIODS**

**OUTCOME:**

Upon completion of the course the student will be able to

- Understand about the basic concept of electro chemistry and its law.
- Explain about the mass transfer in electro chemical system, diffusion and electro chemical reaction.
- Describe the various forms of corrosion and its control methods.
- Define the various electro plating methods like Electro deposition, electro refining, electro forming, electro polishing, anodizing, Selective solar coatings.
- Classify the various types of electrode used in electro chemical industries

**TEXT BOOKS:**


1. Picket, “Electrochemical Engineering “, Prentice Hall. 1977.
2. Newman, J. S., “Electrochemical systems “, Prentice Hall, 1973.


**REFERENCES:**


1. Barak, M. and Stevenge, U. K., “ Electrochemical Power Sources - Primary and Secondary Batteries” 1980
2. Mantell, C.,” Electrochemical Engineering “, McGraw Hill, 1972.

**15UCH919 ENTREPRENEURIAL SKILLS FOR CHEMICAL PRODUCT & DESIGN** **L T P C 3 0 0 3**

**OBJECTIVES**

- To understand entrepreneurship and entrepreneurial process and its significance in economic development.
- To develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
- To evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
- To understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.
- To identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.

**UNIT I** **10**

Entrepreneurship – Employment and Self employment, Government policy – Small industries, medium industries, Growth of small scale sector and their contribution to GDP, The incentives, the back ground , the present position and the future prospects.

Leadership – Attitudes and aptitudes, qualities like risk taking and decision making, commitment & involvement.

**UNIT II** **9**

Chemical Products and Designing - Assessing financial viability from accounting statements, Ratio analysis, Viability of projects and investments, Depreciation, its relevance and its accounting, Preparation of feasibility reports, Role of financial Institutions, Role of government agencies like DIC, TIIC, SIDCO, TIDCO, IDBI, SISI, NSIC, Banks, IBC – Licensing procedures of state and central governments, Industrial subsidies.

**UNIT III** **9**

Chemical Products - Marketing, Market survey, Development of markets, Technology and Product life cycle, Capacity decision and location decision, Production systems and service systems, Layout methods, factors.

**UNIT IV** **9**

Inventory, Sourcing, Purchasing, Stores and accounting, Control of inventory, Obsolescence, Economic order quantity, ABC analysis, Value engineering, Logistics, Indirect taxes and their effect on purchases, Basic provisions of central laws.

**UNIT V** **8**

Factories Act, Environmental Act, Workmen compensation Act, Payment of Wages Act, Sales Tax Act, Shops and Commercial Establishment Act – their objectives and their relevance to the Chemical Industries.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, Students will be able to:

- Understand entrepreneurship and entrepreneurial process and its significance in economic development.
- Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
- Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
- Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.
- Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.

**TEXT BOOKS:**


1. G.G. Meredith, R.E.Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.


**REFERENCES:**


1. Government Publication on SSI, Government of India,
2. Entrepreneurial development in India by Dr. C.B. Gupta, Sultan Chand & Sons. (1998)
3. Entrepreneurship and Small business Management, by Dr. C.B. Gupta & Dr. S.S. Khanna, Sultan Chand & Sons. (1998)
4. Entrepreneurship Development by P. Saravanavel.
5. Innovation and & Entrepreneurship, by Peter Drucker.

| 15UCH920 | PROCESS PLANT UTILITIES | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**Preamble**

This course provides the overview of the process plant utilities and optimization techniques to optimize various parameters in chemical industries.

**Prerequisite**

15UCH304 CHEMICAL PROCESS INDUSTRIES I
15UCH405 CHEMICAL PROCESS INDUSRTIES II

**COURSE OUTCOMES**

On successful completion of the course the student will able to

| | Course Outcome | Bloom's Level |
|---|---|---|
| **CO1:** | Gain a fundamental understanding of process utilities like water, steam etc. and their role and importance in chemical plants. | Understand |
| **CO2:** | Distinguish Various types of steam generation, Steam Traps and Scaling and Trouble Shooting. | Apply |
| **CO3:** | Enumerate the concepts related to Refrigeration system, also about the humidification and dehumidification process and equipment"s. | Analyze |
| **CO4:** | State the performance and characteristics of compressors and pumps. | Apply |
| **CO5:** | Distinguish the various types of fuel and waste disposal methods | Apply |

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) |
|---|---|---|---|
| Remember | 20 | | 10 |
| Understand | 30 | 15 | 20 |
| Apply | | 20 | 20 |

| | | | |
|---|---|---|---|
| Analyze | | 15 | |
| Evaluate | | | |
| Create | | | |
| **Total (50)** | 50 | 50 | 50 |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | Discuss the various methods of industrial water treatment. | Remember |
| 2 | Briefly discuss about the importance of utilities and the requisites of industrial water with its uses. | Remember |
| 3 | Briefly discuss with neat sketch the process of reverse osmosis | Understand |
| 4 | What are the characteristics of boiler feed water, explain the effects of impure boiler feed water. | Understand |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | Discuss the criteria‟s used for the classification of boilers. Explain the types of boilers. | Understand |
| 2 | Explain the construction and working of the Babcock and Wilcox boiler. | Understand |
| 3 | Distinguish fire tube boiler and water tube boiler. | Apply |
| 4 | Explain the construction and working of the Cochran Boilers | Understand |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | Describe the working of vapour compression refrigeration cycle. | Apply |
| 2 | Discuss the various types of refrigerants used. | Apply |

| | | |
|---|---|---|
| 3 | Describe the working of vapour absorption refrigeration cycle. | Apply |
| 4 | Explain the different types of condensers used in refrigeration system. | Apply |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Discuss different methods of producing vacuum in process industry | Remember |
| 2 | Compare the performance of reciprocating and rotary compressors | Apply |
| 3 | Explain the working of reciprocating vacuum pump. | Understand |
| 4 | Discuss the principle and working of two stage reciprocating air Compressor with intercooler. | Remember |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Explain in detail the different types of fuel used in chemical process industries. | Remember |
| 2 | Discuss briefly the types of internal combustion engines used in the process industries. | Understand |
| 3 | Discuss the various treatment methods of spent fuel waste disposal in chemical process industries. | Apply |
| 4 | Discuss briefly the solid waste management techniques in process industries. | Understand |

**Syllabus**

**UNIT I IMPORTANT OF UTILITIES 9**

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

**UNIT II STEAM AND STEAM GENERATION 9**

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

**UNIT III REFRIGERATION 9**

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

**UNIT IV COMPRESSED AIR 9**

Classification of Compressor, Reciprocating Compressor, Single Stage andTwo Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air –Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.

**UNIT V FUEL AND WASTE DISPOSAL 9**

Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine, Petrol and Diesel Engine.Waste Disposal.

**TOTAL: 45 PERIODS**

**TEXTBOOKS:**


3. Eckenfelder, W. W, Jr. “Industrial Water Pollution Control” McGraw-Hill: New York, 1966.
4. P. L. Ballaney, “Thermal Engineering”, Khanna Publisher New Delhi, 1986.
5. Perry R. H. Green D. W. “Perry‟s chemical Engineer‟s Handbook”, McGraw Hill, New York, 2007.


**REFERENCES:**


1. N. Ananthanarayan, “Basic Refrigeration & Air conditioning”, Tata McGraw Hill, New Delhi, 2007.

**15UCH921 QUALITY MANAGEMENT FOR CHEMICAL ENGINEERS L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To facilitate the understanding of Quality Management principles and process.

**UNIT I INTRODUCTION 9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

**UNIT II TQM PRINCIPLES 9**

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

**UNIT III TQM TOOLS AND TECHNIQUES I 9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

**UNIT IV TQM TOOLS AND TECHNIQUES II 9**

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

**UNIT V QUALITY SYSTEMS 9**

Need for ISO 9000 - ISO 9001-2015 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to

- Remembering the basic concepts of total quality management process.
- Understanding the TQM principles.
- Applying the tool and technique – I like seven traditional tools of quality, Bench marking and FMEA.
- Applying the tool and technique – II like Control Charts, Six Sigma and Quality Function Development (QFD).
- Analyzing the various quality system and documentation

**TEXTBOOK:**

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).

**REFERENCES:**

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

**15UCH922 DRUGS AND PHARAMACEUTICAL TECHNOLOGY L T P C**

**3 0 0 3**

**Preamble**

This course provides the basic knowledge of transform raw materials intouseful pharmaceutical and fine chemical products with commercial interestthrough systematic use of engineering concepts and methods

**Prerequisite**

**15UCH302**: **ORGANIC CHEMISTRY**

**COURSE OUTCOMES**

On successful completion of the course the student should able to

| Course Outcome | | Bloom"s Level |
|---|---|---|
| CO1: | Understand about the drastic growth of drugs and pharmaceutical industry. | Understand |
| CO2: | Classify the Drugs metabolis ,pharmaco kinetics & microbiological action on human bodies. | Understand |
| CO3: | Express the important of unit processes and its application in drugs manufacturing industries | Understand |
| CO4: | Describe the Manufacturing principles, packing and quality control of drugs in pharmaceutical industry. | Understand |
| CO5: | Analysis the various types of pharmaceutical products by using instrumentation analysis. | Analyze |

**Assessment Pattern**

| CognitiveLevel | Periodical Test – I (asmarks) | Periodical Test– II (asmarks) | Periodical Test – III (asmarks) |
|---|---|---|---|
| Remember | 10 | 10 | 10 |
| Understand | 40 | 40 | 10 |
| Apply | | | |
| Analyze | | | 30 |
| Evaluate | | | |
| Create | | | |
| **Total (50)** | 50 | 50 | 50 |

**Course Level Assessment Question**

**Course Outcome 1(CO1):**

| | | |
|---|---|---|
| 1 | Define drug | Remember |
| 2 | What are the precautions to be taken during the drug development? | Remember |
| 3 | Describe organic therapeutic agents and their uses. | Understand |
| 4 | Give a detail account of drug discovery process. | Understand |

**Course Outcome 2 (CO2):**

| | | |
|---|---|---|
| 1 | Write the significance of Van der Waals Attraction | Remember |
| 2 | Define Biotransformation | Remember |
| 3 | Write about lattice energy | Understand |
| 4 | Write in detail procedure for determination of dissociation constant of a drug. | Understand |

**Course Outcome 3 (CO3):**

| | | |
|---|---|---|
| 1 | Define dehydration reaction | Remember |
| 2 | What is meant by alkylation? | Remember |
| 3 | Explain the term „Nazarov cyclization reaction" | Understand |
| 4 | Give the detail account of Condensation chemical conversion process and list out its applications | Understand |

**Course Outcome 4 (CO4):**

| | | |
|---|---|---|
| 1 | Define tablet | Remember |
| 2 | What is Granulation? | Remember |
| 3 | Give the detail account of advancement techniques used in granulation. | Understand |
| 4 | Explain in detail about the Compressed tabled process with neat sketch. | Understand |

**Course Outcome 5 (CO5):**

| | | |
|---|---|---|
| 1 | Give examples of cold remedies | Remember |
| 2 | Explain the terms (a) Antiseptics (b) Antacids | Understand |
| 3 | Analysis the drug components present in tablet by using Polarimetry techniques. | Analyze |
| 4 | Analysis the drug components present in oral liquids by using chromatography techniques. | Analyze |

**Syllabus**

**UNIT I INTRODUCTION 9**

Development of drugs and pharamaceutical industry; organic therapeutic agents uses and economics

**UNIT II DRUG METABOLISM AND PHARMACO KINETICS & MICROBIOLOGICAL AND ANIMALPRODUCTS 9**

Drug metabolism; physico chemical principles; pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

**UNIT III IMPORTANT UNIT PROCESSES AND THEIR APPLICATION 9**

Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.

**UNIT IV MANUFACTURIG PRINCIPLES & PACKING AND QUALITY CONTROL 9**

Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.

**UNIT V PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS 9**

Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and

pharmaceuticals – spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pHmetry

**TOTAL : 45 PERIODS**

**TEXT BOOK:**


1. Rawlines, E.A.; "Bentleys Text book of Pharmaceutics ", III Edition, BaillireTindall, London, 1977.


**REFERENCES:**


1. Yalkonsky, S.H.; Swarbick. J.; "Drug and Pharamaceutical Sciences ", Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. "Remingtons Pharmaceutical Sciences ", Mack Publishing Co., 1975.

**15UCH923 CHEMICAL PROCESS PLANT SAFETY L T P C**

**3 0 0 3**

**OBJECTIVE:**

To enable the students

- To become a skilled person in hazard analysis and finding out the root cause of an accident.
- Gain knowledge in devising safety policy and procedures to be adopted to implement total safety in a plant

**UNIT I INTRODUCTION TO SAFETY PROGRAMMES 9**

Safety in industries; need for development; importance safety consciousness in Indian chemical industry; social environmental setup; tolerance limit of the society; psychological attitude towards safety programmes. Elements of safety programme; effective realization; economic and social benefits; effective communication training at various levels of production and operation.

**UNIT II INDUSTRIAL SAFETY 9**

Chemical process industries; potential hazards; chemical and physical job safety analysis; high pressure; high temperature operation; dangerous and toxic chemicals; highly radioactive materials; safe handling and operation of materials and machineries; planning and layout.

**UNIT III SAFETY PERFORMANCE 9**

Appraisal; effective steps to implement safety procedures; periodic inspection and study of plant layout and constant maintenance; periodic advice and checking to follow safety procedures; proper selection and replacement of handling equipments; personal protective equipments.

**UNIT IV ACCIDENTS 9**

Industrial accidents – accident costs – identification of accident spots; remedial measures; identification and analysis of causes of injury to men and machines – accident prevention – accident proneness – vocational guidance, fault free analysis. Fire prevention and fire protection.

**UNIT V HEALTH HAZARDS AND LEGAL ASPECTS 9**

Health hazards – occupational – industrial health hazards – health standards, and rules – safe working environments – parliamentary legislations – factories act – labour welfare act – ESI Act – Workmen Compensation Act .Role of Government, safety organizations, management and trade unions in promoting industrial safety.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to

- Explain about the importance of safety and psychological attitude towards safety programs.
- Know about the various communication levels in operation and production and health and safety issues in and around chemical industries.
- Demonstrate safety inspection for workplace hazards, hazard identification, Safety committees to promote employee involvement and safety education and training.
- Identify the Industrial accidents , accident spots, causes of injury to men and machines and Fire prevention & fire protection.
- Ability to Know about the health hazards & legal aspects and role of government, trade union and organization in promoting industrial safety

**TEXT BOOKS:**


1. Ridley Safety at Work, VII Edition, Butterworth Heinman 2007.
2. William Handley, Industrial Safety Hand Book McGraw-Hill Book Company 2nd Edition, 1977.
3. Fawatt, H.H. and Wood, W.S.Safety and Accident Prevention in Chemical Operation, Interscience, 1965


**REFERENCES:**


1. Heinrich, H.W. Dan Peterson, P.E. and Nester Rood. Industrial Accident Prevention, McGraw-Hill Book Co., 1980
2. Blake, R.P., Industrial Safety, Prentice Hall Inc., New Jersy – 3rd Edn. 1963.

**15UCH924** **CERAMIC TECHNOLOGY** **L T P C**

**3 0 0 3**

**OBJECTIVES:**

The course is aimed to impart basic knowledge about various advanced ceramic materials and its structure, properties and applications

**UNIT- I** **(9)**

Ceramic Processing and Ceramic Products- Surface chemistry- structure of glasses- ceramic raw materials-material characteristics-chemical and phase composition-Particle size and shape-density pore structure and specific surface area- Uses and application of ceramic products and insulators

**UNIT- II** **(9)**

Process additives-liquids & wetting agents, Deflocculants & coagulants, binders and bonding agents, plasticizers, foaming & antifoaming agents, lubricants and preservatives.

Particle mechanics and Rheology – consistency particle mechanics and deformation behavior, Rheological behavior of slurries and pastes.

**UNIT – III** **(9)**

Beneficiation Process : Comminution, milling performance & practice, milling efficiency. Batching and mixing, particle separation concentration and washing process, granulation.

**UNIT – IV** **(8)**

Forming process – pressing, plastic forming process, injection molding casting process, molecular, polymerization forming.

**UNIT – V** **(10)**

Post forming processes – Drying, surface processing and firing mechanism of drying, drying process, drying shrinkage and defects, modes of drying. Shaping, surface finishing, film printing and glazing process.

Firing – presintering, Sintering of glass particles, Sintering of white wares, Sintering of glasses & films, Vitrification cooling and annealing, Relaxation time safe rate of cooling, Hot pressing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students are expected to

- Understand the basic concepts involved in the ceramics technology.
- Classify the suitable processing methods of ceramic materials.
- Analyze the Beneficiation Process for ceramic materials.
- Explain the Forming process involved in the ceramic material cleaning.
- Sintering of glass particles, white wares, glasses & films

**REFERENCES:**


1. James S. Reed, Introduction to Principles of Ceramic Processing, John Wiley & Sons, Singapore (1989)
2. Introduction to Ceramics, Ringery, ($2^{nd}$ Edition), Bowen & Uhimann, John Wiley & Sons, Singapore (1991)
3. Handbook on Refractories, Nandi, Tata McGraw Hill, New Delhi (1987).

**15UCH951 CORROSION SCIENCE AND ENGINEERING L T P C**

**3 0 0 3**

**Preamble**

This course provides the overview of the different types of corrosion and its testing methods, various methods of protection, corrosion in specific environment and the corrosion protection manangement.

**Course outcome**

On successful completion of the course the student will able to

| **COURSE OUTCOMES** | | **Bloom's Level** |
|---|---|---|
| **CO1:** | Gain a fundamental insight into all aspects of corrosion and testing methods | Understand |
| **CO2:** | Apply the principles of corrosion inhibition for protection of process equipments | Apply |
| **CO3:** | Develop knowledge of corrosion inspection and management in chemical industries | Apply |
| **CO4:** | control corrosion and select materials for different applications | Understand |
| **CO5:** | Comprehend the impact of corrosion on nations economy | Undestand |

**Assessment Pattern**

| **CognitiveLevel** | **Periodical Test – I (asmarks)** | **Periodical Test– II (asmarks)** | **Periodical Test – III (asmarks)** |
|---|---|---|---|
| Remember | 20 | 10 | 20 |
| Understand | 30 | 20 | 30 |
| Apply | | 20 | |
| Analyze | | | |
| Evaluate | | | |
| Create | | | |
| **Total (50)** | 50 | 50 | 50 |

**Syllabus**

**UNIT – I** **9**

**Types of Corrosion and Testing Methods:** Basic principles of corrosion and its control – Forms of corrosion, uniform, Galvanic, Crevice, pitting, selective leaching, erosion, stress - corrosion, cracking Cavitation phenomena and their effects –Corrosion testing – Field testing – Electrochemical techniques for measurement of corrosion rates, corrosion detection and components examination – Accelerated salt - spray testing.

**UNIT – II** 9

**Corrosion Protection Methods:** Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoretic coatings and electro painting, powder coating, electrical methods of corrosion protection, composite materials in corrosion minimization – Cathodic and Anodic protections.

**UNIT – III** **9**

**Corrosion in Specific Environments**: Corrosion damage to concrete in industrial and marine environments and its protection; biological corrosion, halogen corrosion of metals, environmental degradation of materials, corrosion and inspection managements in chemical processing and petrochemical industries.

**UNIT – IV** **9**

**Corrosion in Specific Cases and Control** : Corrosion in structure – corrosion of stainless steels – corrosion in power equipments, corrosion in electrical and electronic industry – corrosion and selection of materials of pulp and paper plants – corrosion aspects in nuclear power plants – corrosion of surgical implants and prosthetic devices.

**UNIT – V** **9**

**Corrosion and Country's Economy:** Corrosion protection management – process maintenance procedures under corrosion Environments.

**TOTAL: 45**

**TEXT BOOKS:**

1 Fontana M.G., ¯Corrosion Engineering‖, Tata McGraw Hill, 2005.
2 Jones D.A., ¯Principal and Protection of Corrosion‖, Prentice-Hall, 1996.

**REFERENCE BOOKS:**

1 Pierre R. Roberge, ¯Corrosion Engineering: Principles and Practice‖, McGraw-Hill, 2008.
2 Sastri V.S., Ghali E. And Elboujdaini M., ¯Corrosion Prevention and Protection: Practical Solutions‖, John Wiley and Sons, 2007.

**15UCH952** **BIOSENSORS** **L T P C**

**3 0 0 3**

**AIM**

To attain a broad comprehension of Biosensors

**OBJECTIVES**

- To explain basics of biosensors and its applications
- To know in depth of its principles, various types, immobilization and mobilization polymers, etc

**UNIT I INTRODUCTION, PRINCIPLES, BIOSENSORS BASED IN OXYGEN AVAILABILITY 10**

Principles of enzyme biosensors, enzyme biosensors based on Ph, enzyme biosensors based on gas electrodes, Ions sensitive field effect transducers ISFET, biosensors based on oxygen, biosensors based on hydrogen peroxide electrodes.

**UNIT II MEDIATOR, MODIFIED AND ADVANCE ELECTRODES 9**

Mediator modified carbon phase electrode, Enzyme immobilization and immobilized peroxides, Redox polymers.

**UNIT III CONDUCTING POLYMERS CONDUCTOMETRIC MEASUREMENTS 9**

Neutralized carbon electrodes, Conducting polymers, Conductometric measurements.

**UNIT IV THERMAL DETECTION, TRANSDUCERS 8**

Thermal transducers / thermisters, Fluorometric detection.

**UNIT V MICROBIAL SENSORS, POTENTIOMETRIC AND OPTICAL DETECTION 9**

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Understand the various types of biosensors in engineering fields
- Understand in knowledge for application of biosensors applications, detection, etc.

**TEXT BOOKS:**


1. Patranabis D, “Sensors and Transducers”, Prentice Hall of India, 2nd Edition New Delhi 2003.
2. Doebelin, E.A, “ Measurement Systems -Applications and Design”, Tata McGraw Hill, 2nd Edition, New Delhi, 2003.


**REFERENCE BOOKS:**


1. Patranabis D, “ Principles of Industrial Instrumentation”, Tata McGraw Hill, 16th edition, 2007.
2. Sawhney, A.K, Puneet Sawhney, “A Course in Electrical and Electronic Measurement and Instrumentation”, Dhanpat Rai & Co (P) Ltd, New Delhi, 11th Edition, 2005.

**15UCH953** **ENERGY STORAGE SYSTEMS** **L T P C**

**3 0 0 3**

**AIM :**

This course is intended to build up the necessary background to model and analyze the various types of energy storage systems

**OBJECTIVES :**

- To develop the ability to understand / analyse the various types of energy storage.
- To study the various applications of energy storage systems

**UNIT I** **9**

**INTRODUCTION**

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications

**UNIT II** **9**

**THERMAL STORAGE SYSTEM**

Thermal storage – Types – Modelling of thermal storage units - Simple water and rock bed storage system – pressurized water storage system Modelling of phase change storage system- Simple units, packed bed storage units - Modelling using porous medium approach, Use of Transys

**UNIT III** **9**

**ELECTRICAL ENERGY STORAGE**

Fundamental concept of batteries – measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries - Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide and moder n batteries for example (i) zinc - Air (ii) Nickel Hydride, (iii) Lithium Battery

**UNIT IV** **9**

**FUEL CELL**

Fuel Cell - History of Fuel cell, Principles of Electrochemical storage

Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantage and drawback of each type.

**UNIT V** **9**

**ALTERNATE ENERGY STORAGE TECHNOLOGIES**

Flywheel , Super capacitors, Principles & Methods- Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications

**TOTAL HOURS : 45 PERIODS**

**COURSE OUTCOMES :**

- Able to anlayse various types of energy storage devices and perform the selection based on techno - economic view point

**REFERENCES**


1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002
2. Fuel cell systems Explained, James Larminie and Andrew Dicks, Wiley publications, 2003.
3. Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, Wiley publications, 2012

**15UCH954** **ALTERNATIVE ENERGY SOURCES** **L T P C**

**3 0 0 3**

**AIM:**

This course is intended to build up to harness green and clean renewable energy sources in the State for environment benefits; mitigate Global warming/Climate change and Energy Security.

**OBJECTIVES:**

- To harness the environment friendly resources and to enhance their contribution to the socio-economic development.
- To developing and demonstrating the commercializing new and emerging technologies in the alternative energy sources.

**UNIT I** **9**

Hydrogen production - water splitting – electrolytic methods Chemical cycle - photosplitting - photo galvanic - photo chemical.- Application of Hydrogen – Fuel for Vehicle

**UNIT II** **9**

Tidal energy - operating mode - overfilling of the basins - Energy content. Ocean Thermal Energy Cycle (OTEC) - Baseline design- Heat design - Power cycle design - plant working. Energy - commercialization – problem s and opportunities. Geo- system – classification - convective and conductive systems - binary cycle conversion - waterfed heat pumps - electric generation - steam generation - steam field.

**UNIT III** **9**

Nuclear power systems - light water reactor - hightemperature gas reactors - liquid metal fast breeder reactor - Thermal - Fuel elements - Types -operation - Reactivity coeffi-cient – Positioning fuel requirements.

**UNIT IV** **9**

Fuel cells - General systems - Reactions - Gibbs' rule - of formation - Internal cell voltage - Types of fuel - Design of fuel cell systems - applications - Conversion - problems.

**UNIT V** **9**

Thermoelectric converter - Thermionic converter – Magneto Hydra Dynamic system (MHD) - Electro gas dynamics (EGD) principles - types.

**COURSE OUTCOMES:**

Upon completion of the course the student will be able to

- Understand the Fundamentals process of water splitting and photosplitting.
- Various types of power and steam generation techniques and power cycle design.
- Know about the nuclear power system and nuclear reactors like light water reactor, high temperature gas reactors and liquid metal fast breeder reactor
- Classify the Various typefuel cells and also understand the design of fuel cell and its applications.
- Understand the Thermionic converter like Magneto Hydra Dynamic system (MHD) ,and Electro gas dynamics (EGD).

**REFERENCES:**

1. Culp,J.A., 1979. Principles of Energy conversion McGraw Hill Book Company, London.
2. International compendium. Alternate energy sources, Vol.IV, Hemi sphere publishing company, London.1977
3. Thielhein,K.D. Primary energy. Springler verlas, Berlin, Heidelburg. 1980

**15UCH955 INDUSTRIAL SOLID WASTE MANAGEMENT L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To provide comprehensive overview of solid and hazardous waste management.
- To provide knowledge on solid waste management design aspects.

**UNIT I** **9**

Legal and Organizational foundation: Definition of solid waste - waste generation in a technological society - sources and types of solid waste – legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, batteries waste, E - waste and plastics, monitoring responsibilities.

**UNIT II** **9**

Collection of Solid Waste: type of waste collection systems, analysis of collection system - Alternative techniques for collection system. Separation and Processing and Transformation of Solid Waste: unit operations used for separation and processing, Materials Recovery facilities, Waste transformation through combustion and anerobic composting, anaerobic methods for materials recovery and treatment - Energy recovery - Inc inerators. Transfer and Transport: need for transfer operation, transport means and methods, transfer station types and design requirements. Landfills: Site selection, design and operation, drainage and leachate collection systems - requirements and technical solutions, designated waste landfill remediation - Integrated waste management facilities.

**UNIT III** **9**

Definition and identification of hazardous wastes - sources and characteristics - hazardous wastes in Municipal Waste - Hazardous waste regulations - minimization of Hazardous Waste - compatibility, handling and storage of hazardous waste - collection and transport.

**UNIT IV** **9**

Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste - Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation - remediation of hazardous waste disposal sites.

**UNIT V** **9**

Sampling and characterization of Solid Wastes; TCLP tests and leachate studies

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Be familiar with solid waste remedial measures and their importance.
- The students will undertake projects related to solid waste management.
- Be familiar with legislations pertaining to solid waste management.

**REFERENCES**

1. Techobanoglous G, Integrated Solid Waste Management, McGraw - Hill Publication, 1993.
2. Wentz C A, Hazardous Waste Management, McGraw - Hill Publication, 1995.
3. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental
4. Resources Management, Hazardous waste Management, Mc - Graw Hill International edition, New York, 2001.
5. CPHEEO, “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2000.
6. Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.

**15UCH861** **MATLAB FOR CHEMICAL ENGINEERING** **L T P C**
**0 0 2 1**

**OBJECTIVES**

- To explain basics of numerical methods calculations involved in chemical process systems.
- To know in depth of mathematical modeling of a given physical or chemical systems with the simulation.

**Course Contents**

1. Basics of MATLAB,
2. Data Types in MATLAB
3. Random Numbers
4. Variables and Variable Names
5. Suppressing Output
6. Built-in Functions in MATLAB – Go through the Function list
7. Vectors and Arrays
8. Plotting in MATLAB 9. Loops in MATLAB
10. Data Transfer in MATLAB
11. Solution of System of Linear Algebraic Equations using MATLAB
12. Solution of Single Non-linear Algebraic Equation using MATLAB
13. Solving Single Ordinary Differential Equations (ODEs) in MATLAB
14. Solving Simultaneous ODEs in MATLAB
15. Solving Mixed Differential and Algebraic Equations in MATLAB
16. Development of Graphical User Interfaces (GUI) in MATLAB

**TOTAL: 35 PERIODS**

**COURSE OUTCOMES**

Upon completion of the course students will,

- Understand the importance and use mathematical modeling and numerical calculations in chemical or physical systems.
- Able to construct models using MATLAB simulation software.
- Understand and use methods for model simplification.

**TEXT BOOK:**

1. Mathematical modeling in Chemical Engineering by Anders Rasmuson, Bengt Andersson, Louise Olsson, Ronnie Andersson, Cambridge University Press 2014, New York.

**REFERENCE BOOK:**

1. Numerical Methods Applied to Chemical Engineering by Frederick bernardin, MIT Open CourseWare, Fall 2006.

**15UCH862 SIMULATION ON PROCESS FUNDAMENTALS L T P C**

**0 0 2 1**

**Course Objective:**

This course is designed to provide knowledge on Industrial operations and training in the operation of major equipment deployed in process industry. It includes classroom instructions, as well as hands-on training with a PC based, full scope Simulator. The classroom instructions cover all major unit operations and their controls. Simulator training includes startup from cold condition to full load, load maneuvering, and shutdown from full load to cold condition, major malfunctions, and efficient operations of various equipment.

**List of Experiments**

1) Introduction to process control, Control objectives and benefits, Distributed control and DCS operation, Hands-on training on Simulator.
2) Automatic Control Systems (PID Control, On-Off, Flow, Level, Pressure, Temperature Controls), Advanced Control Systems (Cascade, Split Range and Feed Forward & Feed Back Controls and 3-element boiler level control)
3) Hands-on training on Simulator
4) Heat exchangers - Heat transfer calculation, Exercise on simulator
5) Pumps - Flow in a pump, head, characteristic curve, NPSH, Exercise on simulator
6) Compressor - Gas compression, discharge temperature, power, Performance, characteristic, Surge curve, Exercise on simulator
7) Distillation - Principles of distillation , Configuration of distillation column, Operating parameters, Dynamics, Malfunctions, Distillation startup
8) Furnace operation - Combustion principle , Operating parameters , Dynamics, Exercise on simulator, Start-up , Shutdown
9) Boiler - Operating parameters , Dynamics , Exercise on simulator , Start-up
10) Reactors - CSTR, PFR & Fixed bed reactor - Theory , Exercise on simulator, Start-up , Shutdown

**TOTAL: 30 PERIODS**

**OUTCOMES:**

After completion of the course students will able to

Understand the fundamental knowledge on process control and instrumentation, operations of major unit operations in a process plant.

Understand the trouble shooting, emergency handling, startup and shutdown operations of the unit operations.

**15UCH863 SUGARCANE PROCESSING AND ITS PRODUCTS L T P C**
**2 0 0 1**

**AIM:**

- To attain a broad comprehension of sugarcane processing and its products

**OBJECTIVES:**

- To explain various sources of sugar.
- To know in depth of its principles, types, methods of production, protection of environment, environmental impact of the unit.

**UNIT I** **8**

Introduction, classification of sugar, composition of raw materials; Different types of raw materials used, various methods are available for manufacturing of sugar; Details of the process, advantages and disadvantages of the various processes used; Equipments and machineries are used in the process.

**UNIT II** **7**

Quality of sugar, Sugar analysis, Refining, crystallization, packing, storing, shipping, Sugar derivatives, starch, uses of sugar, by products from sugar processing, solis, water and air pollution control applicable in the process, Quality of product

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

After the completion of course,

- Students are able to understand the various process of sugar manufacturing operations in details.
- Students are able to understand in depth of its principles, types, methods of production, protection of environment, environmental impact of the Sugar processing unit.

**TEXT BOOKS:**


1. Chemical Process Indusries by R.N. Shreve and T. Austin, McGraw Hill Book company, 5th Edition, Singapore.
2. Outline of Chemical Technology by C.E. Dryden, Affiliated East West press, New Delhi,


**REFERENCE BOOKS:**


1. Encyclopedia of Chemical Technology by Kirk & Othmer, Wiley & Sons, New York.
2. Hand Book of Sugar Manufacture by Newis Lanrence. N.J., Oxford University Press.

**15UCH864 DRY CEMENTS MANUFACTURING PROCESS L T P C**

**2 0 0 1**

**AIM:**

- To attain a broad comprehension of cement manufacturing processing and its products.

**OBJECTIVES:**

- To explain various sources of cement
- To know in depth of its principles, types, methods of production, protection of environment, environmental impact of the cement manufacturing unit.

**UNIT I** **7**

Introduction, Classification of cements, compositions of raw materials, various methods for manufacturing of cement, advantages and disadvantages of the various processes used; different types of raw materials used; Equipments and machineries are used in the process; solids and air pollution control applications in the process.

**UNIT II** **9**

Clinker chemistry, clinker formation, raw materials proportions, Hydration, cement paste structure and concrete properties, unit operations, chemical conversions, energy requirements, compounds in cements, setting and hardening of cement, special cements, Quality of cement, Cement Analysis, packing, storing, shipping, by products from cement processing, water, land and air pollution control applicable in the process, Quality of the product.

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

After the completion of the course,

- Students are able to understand the various process of cement manufacturing operations in details.
- Students are able to understand of its principles, types, methods of production, protection of environment, environmental impact of the cement manufacturing unit

**TEXT BOOKS:**

1. Chemical Process Indusries by R.N. Shreve and T. Austin, McGraw Hill Book company, 5th Edition, Singapore.
2. Outline of Chemical Technology by C.E. Dryden, Affiliated East West press, New Delhi,

**REFERENCE BOOKS:**

1. Encyclopedia of Chemical Technology by Kirk & Othmer, Wiley & Sons, New York.
2. Hand Book of Cement Manufacture by Alexander. K. I. Tata McGraw Hill Publishing Company.

**15UCH865** **RECLAMATION OF WASTE LUBRICATING OILS AND ITS PRODUCTS** **L T P C 2 0 0 1**

**AIM:**

- To attain a broad comprehension of Reclamation of Waste Lubricating Oils and its products.

**OBJECTIVES:**

- To explain basics of reclamation process systems.
- To know in depth of its types, process and design of reclamation of waste lubricating oils.

**UNIT I** **9**

Introduction to engine oil grade and uses, analysis of oils, physico chemical properties of oils, carbon residue in oil and viscosity characteristics. Basic analysis parameters like acid number, iodine number, base number, etc., Sludge analysis and analysis of waste engine oils, use of chemicals for reclamation.

**UNIT II** **6**

Various methods for reclamation waste lube oils process, economics of the process and its products

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

- Understand the basics of reclamation processes
- Understand in depth of its types and design of various pyrotechnics products and its composition.

**REFERENCE BOOK:**

1. Hand book of Waste Oil Reclamation by Walter Wanes. D.J.M.M, McGraw Hill Publishing co., Singapore.

**15UCH866 POLLUTION CONTROL ENGINEERING L T P C**
**2 0 0 1**

**AIM:**

- To attain a broad comprehension of pollution control engineering to the environment

**OBJECTIVES:**

To enable students to learn about Air, Water pollution, effects of air, water pollution, Global effects, Sampling of pollutants, Meteorology and air and water pollution, Atmospheric stability, Plume rise and dispersion and Prediction of air and water quality

**UNIT I INTRODUCTION, PROCESS ANALYSIS AND SELECTION 8**

Air pollution regulatory framework history – Regulatory system – Laws and Regulations – Clean air act – Provisions for recent developments.

Terminology, regulations, health and environment concerns in waste management, constituents, Components of flue gases and waste water flows – Analysis of data – Reactors used in waste water and flue gases treatment – Mass Balance Analysis – Process Selection.

**UNIT II POLLUTION PREVENTION 7**

Mass exchange network synthesis for pollution control and minimization implications of environmental constraints for process design, policies for regulation of environmental impacts.

Concepts of common effluent treatment; Environmental Legislations, Role of Government and Industries.

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course,

- Students would have knowledge on physical/chemical/biological characteristics and the evaluation technique for pollutants

**TEXTBOOKS:**


1. Air Pollution Control Equipment by Louis Theodore, Burley intuscence 2008.
2. Air Pollution Control by C.D. Cooper and F.C. Alley Wairland Press III Edition 2002.
3. Industrial Waste Water Management Treatment and Disposal of Waste water, McGraw Hill III edition, 2008.


**REFERENCE BOOK:**


1. Kirk and Othmer, Chemical Technology Hand Books, IV Edn, (1994)

**15UCH867 ENZYMES FOR ENVIRONMENTAL APPLICATIONS L T P C**
**2 0 0 1**

**AIM:**

- To attain a broad comprehension of Enzymes used in environmental applications

**OBJECTIVES:**

- To explain basics of enzymes for environmental applications
- To know in depth of its principles, treatment methods for various types of waste water effluents

**UNIT I** **7**

Nature, Enzyme: Characteristics, Substrate Binding, Reactors, Immobilization, Sensors: Types of Pollutants, Quality Product After Treatment, Treating, Aromatic Pollutants

**UNIT II** **8**

Treating methods for pesticide residues, heavy metals, solid wastes, surfactants in effluents, food process industry wastes, water treatment

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

- Understand the various types of enzymes for environmental applications process
- Understand in knowledge for application of enzymes in industrial waste water effluents.

**REFERENCE BOOKS:**


1. Enzyme Immobilization: Advances in Industry, Agriculture, Medicine and the Environment by Alka Dwevedi, Springer International Publishing, Switzerland 2016.s
2. Enzymes in the Environment: Activity, Ecology, and Applications by Richard G. Burns, Richard P. Dick, CRC Press, 2002, Marcel Dekker, Inc., New York, Basel.

**15UCH868** **RECLAMATION OF PRESS MUD WAX** **L T P C**
**2 0 0 1**

**AIM:**

- To attain a broad comprehension of reclamation processes for press mud wax

**OBJECTIVES:**

- To explain basics of reclamation process press mud wax
- To know in depth of its types, process and design of reclamation of press mud wax

**UNIT I** **9**

Introduction to press mud wax and uses, analysis of press mud, physic chemical properties of press mud, characteristics of press mud. Basic analysis parameters, sludge analysis and analysis of press mud, use of chemicals for reclamation, processing of press mud.

**UNIT II** **6**

Various methods for reclamation press mud wax process, economics of the process and its products

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

- Understand the basics of reclamation processes of press mud
- Understand in depth of its types and design of various methods and products and its composition of press mud

**REFERENCE BOOK:**

1. Hand Book of press mud reclamation by John. Fridrick. J.L., Koes Hudny. I. L., McGraw Hill Publishing Co.

**15UCH869** **SENSORS FOR AIR POLLUTION** **L T P C**
**2 0 0 1**

**AIM:**

- To attain the basics of Air Pollution Sensors

**OBJECTIVES:**

- To explain basics of Air Pollution Control Sensor Systems
- To know in depth of its principles, types, materials, process and design of water purification
- To enable the students to learn about sensors for air pollution effects, sampling of pollutants, plume rise and dispersion and prediction of air quality

**UNIT I** **7**

Introduction, quality of air, effect of air pollutants, types of air sensors, Sensors for air pollution, basics of quality of air, types of air sensors

**UNIT II** **8**

Description of personal exposure monitoring, types of pollutants to characterize sensors, environmental condition for air pollution and health implications, parameters used to design sensors, economics in the design

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course the students,

- Would have the knowledge of ambient sensors for air pollution, its sources and design
- Able to understand the basics of air pollution sensors
- Able to understand in depth of air pollution, effect of air pollution, characteristics and monitoring and design of sensors for air pollution.

**TEXT BOOKS:**


1. Air Pollution Control Equipment by Louis Theodore, Burley intuscence 2008.
2. Air Pollution Control by C.D. Cooper and F.C. Alley Wairland Press III Edition 2002.
3. Air pollution control engineering by Noel de Nevey – McGraw Hill, co.
4. Air pollution control engineering by de Nevey, N., – McGraw Hill, Inc., 2000
5. Air pollution control : A design approach by Cooper, C.D. and Alley, F.C. Waveland Press, 2002.


**REFERENCE BOOKS:**


1. Chemical Technology Hand Book by Kirk and Othmer, IV edn 1994
2. Fundamentals of air pollution by Vallero, A., Daniel A., (Electronic resources) Amsterdam.

**15UCH870 WASTE RECYCLING FROM PULP AND TEXTILE MILLS L T P C**
**2 0 0 1**

**AIM:**

- To attain a broad comprehension of water recycling from pulp and textile mills systems

**OBJECTIVES:**

- To explain various water recycling from pulp and textile mills systems
- To know in depth of its principles, various methods of processing of waste water from Pulp and Textile mills

**UNIT I** **9**

Characterization of waste water from pulp and textile mills, composition of waste water, various treatment methods of waste water, products and by products, quality of water, sludge disposal, Evaluation, classifications and characterization of waste water, Treatment types o waste water: Preliminary, Primary, Secondary and Tertiary methods, Advantages and Disadvantages of the methods

**UNIT II** **6**

Theory and practice of aeration in waste water treatment, Sludge treatment: Sludge disposal, activated sludge process, other methods and products and by products.

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

After completion of the course, Students are

- Able to understand the various water recycling from pulp and textile mills mehods
- Able to understand in depth of its principles, various methods of processing of waste water from pulp and textile mills.

**TEXTBOOKS:**


1. Introduction to waste water treatment processes by R.S. Ramlho, Academic press, New York.
2. Chemical Process Industries by R.N. Shreves and T. Austin, McGraw Hill Book Company, 5th Edition, Singapore.
3. Outline of Chemical Technology by C.E. Dryden, Affiliated East West Press, New Delhi

**REFERENCE BOOKS:**


1. Encyclopedia of Chemical Technology by Kirk and Othmer, Wiley & Sons, New York.
2. Industrial Pollution Control Hand Book by Lund J.E., McGraw Hill Publishers 1971.
3. American Public Health Association Inc., Standard methods for the examination of water & Waste Water- New York.

**15UCH871** **MEMBRANE TECHNOLOGY** **L T P C**
**2 0 0 1**

**AIM:**

- To attain a broad comprehension of Membrane technology for water purification process.

**OBJECTIVES:**

- To explain basics of membrane technology process systems
- To know in depth of its principles, types, materials, process and design of Membranes for water purification

**UNIT I** **5**

Introduction, principles, theory - Membrane transport theory, membranes and modules, various types

**UNIT II** **10**

Advanced processes, membrane reactors and application Reverse Osmosis, Ultra filtration and micro filtration, gas serration and per evaporation, ion exchange membranes, advance dialysis.

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

- Understand the basics of membrane technology
- Understand in depth of its types, principles, materials used, advanced methods, applications of membrane technology.

**TEXTBOOKS:**


1. Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publications.
2. Coulson and Richardson‟s Chemical Engineering , Volume 2, Elesvier.
3. S.P. Nunes and K.V. peinemann, Membrane Technology in the Chemical industry, Wiley – VCH.
4. R. Rautanbach and R. Albrecht, Membrane Process, John Wiley & Sons.

**REFERENCE BOOKS:**


1. R.Y.M. Huang, Perevaporation Membrane Separation Processes, Elsevier.
2. J.G. Crespo, K.W. Boddekes, Membrane Processes in Separation and Purification, Kluwer Academic Publications
3. Larry Ricci and the staff of Chemical Engineering Separation Techniques, McGraw Hill Publications
4. Richard W. Baker, Membrane technology and Applications, John Wiley & Sons, Ltd.

**15UCH872** **PYROTECHNOLOGY** **L T P C**
**2 0 0 1**

**AIM:**

- To attain a broad comprehension of Pyrotechnology systems used for various applications.

**OBJECTIVES:**

- To explain basics of pyrotechnology systems
- To know in depth of its types and design of pyrotechnics systems

**UNIT I** **7**

Classification of energetic materials and its compositions, basic chemistry, uses of ire, how to control fire, Environmental effects and concerns

**UNIT II** **8**

Pyrotechnic oxidizers, fuels, binders, other ingredients, important properties, ignition and propagation of reaction; characterization of pyrotechnics, pyrotechnics applications: heat generation, color/light generation, smoke generation, sound generation.

**TOTAL: 15 PERIODS**

**COURSE OUTCOMES:**

- Understand the basics of pyrotechnics
- Understand in depth of its types and design of various pyrotechnics products and its composition.

**REFERENCE BOOKS:**


1. Hand Book of Pyrotechnics by john Wales. F.R., McGraw Hill Publishing Co., Singapore.
2. Pyrotechnics by George Weingart, 2 Edm, 1992, Oxford University Press.
3. Principles o Pyrotechnics by A.A. Shidlovskiy: ISBN-13:978-0929931135.

## WASTE TO ENERGY CONVERSION

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**OFFERING DEPARTMENTS: CIVIL & CHEMICAL**

**UNIT-1 INTRODUCTION TO WASTE & WASTE PROCESSING 9**

Definitions, sources, types and composition of various types of wastes; Characterisation of Municipal Solid Waste (MSW) , Industrial waste and Biomedical Waste (BMW), waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of MSW; Life Cycle Analysis (LCA), Material Recovery Facilities (MRF), recycling processes of solid waste

**UNIT-2 WASTE TREATMENT AND DISPOSAL 9**

Aerobic composting, incineration, different type of incineration; medical and pharmaceutical waste incinerations- land fill classification, types, methods and sitting consideration, layout and preliminary design of landfills: composition, characteristics, generation, movement and control of landfill leachate and gases, environmental monitoring system for land fill gases

**UNIT-3 ENERGY FROM WASTE-THERMO CHEMICAL CONVERSION 9**

Sources of energy generation, incineration, pyrolysis, gasification of waste using gasifiers, briquetting, utilization and advantages of briquetting,- environmental and health impacts of incineration; strategies for reducing environmental impacts.

**UNIT-4 ENERGY FROM WASTE- BIO-CHEMICAL CONVERSION 9**

Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion biogas production, land fill gas generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages.

**UNIT-5 ENVIRONMENTAL AND HEALTH IMPACTS-CASE STUDIES 9**

Environmental and health impacts of waste to energy conversion, case studies of commercial waste to energy plants, waste to energy- potentials and constraints in India, eco-technological alternatives for waste to energy conversions - Rules related to the handling, treatment and disposal of MSW and BMW in India.

TOTAL: 45 PERIODS

**COURSE OUTCOMES:**

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

- Describe the characterization process of wastes (Understand)
- Explain the different waste treatment and disposal methods (Understand)
- Summarise the energy generation using thermo chemical conversion methods (Understand)
- Describe energy generation using Biochemical conversion methods. (Understand)
- Elaborate some case studies on Environmental and health impacts of waste to energy conversion (Understand)

**REFERENCES:**


1. Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN:9780470539675, Publisher: John Wiley & Sons, Publication Date: June 2010.
2. Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1- 57808 200-1; 2002
3. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987.
5. Waste-to-Energy by Marc J. Rogoff, DEC-1987, Elsiever, and ISBN-13: 978-0-8155-1132-8, ISBN-10: 0-8155- 1132-9.
6. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
7. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.
8. Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.
9. Robert Green, From Waste to Energy, Cherry Lake Pub. ISBN: 1602795096, 2009. [10] G. Evans, Biowaste and Biological Waste Treatment, 2005
10. Biogas from waste and renewable resources, by Dieter D. And Angelika S. Wiley-Vch Publication 2010.