**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM**
**SCHEME OF TEACHING AND EXAMINATION, 2017-2018**
**CHOICE BASED CREDIT SYSTEM (CBCS)**
**B.E: CHEMICAL ENGINEERING**

**III SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hrs/Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Pract. / Drg. | Duration Hrs | SEE Mark | CIE Mark | Total Marks | |
| 1 | 17MAT311 | Engineering Mathematics III* | Maths | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 2 | 17CH32 | Momentum Transfer [ D. C] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 3 | 17CH33 | Chemical Process Calculations [D.C] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 4 | 17CH34 | Mechanical Operations [D.C] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 5 | 17CH35 | Chemical Technology-I [D.C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 3 |
| 6 | 17CH36 | Technical Chemistry [F.C] | Chemistry | 03 | -- | 03 | 60 | 40 | 100 | 4 |
| 7 | 17CHL37 | Momentum Transfer Lab | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17CHL38 | Technical Chemistry Lab | Chemistry | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 9 | 17KL/CPH39/ 49 | Kannada/Constitution of India, Professional Ethics and Human Rights | Humanities | 01 | | 01 | 30 | 20 | 50 | 1 |
| **TOTAL** | | | **24** | **Theory: 24 Hours Practical:06 Hours** | | **25** | **510** | **340** | **850** | **28** |

**NOTE**: **Comm**. - Common to all Branches, **D.C** - Departmental Core, **F.C**- Foundation Course

1. **Departmental Core [D.C.]:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Foundation Course [F.C.]:**This gives the fundamental knowledge about the discipline.
3. **Kannada/Constitution of India, Professional Ethics and Human Rights:** 50% of the programs of the Institution have to reach Kannada/ Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.
4. **Audit Course: (i)** * All lateral entry students (except B.Sc. candidates) have to register for Additional Mathematics-I, which is 03 contact hours per week

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 17MATDIP31 | Additional Mathematics-I | Maths | 03 | | 03 | 60 | -- | 60 | -- |

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc. candidates)

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**IV SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hrs/Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Pract. / Drg. | Duration Hrs | SEE Marks | CIE Marks | Total Marks | |
| 1 | 17MAT41 | Engineering Mathematics IV* | Maths | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 2 | 17CH42 | Chemical Technology-II [D.C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 3 |
| 3 | 17CH43 | Chemical Engg Thermodynamics [D. C] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 4 | 17CH44 | Material Science [D.C] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 5 | 17CH45 | Process Heat Transfer [ D. C] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 6 | 17CH46 | Instrumental Analysis [F.C] | Chemistry | 03 | -- | 03 | 60 | 40 | 100 | 4 |
| 7 | 17CHL47 | Chemical Engg. Drawing Lab | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17CHL48 | Mechanical Operations Lab | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 9 | 17KL/CPH39/ 49 | Kannada/Constitution of India, Professional Ethics and Human Rights | Humanities | 01 | | 01 | 30 | 20 | 50 | 1 |
| **TOTAL** | | | **24** | **Theory: 24 Hours Practical:06 Hours** | | **25** | **510** | **340** | **850** | **28** |

**NOTE**: **Comm**. - Common to all Branches, **D.C** - Departmental Core, **F.C**- Foundation Course

1. **Departmental Core [D.C.]:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
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3. **Kannada/Constitution of India, Professional Ethics and Human Rights:** 50% of the programs of the Institution have to reach Kannada/ Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.
4. **Audit Course: (i)** * All lateral entry students (except B.Sc. candidates) have to register for Additional Mathematics-I, which is 03 contact hours per week

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 17MATDIP41 | Additional Mathematics-II | Maths | 03 | | 03 | 60 | -- | 60 | -- |

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc. candidates)

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**V SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hrs/Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Pract. / Drg. | Duration Hrs | SEE Marks | CIE Marks | Total Marks | |
| 1 | 17CH51 | Process Industry Management [D.C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 2 | 17CH52 | Mass Transfer Operations-I [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 3 | 17CH53 | Chemical Reaction Engineering-I [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 4 | 17CH54 | Chemical Equipment Design [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 5 | 17CH55X | Professional Elective-I [P. E.] | Chemical | 03 | -- | 03 | 60 | 40 | 100 | 3 |
| 6 | 17CH56X | Open Elective-I [O.E.] | Any Dept. | 03 | -- | 03 | 60 | 40 | 100 | 3 |
| 7 | 17CHL57 | Heat Transfer Laboratory | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17CHL58 | Pollution Control and Instrumental Analysis Laboratory | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| **TOTAL** | | | **24** | **Theory: 22 Hours Practical:06 Hours** | | **24** | **480** | **320** | **800** | **26** |

| 17CH55X: Professional Elective-I | | 17CH56X: Open Elective-I *** | |
|---|---|---|---|
| 17CH551 | Oils and Fats Technology | 17CH561 | Process Waste Water Management |
| 17CH552 | Petroleum Refining Engineering | 17CH562 | Process Air Pollution and Control |
| 17CH553 | Pharmaceutical Technology | 17CH563 | Solid Waste Management in Process Industries |
| 17CH554 | Polymer Technology | 17CH564 | Process Safety and Environmental Management |
| | | 17NC565 | Essentials of NCC |

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*******Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).

Selection of an open elective is not allowed, if: · The candidate has no pre – requisite knowledge, · The candidate has studied similar content course during previous semesters. The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).
Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

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**VI SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hrs/Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Pract. / Drg. | Duration Hrs | SEE Marks | CIE Marks | Total Marks | |
| 1 | 17CH61 | Chemical Reaction Engineering-II [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 2 | 17CH62 | Mass Transfer Operations-II [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 3 | 17CH63 | Industrial Pollution Control [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 4 | 17CH64 | Process Equipment Design and Drawing [D.C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 5 | 17CH65X | Professional Elective-II [P.E.] | Chemical | 03 | -- | 03 | 60 | 40 | 100 | 3 |
| 6 | 17CH66X | Open Elective-II [O.E.] | Any Dept. | 03 | -- | 03 | 60 | 40 | 100 | 3 |
| 7 | 17CHL67 | Chemical Reaction Engineering Laboratory | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17CHL68 | Mass Transfer Operations Laboratory | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| **TOTAL** | | | **24** | **Theory: 22 Hours Practical:06 Hours** | | **24** | **480** | **320** | **800** | **26** |

| 17CH65X: Professional Elective-II | | 17CH66X: Open Elective-II | |
|---|---|---|---|
| 17CH651 | Electro Chemical Technology | 17CH661 | Food Technology |
| 17CH652 | Petrochemicals | 17CH662 | Sugar Technology |
| 17CH653 | Fermentation Technology | 17CH663 | Petro-Chemical Engineering |
| 17CH654 | Pulp and Paper Technology | 17CH664 | Polymer and Plastic Engineering |

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2. **Professional Elective [P.E.]:** Elective relevant to chosen specialization/ branch**,**
3. **Open Elective [O.E.]:** Electives from other technical and/or emerging subject areas.

*****Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).
Selection of an open elective is not allowed, if: · The candidate has no pre – requisite knowledge, · The candidate has studied similar content course during previous semesters. The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).

Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

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**VII SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hrs/Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Pract. / Drg. | Duration Hrs | SEE Marks | CIE Mark | Total Marks | |
| 1 | 17CH71 | Biochemical Engineering [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 2 | 17CH72 | Computer Applications and Modeling [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 3 | 17CH73 | Process Control and Instrumentation [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 4 | 17CH74X | Professional Elective-III [P.E.] | Chemical | 03 | -- | 03 | 60 | 40 | 100 | 3 |
| 5 | 17CH75X | Professional Elective -IV[P.E.] | Chemical | 03 | -- | 03 | 60 | 40 | 100 | 3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 17CHL76 | Process Control Laboratory | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 7 | 17CHL77 | Computer Applications and Simulation | Chemical | -- | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17CHP78 | Project Phase –I + Project Work Seminar | Chemical | -- | 03 | -- | -- | 100 | 100 | 2 |
| **TOTAL** | | | **24** | **Theory: 18 Hours Practical and Project: 09 Hours** | | **21** | **420** | **380** | **800** | **24** |

| 17CH74X : Professional Elective-III | | 17CH75X : Professional Elective-IV | |
|---|---|---|---|
| 17CH741 | Applied Mathematics in Chemical Engineering | 17CH751 | Composite Materials |
| 17CH742 | Chemical Process Integration | 17CH752 | Cement and Ceramic Technology. |
| 17CH743 | Transport Process and Modeling of Aquatic Systems | 17CH753 | Novel Separation Techniques |
| 17CH744 | Pilot Plant and Scale-up Studies | 17CH754 | Downstream Processing |

1. **Departmental Core [D.C.]:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study**.**
2. **Professional Elective [P.E.]:** Elective relevant to chosen specialization/ branch**,**
3. **Project Phase – I and Project Work Seminar:** Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and Seminar presentation skill.

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**VIII SEMESTER**

| 17CH83X: Professional Elective-V | |
|---|---|
| 17CH831 | Chemical Plant Utilities and safety |
| 17CH832 | Multicomponent Distillation |
| 17CH833 | Energy Technology |
| 17CH834 | Interfacial Phenomena and Surface Engineering |

1. **Departmental Core [D.C.]:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study**.**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hrs/Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Pract. / Drg. | Duration Hrs | SEE Marks | CIE Marks | Total Marks | |
| 1 | 17CH81 | Transport Phenomena [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 2 | 17CH82 | Process Engineering Economics and Management [D. C.] | Chemical | 04 | -- | 03 | 60 | 40 | 100 | 4 |
| 3 | 17CH83X | Professional Elective-V [P.E.] | Chemical | 03 | -- | 03 | 60 | 40 | 100 | 3 |
| 4 | 17CH84 | Internship / Professional Practice | Chemical | Industry Oriented | | 03 | 50 | 50 | 100 | 2 |
| 5 | 17CHP85 | Project Work -II | Chemical | -- | 6 | 03 | 100 | 100 | 200 | 6 |
| 6 | 17CHS86 | Seminar | Chemical | -- | 4 | - | -- | 100 | 100 | 1 |
| **TOTAL** | | | **24** | **Theory: 11 Hours Project and Seminar: 10 Hours** | | **15** | **330** | **370** | **700** | **20** |

2. **Professional Elective [P.E.]:** Elective relevant to chosen specialization/ branch**,**
3. **Internship/ Professional Practice:** 4 Weeks internship to be completed between the (VI and VII semester vacation) and/or (VII and VIII semester vacation) period.

## ENGINEERING MATHEMATICS III

**Sub Code : 17MAT31** **CIE Marks:40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 04**

[COMMON TO ALL BRANCHES]

## MOMENTUM TRANSFER

**Sub Code : 17CH32** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 04**

**COURSE OBJECTIVES:** The students will

1. Understand concepts on nature of fluids, pressure concepts and measurement of pressure by various experimental methods and by mathematical relations and enhancement of problem solving skills.
2. Learn detailed explanation on types of fluids, stress and velocity relations, type of fluid flow and boundary layer relations.
3. Understand relationship between kinetic energy, potential energy, internal energy and work complex flow systems using Bernoulli's equation with application to industrial problems.
4. Understand clear concepts on Flow of incompressible fluids in conduits and thin layers and friction factor variations with velocity and friction losses using Bernoulli's Equations and they will be demonstrated experimentally.
5. Study Flow of compressible fluids, Dimensional analysis, Dimensional homogeneity and various dimensionless numbers and their applications.
6. Understand principles and working of various types of pumps, transportation and metering of fluids using various experimental techniques and applications to industry.

| **Module 1** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
|---|---|---|---|
| **FLUID STATICS AND ITS APPLICATIONS:** Concept of unit operations, Concept of momentum transfer, Nature of fluids and pressure concept, variation of pressure with height – hydrostatic equilibrium, Barometric equation, Measurement of fluid pressure – manometers, Continuous gravity decanter, Centrifugal decanter. | | **5Hrs** | **L-1, L-2** |
| **FLUID FLOW PHENOMENA:** Type of fluids – shear stress and velocity gradient relation, Newtonian and Non- Newtonian fluids, Viscosity of gases and liquids. Types of flow – laminar and turbulent flow, Reynolds stress, Eddy viscosity. Flow in boundary layers, Reynolds number, and Boundary layer separation and wake formation. | | **5Hrs** | **L-1, L2** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **BASIC EQUATIONS OF FLUID FLOW:** Average velocity, Mass velocity, Continuity equation, Euler and Bernoulli equations Modified equations for real fluids with correction factors, Pump | | **6Hrs** | **L-2, L-3** |

| | | |
|---|---|---|
| work in Bernoulli equation, Angular momentum equation. | | |
| **FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS:**<br>Laminar flow through circular and non-circular conduits, Hagen Poiseuille equation, Laminar flow of Non-Newtonian liquids, Turbulent flow in pipes and closed channels. | **4Hrs** | **L-2, L-3** |
| **Module 3** **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS:(Contd..)**<br>Friction factor chart, friction from changes in velocity or direction, Form friction losses in Bernoulli equation, Flow of fluids in thin layers | **4Hrs** | **L-2, L-3** |
| **FLOW OF COMPRESSIBLE FLUIDS:**<br>Continuity equation, Concept of Mach number, Total energy balance, Velocity of sound, Ideal gas equations, Flow through variable-area conduits, Adiabatic frictional flow, Isothermal frictional flow (elementary treatment only). | **6Hrs** | **L-2, L-3** |
| **Module 4** **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **TRANSPORTATION AND METERING OF FLUIDS:**<br>Pipes, Fittings and valves, Measurement of fluid and gas flow rates by orifice meter, rotameter and pitot tube, Elementary concept of target meter, vortex-shedding meters, turbine meters, positive displacement meters, magnetic meters, coriolis meters and thermal meters, Flow through open channel-weirs and notches. | **10Hrs** | **L-2, L-3** |
| **Module 5** **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **PUMPS:**<br>Performance and Characteristics of pumps-positive displacement and centrifugal pumps, Fans, compressors, and blowers. | **4Hrs** | **L-2, L-3** |
| **INTRODUCTION TO UNSTEADY STATE FLOW:**<br>Time to empty the liquid from the tank. | **2Hrs** | **L-2, L-3** |
| **DIMENSIONAL ANALYSIS:**<br>Dimensional homogeneity, Rayleigh's and Buckingham Π- methods, Significance of different dimensionless numbers, Elementary treatment of similitude between model and prototype. | **4Hrs** | **L-2, L-3** |

**COURSE OUTCOMES:** On completion of this course the students will be able to

1. Analyze different types of fluids and able to measure pressure difference for flow of fluids.
2. Understand and analyze the relationship between kinetic and potential energy, internal energy, work, and heat in complex flow systems using Bernoulli's equation, perform macroscopic energy balances.
3. Analyze and calculate friction factor for different types of flow in various types of constructions.
4. Develop mathematical relations using Dimensional analysis by Rayleigh's and Buckingham – $\pi$ method.

**GRADUATE ATTRIBUTES:**

- Design and development of solutions.
- Problem analysis

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks

- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**


1. McCabe, W.L., *et.al.*,**"Unit Operations in Chemical Engineering"**, 5$^{th}$edn., McGraw Hill, New York 1993
2. Kumar K.L., **"Engineering Fluid Mechanics"**, Eurasia Publishing House (p) Ltd., New Delhi, 3$^{rd}$edn. 1984
3. Dr R K Bansal., "**A Text Book of Fluid Mechanics**" 1$^{st}$edn., Laxmi Publications (P) Ltd., New Delhi. 2005.


**REFERENCE BOOKS:**


1. Coulson J.H. and Richardson J.F., **"Chemical Engineering"**, Vol-I, 5$^{th}$edn., Asian Books (p) Ltd., New Delhi, 1998
2. Badger W.L. and Banchero J.T., **"Introduction to Chemical Engineering"**, Tata McGraw Hill, New York, 1997


## CHEMICAL PROCESS CALCULATIONS

**Sub Code : 17CH33** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 04**

**COURSE OBJECTIVES:** The students will

1. Learn basic laws about the behavior of gases, liquids and solids and some basic mathematical tools.
2. Understand systematic problem solving skills, enhance confidence, and generate careful work habits.
3. Learn what material balances are, how to formulate and apply them, how to solve them.
4. Learn what energy balances are, and how to apply them and finally, to learn how to deal with the complexity of big problems.

| Module 1 | Content | Contact Hours | Blooms Taxonomy |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **UNITS AND DIMENSIONS:**<br>Fundamental and derived units, Conversion, Dimensional consistency of equations, Dimensionless groups and constants, conversions of equations.<br>**BASIC CHEMICAL CALCULATIONS:**<br>Concept of mole, mole fraction, Compositions of mixtures of solids, liquids and gases, Concept of Normality, Molarity, Molality, ppm, Use of semi-log, log-log, triangular graphs, Ideal gas law calculations. | | **10Hrs** | **L-1, L-2.** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **MATERIAL BALANCE WITHOUT REACTION:**<br>General material balance equation for steady and unsteady state, Typical steady state material balances in distillation, absorption, extraction, crystallization, | | **10Hrs** | **L-2, L3.** |
| **Module 3** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **MATERIAL BALANCE WITHOUT REACTION:**<br>Drying, mixing and evaporation, Elementary treatment of material balances involving bypass, recycle and purging, Psychrometry, Humidification and dehumidification. | | **10Hrs** | **L-2, L3.** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **STEADY STATE MATERIAL BALANCE WITH REACTION:**<br>Principles of Stoichiometry, Concept of limiting, excess reactants and inerts, fractional and percentage conversion, fractional yield and percentage yield, selectivity, related problems, Ultimate and proximate analysis of fuels, Calculations involving burning of solid, liquid and gaseous fuels, excess air, air-fuel ratio calculations. | | **10Hrs** | **L-2, L3.** |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **ENERGY BALANCE:**<br>General steady state energy balance equation, Thermo physics, Thermo chemistry and laws, Heat capacity, Enthalpy, Heat of formation, Heat of reaction, Heat of combustion and Calorific values. Heat of solution, Heat of mixing, Heat of crystallization, determination of $\Delta H_R$ at standard and elevated temperatures, Theoretical flame temperature and adiabatic flame temperature | | **10Hrs** | **L-2, L3.** |

**COURSE OUTCOMES:** On completion of this course the student will have

1. Clear idea of various types of unit systems and they will be able to convert units from one form of the unit to other.
2. Sound strategy for solving material and energy balance problems.
3. Adopt the tools learned from the course from the numerical problems which contain more than two unit operations.
4. Develop mathematical relations for mass balance and energy balances for any processes.

**GRADUATE ATTRIBUTES:**

- Design and development of solutions.
- Problem analysis
- Computational knowledge.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Note: Question Paper to contain at least 30% Theory**

**TEXT BOOKS:**


1. Bhatt B.I. and Vora S.M., **"Stoichiometry (SI Units)"**, 3rd edn, 1996, Tata McGraw Hill Publishing Ltd., New Delhi, 1996
2. Hougen O.A., Watson K.M. and Ragatz R.A., **"Chemical Process Principles - Part I"**
3. **"Material and Energy balances"**, 2nd edn, CBS publishers and distributors, New Delhi, 1995


**REFERENCE BOOK:**


1. Himmelblau D.M., **"Basic principle and Calculations in Chemical Engineering"**, 6th edn, Prentice Hall of India, New Delhi,1997


## MECHANICAL OPERATIONS

**Sub Code : 17CH34** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 04**

**COURSE OBJECTIVES:** The students will

1. Study different properties of particulate solids, handling and mixing of solid particles.
2. Study principles of comminution and different types of equipment for size reduction like crushers, grinders etc.
3. Understand mechanical separation aspect such as screening, filtration, sedimentation, transportation of solids etc.
4. Understand energy requirements in solids handling, agitation and mixing, solid conveying and storage.
5. Hands on experience of working by conducting experiments on some of the basic unit operations such as separation and size reduction.
6. Present seminar on current separation techniques and submit the report on the same.

| Module 1 | Content | Contact Hours | Blooms Taxonomy |
|---|---|---|---|
| **PARTICLE TECHNOLOGY:** Particle shape, particle size, different ways of expression of particle size, shape factor, sphericity, particle size analysis, screens – ideal and actual screens, Differential and cumulative size analysis, effectiveness of screen, Specific surface of a mixture of particles, Number of particles in a mixture, | | **10Hrs** | **L-1, L-2, L-3** |

| | | | |
|---|---|---|---|
| standard screens, Industrial screening equipment, Motion of screen, Grizzly, Gyratory screen, Vibrating screen, Trommels, sub sieve analysis - Air permeability | | | |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **SIZE REDUCTION:**<br>Introduction – types of forces used for comminution, Criteria for comminution, Characteristics of comminuted products, Laws of size reduction, Work Index, Energy utilization, methods of operating crushers – Free crushing, choke feeding, open circuit grinding, Closed circuit grinding, wet and dry grinding, Equipment for size reduction – Classification of size reduction equipment, equipment – Blake jaw crusher, Gyratory crusher, Smooth roll crusher, Toothed roll crusher, impactor, Attrition mill, Ball mill, Critical speed of ball mill, Ultra fine grinders, Fluid energy mill, colloid mill, Cutters – Knife cutter. | | **10Hrs** | **L-1, L-2, L-3** |
| **Module 3** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **FLOW OF FLUID PAST IMMERSED BODIES:**<br>Drag, Drag coefficient, Pressure drop – Kozeny-Carman equation, Blake-Plummer, Ergun equation, Fluidization, conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Applications of fluidization, Slurry transport, Pneumatic conveying. | | **5Hrs** | **L-1, L-2, L-3** |
| **MOTION OF PARTICLES THROUGH FLUIDS:**<br>Mechanics of particle motion, Equation for one dimensional motion of particles through a fluid in gravitational and centrifugal field, Terminal velocity, Drag coefficient, Motion of spherical particles in Stoke's region, Newton's region, and Intermediate region, Criterion for settling regime, Hindered settling, Modification of equation for hindered settling, Centrifugal separators, Cyclones and Hydro cyclones. | | **5Hrs** | **L-1, L-2, L-3** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **SEDIMENTATION:**<br>Batch settling test, Application of batch settling test to design of a continuous thickener, Coe and Clevenger theory, Kynch theory, thickener design, Determination of thickener area. | | **5Hrs** | **L-1, L-2, L-3** |
| **FILTRATION:**<br>Introduction, Classification of filtration, Cake filtration, Clarification, batch and continuous filtration, Pressure and vacuum filtration, Constant rate filtration and cake filtration, Characteristics of filter media, Industrial filters, Sand filter, Filter press, Leaf filter, Rotary drum filter, Horizontal belt filter, Bag filter, Centrifugal filtration – Suspended batch centrifuge, Filter aids, Application of filter aids, Principles of cake filtration, Modification of Kozeny – Carman for filtration. | | **5Hrs** | **L-1, L-2, L-3** |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **AGITATION AND MIXING:**<br>Application of agitation, Agitation equipment, Types of impellers – Propellers, Paddles and Turbines, Flow patterns in agitated vessels, Prevention of swirling, Standard turbine design, Power correlation and power calculation, Mixing of solids, Types of mixers – Change can mixers, Muller mixers, Mixing index, Ribbon blender, Internal screw mixer, Tumbling mixer. | | **4Hrs** | **L-1, L-2, L-3** |
| **SAMPLING, STORAGE AND CONVEYING OF SOLIDS:**<br>Sampling of solids, Storage of solids, Open and closed storage, Bulk and bin | | **3Hrs** | **L-1, L-2, L-3** |

| | | |
|---|---|---|
| storage, Conveyors – Belt conveyers, Chain conveyor, Apron conveyor, Bucket conveyor, Screw conveyor. | | |
| **MISCELLANEOUS SEPARATION:** Magnetic separation, Electrostatic separation, Jigging, Heavy media separation, Froth floatation process, Additives used during floatation, Floatation cells, Typical floatation circuits, Size enlargement (only principle and equipment) – Flocculation, Briquetting, Pelletization, Granulation. | **3Hrs** | **L-1, L-2, L-3** |

**COURSE OUTCOMES:** The students are expected to do the following

1. Classify and suggest different type of separation processes required for the feed material.
2. Suggest different types of size reduction methods such as crushing, grinding, milling depending on the type and size of the material.
3. Calculate the power requirements for different type of mechanical operations.
4. Select different type of conveying methods.
5. Hands on experience on various separation and size reduction experiments.

**GRADUATE ATTRIBUTES:**

- Problem analysis.
- Design/development of solutions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**


1. McCabe, W.L., *et.al.*,**"Unit Operations in Chemical Engineering"**, 5th edn., McGraw Hill International, Singapore, 2000
2. Badger W.L. and Banchero J.T., **"Introduction to Chemical Engineering"**, 3rd edn. Tata McGraw Hill International Edition, Singapore , 1999
3. Coulson J.H. and Richardson J.F., **"**Coulson and Richardson's **Chemical Engineering"**, Vol-II Particle Technology and Separation Process, 6th edn., Asian Books (p) Ltd., New Delhi, 1998


**REFERENCE BOOKS:**


1. Brown G.G., et.al., "Unit Operations", 1st edn., CBS Publisher, New Delhi, 1995
2. Foust A.S., et.al., "Principles of Unit Operations", 3rd edn., John Wiley and Sons, New York, 1997


## CHEMICAL TECHNOLOGY-I

**Sub Code : 17CH35** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 03**

**COURSE OBJECTIVES:**The students will

1. Understand industrial scale operations and processes employed at inorganic chemical industries.
2. Be exposed to various types of reactions and reactor types involved.
3. Understand various types of engineering problems encountered at these industries.
4. Be exposed to National importance and major plant locations of these industries.

5. Understand safety and environmental concerns of these industries.

**Note: Unit processes and unit operations involved, main/side reactions, raw materials / utility required, material and energy balances, flow sheet of the process, equipment used, major and minor engineering problems, uses, examples of such industries in India, reasons for their locations of the above industries are to be discussed.**

| **Module 1** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
|---|---|---|---|
| **Water and Air:**<br>**Water:**<br>Introduction, sources of water , impurities in water, soft water-hard water, causes of hardness, disadvantages of hard water, measurement of hardness, methods of softening of water, drinking water, purification of water, treatment of boiler feed water.<br>**Air:**<br>Introduction, constituents, compressed air, blower air, fan air, types of compressors, instrumental air. | | **10 Hrs** | **L-1, L-2, L-3** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **Industrial Gases and Acids:**<br>**Industrial Gases:** $CO_2$, $H_2$, $O_2$, $N_2$, $SO_2$, $SO_3$, Water Gas, Shift Gas**.**<br>**Industrial Acids:** Sulfuric, Nitric, Hydrochloric and Phosphoric Acids. | | **10 Hrs** | **L-1, L-2, L-3** |
| **Module 3** | **Content** | **Contact Hours** | **Blooms taxonomy** |
| **Chlor-alkali and Cement industries:**<br>**Alkali industries:** Sodium chloride, Soda ash, Caustic soda, Chlorine, Bleaching powder.<br>**Cement industries:** Classification, manufacture, reactions, flow diagrams, major and minor engineering problems, applications. | | **10 Hrs** | **L-1, L-2, L-3** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **Inorganic Fertilizers:** Ammonia, urea, ammonium phosphate, ammonium nitrate, ammonium sulphate, DAP, Potash fertilizers, phosphorous pentoxide, phosphatic fertilizers, super phosphate and triple super phosphate. | | **10 Hrs** | **L-1, L-2, L-3** |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **Miscellaneous Industries**: Paints, pigments, varnishes, enamel, lacquers, hydrogen peroxide, silicon carbide, glass. | | **10 Hrs** | **L-1, L-2, L-3** |

**COURSE OUTCOME:** At the end of the course, students are expected to

1. Understand the industrial activities at different inorganic industries.
2. Know the major and minor engineering problems in different industries.
3. Importance of these industries in National economy.
4. Understand the safety practices in these industries.

**GRADUATE ATTRIBUTES:**

- Problem analysis.
- Design/development of solutions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks

- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**

1. **Shreve's Chemical Process Industries,** 4th edn, McGraw Hill.
2. **Dryden – Outlines of Chemical Technology for 21stCentury,** Gopal Rao & Marshall Sittig, 3rd Edn., EWP.
3. **Unit Processes in Organic Chemical Industries**, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.

**REFERENCE BOOK:**

1. **Encyclopedia of Chemical Technology**, Kirk and Othmer, 27th volume, 5thEdn, Wiley, 2004.

## TECHNICAL CHEMISTRY

**Sub Code : 17CH36** **CIE Marks: 40**
**Hrs/Week : 03** **SEE Marks: 60**
**Total Hrs : 40** **Exam Hours: 03**
**Credits: 04**

**COURSE OBJECTIVES:** The students will

1. Study the basic of bond formation, Types ofbonding, Anti bonding.
2. Study of Colligative properties; determine the effects of solutes on boiling point, freezing point, and osmotic pressure and to calculate the molecular weight of the unknown solute using freezing point depression.
3. Study of isomerism nomenclature properties of isomers.
4. Study of Coordinate compounds.
5. Study of Heterocyclic compounds.
6. Study of reactions & mechanisms.

| **Module 1** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
|---|---|---|---|
| **BONDING: Atomic and Molecular orbital theory:** Theory of bonding, Types of bonds, Hydrogen bond with discussion on interaction between two atoms such as exchange of electron, screen effect of electrons, ionic character of H-OH bond. Anti bonding, Bond theory of metals, Theory of resonance, Structural stability, structure of carbonate ion and benzene, Importance of resonance compounds. | | **8 Hrs** | **L-1, L-2, L-3** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **COLLIGATIVE PROPERTIES:** Colligative properties - meaning and types, Lowering of vapor pressure - Raoult's law - statement, limitation, Determination of molecular weight by lowering of vapor pressure. Problems, Ostwald's and Walker's method, Elevation in boiling point of a solvent – derivation, Experimental determination of molecular weight by ebullioscopy method, problems, Isotonic solutions - abnormal molecular weight. Osmosis and osmotic pressure – explanation of the terms, effect of temperature and concentration | | **8 Hrs** | **L-1, L-2, L-3** |

| | | | |
|---|---|---|---|
| and simultaneous effect of both, Determination of molecular weight, Berkeley and Hartley's method. | | | |
| **Module 3** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **ISOMERISM:**<br>Definition, Types, Conformational isomerism in alkanes, free rotation about carbon- carbon single bond, conformation of ethane, propane n, butane , relative stability of different conformations. Optical isomers – Isomer number & tetrahedral carbon atom chirality, optical isomerism with one asymmetric carbon atom, Polarimeter, Specific rotation, Enantiomerism R & S Nomenclature. Geometrical isomerism – Definition, conditions for geometrical isomerism, cis-trans & E-Z nomenclature, physical & chemical properties of geometrical isomerism | | **4 Hrs** | **L-1, L-2, L-3** |
| **COORDINATION CHEMISTRY:**<br>Werner's theory, Nomenclature, effective atomic number, stability of complex ions, factors affecting the stability, stereochemistry of co-ordination compounds. Isomerism of co-ordination compounds. Importance of coordination compounds. | | **4 Hrs** | **L-1, L-2, L-3** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **HETEROCYCLIC COMPOUNDS**:<br>Nomenclature, Classification, Structure, Preparation, Properties & Reactions of Heterocyclic, Analogues of Cyclopropane, Cyclo butane Cyclopentadiene, Heterocyclic's one or more hetero atoms, Azetidenes, Furans, Pyratidine, Pyroles, diazines, Fused heterocyclics, Heterocyclics in Dyes, Medicines, Natural products | | **8 Hrs** | **L-1, L-2, L-3** |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **REACTIONS & MECHANISMS:**<br>Concept of Steady states, reactive intermediates, Carbanions, Carbocations, Inductive and resonance effects. Mechanism of nucleophilic substitution (SN1 and s2) in alkyl halides. Mechanism of elimination reactions (E1 and E2). Mechanism of electrophilic substitution in benzene, nitration, sulphonation, halogenation. Friedel-crafts alkyl and acylation reactions. Electronic interpretation of orienting influence of substituents in aromatic electrophilic of toluene, chlorobenzene, phenol and nitrobenzene. Solvents effects | | **8 Hrs** | **L-1, L-2, L-3** |

**COURSE OUTCOMES:** On successful completion of this course students will be able to

1. Explain the bond theory Resonance theory H-OH Bonds
2. Explain the effects of solutes on boiling point, freezing point, and osmotic pressure and to calculate the molecular weight of the unknown solute using freezing point depression.
3. Explain the structure and bonding of coordination compounds with proper reason of deviation, isomerism prevailing
4. Write reaction mechanisms in various types of reactions.

**GRADUATE ATTRIBUTES:**

- Problem analysis.
- Design/development of solutions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks

- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**

1. ArunBahl and Bahl B.S., **"A text book of Organic Chemistry"**, 15$^{th}$edn., Chand S. and Company, New Delhi, 1998
2. Morrison B.R. and Boyd L.L., **"Organic Chemistry"**, 6$^{th}$edn, ELBS, New Delhi, 1998
3. Tiwari Melhotra and Vishnoi, **"Organic Chemistry"**, 7$^{th}$edn., Chand S. and Company, New Delhi, 1996

**REFERENCE BOOKS:**

1. Puri L.R. and Sharma B.R., **"Physical Chemistry"**, 14$^{th}$edn., Chand S. and Company, New Delhi, 1998
2. James Huheey, **"Inorganic Chemistry"**, 19$^{th}$edn. Wiley Publishers, New Delhi, 1997
3. Dhone D. B., A Text Book of Plant Utilities, Nirali Publications.

## MOMENTUM TRANSFER LAB

**Sub Code : 17CHL37** **CIE Marks: 40**
**Hrs/Week : 1I + 2P** **SEE Marks: 60**
**Total Hrs : 42** **Exam Hours: 03**
**Credits: 02**

The experiments are to be conducted on the following topics,

1. Friction in circular pipes.
2. Friction in non-circular pipes.
3. Friction in helical/spiral coils.
4. Flow measurement using venturi/orifice meters (incompressible fluid).
5. Local velocity measurement using Pitot tube
6. Flow over notches
7. Hydraulic coefficients – open orifice
8. Packed bed
9. Fluidized bed
10. Study of characteristics for centrifugal , Positive displacement pump
11. Study of various pipe fittings and their equivalent lengths.
12. Compressible fluid flow
13. Reynolds apparatus.
14. Unsteady flows - Emptying of Tank

**Note: Minimum of 10 experiments are to be conducted.**

## TECHNICAL CHEMISTRY LAB

**Sub Code : 17CHL38** **CIE Marks: 40**
**Hrs/Week : 1I + 2P** **SEE Marks: 60**
**Total Hrs : 42** **Exam Hours: 03**
**Credits: 02**

Experiments are to be conducted on the following topics,

1. Critical Solution Temperature- Water – Phenol System
2. Distribution Coefficients - Iodine in Water Chloroform
3. Boiling Point Elevation -Water acetic acid solution
4. Estimation of dissolved oxygen in given sample of water by Winkler's method.
5. Estimation of Iodine & Saponification number of vegetable oil
6. Analysis of alloy- Stainless steel/ Brass
7. Analysis of Bleaching Powder -Available chlorine
8. Molecular weight determination -Victor Mayers Method
9. Freezing point depression- Ice-salt system
10. Refractometric Estimation - Sugar content of solution
11. Heats of mixing -Water –HCl system
12. Conductometric estimation- Water hardness estimation
13. Calorimetric Estimation – Potassium dichromate Estimation
14. Analysis of coal- Moisture Volatile matter & Ash content
15. Study of kinetics of reaction between $K_2S_2O_8$ and KI
16. Study of kinetics of hydrolysis of ester
17. Conductometric determination of equivalent conductance of acetic acid at infinite dilution (using Kohlrausch Law)
18. Estimation of phenol by iodometric method
19. Preparation of p-bromo acetanilide from acetanilide
20. Colorimetric estimation of fluoride in water using SPADNS reagent

**Minimum of 10 experiments are to be performed**

## KANNADA

**Sub Code : 17KL39/49** **CIE Marks:20**
**Hrs/Week : 01** **SEE Marks:30**
**Total Hrs : 16** **Exam Hours:**
**01Credits: 01**

[COMMON TO ALL BRANCHES]

# OR

**CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND HUMAN RIGHTS**

**Sub Code : 17CPH39/49** **CIE Marks:20**
**Hrs/Week : 01** **SEE Marks:30**
**Total Hrs : 16** **Exam Hours:**
**01Credits: 01**

[COMMON TO ALL BRANCHES]

**ENGINEERING MATHEMATICS – IV**

**Sub Code : 17MAT41** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 04**

**[COMMON TO ALL BRANCHES]**

**CHEMICAL TECHNOLOGY-II**

**Sub Code : 17CH42** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 03**

**COURSE OBJECTIVES:** Students will be able to

1. Understand the basic concepts of Industrial Processes practiced in different Organic Chemical Industries.
2. Get insight in to the safety and environmental management schemes practiced.
3. Assess different engineering problems of individual processes.

4. Understand the plant layout and equipment used in the processes.

| **Module 1** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
|---|---|---|---|
| **OILS, FATS, WAXES, SOAPS AND DETERGENTS:** Vegetable and animal oils and fats. Extraction of vegetable oils, refining of edible oils. Hydrogenation of oils, waxes and their applications. Soaps and detergents, theory of detergency. Miscellaneous concentrations. Manufacture of soaps and heavy duty detergents. Linear alkyl benzenes. | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **SUGAR, STARCH AND ALLIED INDUSTRIES:** Production of cane sugar. Chemistry of starch. Manufacturing of industrial starch and its applications.Fermentation industries: Production of alcohol, Manufacture of beer, wines and liquors. Acetic acid and citric acid by fermentation. | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 3** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **PETROLEUM INDUSTRIES AND PETROCHEMICALS:** Origin and classification. Petroleum refining and processing. LPG, CNG, LNG technologies, methane, propylene, benzenes. | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **COAL:** Formation and Classification of coal, mining of coal, destructive distillation of coal, coking of coal, coal tar distillation, chemicals from coal. **PULP AND PAPER INDUSTRIES:** Raw materials, manufacture of pulp, paper and structural boards. Effluent treatment appropriate for pulp and paper industries. | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **POLYMERS AND RUBBER:** Macromolecules. Polymerization. PVC, LDPE. Polypropylene. Cross-linked polymers. UF and MF. Natural rubber. Synthetic rubber and rubber compounding. | | **10Hrs** | **L-1, L-2, L-3,** |

**COURSE OUTCOMES:** The students are expected to understand

1. Different processes employed in industries for manufacture of various products.
2. Various equipment used.
3. Flow sheet and plant layout.
4. Material and energy balances.
5. Safety and environmental aspects.
6. Engineering problems of different processes.

**GRADUATE ATTRIBUTES:**

- Problem analysis.
- Design/development of solutions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**

1. **Shreve's Chemical Process Industries,** 4th edn, McGraw Hill.
2. **Dryden – Outlines of Chemical Technology for 21st Century,** Gopal Rao & Marshall Sittig, 3rd edn. EWP.
3. **Unit Processes in Organic Chemical Industries**, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.

**REFERENCE BOOK:**

1. **Encyclopedia of Chemical Technology**, Kirk and Othmer, 27th volume, 5th edn, Wiley, 2004.

## CHEMICAL ENGINEERING THERMODYNAMICS

**Sub Code : 17CH43** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 04**

**COURSE OBJECTIVES:** The students will

1. Learn fundamentals of thermodynamics such as types of properties, processes and laws of thermodynamics for flow and non flow process.
2. Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility and problem solving skills.
3. Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.
4. Study the estimation of partial molar properties, property changes of mixing, and ideal and non ideal solutions.
5. Learn the fundamentals of phase equilibrium, concept of chemical potential and generation and consistency check for VLE data.
6. Understand fundamentals of chemical reaction equilibrium to find feasibility and extent of conversion for the industrial reactions.

| **Module 1** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
|---|---|---|---|
| **BASIC CONCEPTS**:System, Surrounding and processes, Closed and Open systems, state and Properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase rule, Zeroth law of thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes.<br>**FIRST LAW OF THERMODYNAMICS:**General statement of First law of thermodynamics, First law for cyclic process and non-flow processes, Heat capacity.<br>**HEAT EFFECTS ACCOMPANYING CHEMICAL REACTIONS**:Standard heat of reaction, formation, combustion, Hess's law of constant heat summation, effect of temperature on standard heat of reaction. | | **10Hrs** | **L-1, L-2.** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **P-V-T BEHAVIOUR:**P-V-T behavior of pure fluids, Equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equation of state for real gases: vander Waals equation, Redlich – Kwong equation, Peng – Robinson equation, Virial equation, Compressibility charts: Principles of | | **10Hrs** | **L-1, L-2, L-3,** |

| | | | |
|---|---|---|---|
| corresponding states, generalized compressibility charts.<br>**SECOND LAW OF THERMODYNAMICS:**General statements of the Second law, Concept of Entropy, The Carnot Principle, calculation of entropy changes, Clausius Inequality, Entropy and Irreversibility, Third law of Thermodynamics. | | | |
| **Module 3** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **THERMODYNAMIC PROPERTIES OF PURE FLUIDS:** Reference Properties, Energy Properties, Derived Properties, Work function, Gibbs free energy, Relationships among thermodynamic properties, Exact differential equations, Fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Modified equations for U & H, Effect of temperature on U, H & S, Relationships between $C_P$& $C_V$, Gibbs-Helmholtz equation, Fugacity, Fugacity coefficient, Effect of temperature and pressure on Fugacity, Determination of Fugacity of pure gases, Fugacities of solids and liquids, Activity, Effect of temperature and pressure on activity, Thermodynamic diagrams | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **PROPERTIES OF SOLUTIONS:**<br>Partial molar properties, Chemical potential, Fugacity in solutions, Henry's law and dilute solutions, activity in solutions, Activity coefficients, Gibbs – Duhem's equation, Property changes of mixing, excess properties. | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **PHASE EQUILIBRIA**:Criteria of phase Equilibria, Criterion of stability, Duhem's theorem, Vapor – Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, VLE at low pressures, VLE at high pressures, consistency test for VLE data, Calculation of Activity coefficients using Gibbs – Duhem's equation.<br>**CHEMICAL REACTION EQUILIBRIUM**:Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, Pressure on equilibrium constants and other factors affecting equilibrium conversion, Liquid phase reactions, heterogeneous reaction equilibrium, phase rule for reacting systems. | | **10Hrs** | **L-1, L-2, L-3,** |

**COURSE OUTCOMES:** The students are expected to do the following

1. Calculate the heat and work requirements for the given flow or non-flow processes.
2. Analyze and find properties such as Pressure, Volume and temperature for equations of states and from the fundamentals of first law of thermodynamics.
2. Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
3. Differentiate between ideal and non-ideal solution and estimate partial molar properties.
4. Generate Vapor Liquid Equilibrium data for ideal and non-ideal solutions and check for their consistency by various methods.
5. Find the feasibility and extent of conversion for any reaction.

**GRADUATE ATTRIBUTES:**

1. Problem analysis.
2. Design/development of solutions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks

- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Note: Use of steam tables permitted in examination and internal assessment test.**

**TEXT BOOKS:**


1. Smith J.M. and Vanness H.C., "Introduction to Chemical Engineering Thermodynamics", 5th edn., McGraw Hill, New York, 1996
2. Rao Y.V.C., "Chemical Engineering Thermodynamics", New age International Publication, Nagpur, 2000


**REFERENCE BOOK:**


1. Narayanan K.V., "Text book of Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.


## MATERIAL SCIENCE

**Sub Code : 17CH44** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 04**

**COURSE OBJECTIVES:** The students will be able

1. Understand concepts on properties and selection of metals, ceramics, and polymers for design and manufacturing.
2. Study variety of engineering applications through knowledge of atomic structure, electronic structure, chemical bonding, crystal structure, X-rays and X-ray diffraction, defect structure.
3. Study Microstructure and structure-property relationships, Phase diagrams, heat treatment of steels.
4. Study detailed information on types of corrosion and its prevention.
5. Learn information on selection of materials for design and manufacturing.

| **Module 1** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
|---|---|---|---|
| **INTRODUCTION**: Introduction to material science, Classification of engineering materials, Level of structure, Structure property relationships in materials.<br>**CRYSTAL GEOMETRY AND STRUCTURE DETERMINATION**: Geometry of crystals – the Bravais lattices, Crystal directions and planes – the miller indices, Structure determination – X –Ray diffraction – Bragg law, The powder method.<br>**ATOMIC STRUCTURE, CHEMICAL BONDING AND STRUCTURE OF SOLIDS**: Structure of atom, Periodic table, Ionization potential, Electron affinity and Electro-negativity, Primary and secondary bonds, variation of bonding character and properties, Covalent solids, Metals and alloys, Ionic solids, structure of silica and silicates, Polymers. | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **CRYSTAL IMPERFECTIONS**: Point Imperfections, Line imperfections – | | **10Hrs** | **L-1, L-2,** |

| | | | |
|---|---|---|---|
| edge and screw dislocations, the Burgers vector, line energy of dislocations, Surface imperfections.<br>**PHASE DIAGRAM AND PHASE TRANSFORMATIONS**: Phase rule, Single component systems, Binary phase diagrams, Lever rule, Typical phase diagrams for Magnesia-Alumina, Copper – Zinc, iron – carbon systems, Nucleation and growth, Solidification, Allotropic transformation, Cooling curve for pure iron, Iron – Carbon equilibrium diagram, Isothermal transformations (TTT curves). | | | **L-3,** |
| **Module 3** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **DEFORMATION OF MATERIALS AND FRACTURE:**Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture.<br>**HEAT TREATMENT**:Annealing, normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening. | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **CORROSION AND ITS PREVENTION**:Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, factors influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings. | | **10Hrs** | **L-1, L-2, L-3,** |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **TYPICAL ENGINEERING MATERIALS**:Ferrous metals, Non ferrous metals and alloys – Aluminum and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Mechanical, electrical and thermal properties of ceramic phases, Refractories, Glasses, abrasives, Organic materials – Mechanism of polymerization, Additives to polymers, Plastics, fibres and elastomers, Organic protective coatings. | | **10Hrs** | **L-1, L-2, L-3,** |

**COURSE OUTCOMES:** The students are expected to do the following

1. Classify different types of engineering materials depending on structure property, crystal geometry and X-Ray diffraction.
2. Explain atomic structures, types of bonding and crystal imperfections.
3. Draw phase diagrams of different metals, TTT curves and explain deformation of materials.
4. Suggest different type of heat treatment techniques depending on the type of the material and they can analyze different types of corrosions and suggest preventive methods.
5. Select materials depending on type of application.

**GRADUATE ATTRIBUTES:**

1. Problem analysis.
2. Design/development of solutions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**

1. Raghavan V., "Materials Science and Engineering – A First Course", 3rd edn., Prentice Hall of India Pvt. Ltd., New Delhi, 1996
2. Hajra Choudhury S.K., "Materials Science and Processes", Indian book distributing Co., 1982

**REFERENCES:**

1. Van Vlack H.L., "Elements of Material Science", 2nd edn., Addison – Wesly Publishing Company, New York, 1964

## PROCESS HEAT TRANSFER

**Sub Code : 17CH45** **CIE Marks: 40**
**Hrs/Week : 04** **SEE Marks: 60**
**Total Hrs : 50** **Exam Hours: 03**
**Credits: 04**

**COURSE OBJECTIVES:** The students will

1. Study various modes of Heat transfer and their fundamental relations.
2. Study conduction heat transfer and develop mathematical relations for various solid geometries.
3. Understand properties of insulation and critical thickness of insulation.
4. Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
5. Study the Boiling phenomenon and to generate pool boiling curve.
4. Understand the working of Heat exchangers and to learn design of double pipe, shell and tube heat exchangers and design of evaporators and conduct experiments and to submit the report.
5. Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

| **Module 1** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
|---|---|---|---|
| **INTRODUCTION:**Various modes of heat transfer Viz. Conduction, Convection and Radiation.<br>**CONDUCTION:**Fourier's law, Steady state unidirectional heat flow through single and multiphase layers slabs, cylinders and spheres for constant and variable thermal conductivity.<br>**INSULATION:**Properties of insulation materials, Types of insulation, Critical and Optimum thickness. | | **10Hrs** | **L-1, L-2, L-3** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **EXTENDED SURFACES**:Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness, Elementary treatment of unsteady state heat conduction.<br>**CONVECTION**:Individual and overall heat transfer coefficient, LMTD, LMTD correction factor, Dimensionless numbers, Dimensional analysis, Empirical correlation for forced and natural convection. | | **10Hrs** | **L-1, L-2, L-3** |
| **Module 3** | **Content** | **Contact Hours** | **Blooms Taxonomy** |

| | | | |
|---|---|---|---|
| **ANALOGY:**Analogy between momentum and heat transfer- Reynolds, Colburn and Prandtl analogies.<br>**HEAT TRANSFER WITH PHASE CHANGE:**Boiling phenomena, Nucleate and Film boiling, Condensation - Film and Drop wise condensation, Nusselts equations.<br>**HEAT TRANSFER EQUIPMENT**:Double pipe heat exchangers, Shell and tube heat exchangers – Types of shell and tube heat exchangers, Construction details, Condenser, types of condensers. | | **10Hrs** | **L-1, L-2, L-3** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **DESIGN OF HEAT TRANSFER EQUIPMENT**:Elementary design of double pipe heat exchanger, shell and tube heat exchangers and condensers. Numerical Problems. | | **10Hrs** | **L-1, L-2, L-3** |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **EVAPORATORS**:Types of evaporators, performance of tubular evaporator – Evaporator capacity, Evaporator economy, Multiple effect evaporator – Methods of feeding, effect of liquid head and boiling point elevation, Vapor recompression evaporation.<br>**RADIATION:**Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation, Gray body radiation, Stefen – Boltzmann law, Wein's displacement law, Kirchhoff's law, View factors, Radiation between surfaces, Radiation involving gases and vapors, Radiation shields. | | **10Hrs** | **L-1, L-2, L-3,** |

**COURSE OUTCOMES:** The students will be able to do the following

1. Write all fundamental heat transfer relations.
2. Derive equations for the calculation of heat flux and estimation of intermediate temperatures in multilayer systems.
3. Calculate critical thickness of insulation requires for different geometry of solids.
4. Write different dimensionless numbers and explain their significance.
5. Estimate LMTD and heat transfer coefficients for different types of flows.
6. Design Shell and tube and double pipe heat exchanger, condensers and Evaporator.
7. Explain radiation in different type of solids and estimate emissivity.

**Note: Use of steam tables permitted in examination and internal assessment test.**

**GRADUATE ATTRIBUTES:**

- Problem analysis.
- Design/development of solutions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**


1. Kern D.Q., **"Process Heat Transfer"**, McGraw Hill., New York, 1965
2. McCabe W.L., et.al., **"Unit Operations of Chemical Engineering"**, $5^{th}$edn., McGraw Hill, New York, 2000

3. Coulson J.M. and Richardson J.F., **"Unit Operations of Chemical Engineering"**, Vol-I, 5th edn., Chemical Engg, Pergamon& ELBS, McGraw Hill, New York, 2000

**REFERENCES:**

1. Rao Y.V.C., "Heat Transfer", 1st edn. Universities Press (India) Ltd., New Delhi, 2001.

Dutta, Binay K., "Heat Transfer: Principles and Applications", PHI Learning. 2000

## INSTRUMENTAL ANALYSIS

**Sub Code : 17CH46** **CIE Marks: 40**
**Hrs/Week : 03** **SEE Marks: 60**
**Total Hrs : 40** **Exam Hours: 03**
**Credits: 04**

**COURSE OBJECTIVES:**The course is designed to impart the knowledge in the field of Instrumental Analysis. The various modern analytical techniques like UV-Visible, IR, NMR, Mass, GC, HPLC, different chromatographic methods and other important topics are taught to enable the students to understand and apply the principles involved in the determination of different bulk drugs and their formulation. In addition to the theoretical aspects, the basic practical knowledge relevant to the analysis is also imparted.

| **Module 1** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
|---|---|---|---|
| **CHROMATOGRAPHY:** Classification of chromatographic methods based on the mechanism of separation. Column Chromatography: Adsorption and partition, theory, preparation, procedure and methods of detection. Thin Layer Chromatography: Theory, preparation, procedures, detection of compounds. Paper Chromatography: Theory, different techniques employed, filter papers used, qualitative and quantitative detection .Counter – current extraction, solid phase extraction techniques, gel filtration | | **8 Hrs** | **L-1, L-2, L-3,** |
| **Module 2** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **GAS CHROMATOGRAPHY:** Introduction, fundamentals, instrumentation, columns: preparation and operation, detection, dramatization. . HPLC: Principles and instrumentation, solvents and columns, detection and applications, HPTLC: Theory and principle, instrumentation, elution techniques. | | **8 Hrs** | **L-1, L-2, L-3,** |
| **Module 3** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **SPECTROSCOPY**: Introduction, electromagnetic spectrum, absorbance laws and limitations, instrumentation-design and working principle, chromophore concept, auxochromes, Wood-Fisher rules for calculating absorption maximum, applications of UV-Visible spectroscopy . IR spectroscopy: Basic principles-Molecular vibrations, vibrational frequency, factors influencing vibrational frequencies, sampling techniques, instrumentation, interpretation of spectra, FT-IR, theory and applications. | | **8 Hrs** | **L-1, L-2, L-3,** |
| **Module 4** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **MASS SPECTROSCOPY:**Theory, ionization techniques: electron | | **8 Hrs** | **L-1, L-2, L-3,** |

| | | | |
|---|---|---|---|
| impact ionization, chemical ionization, field ionization, fast atom bombardment, plasma desorption, fragmentation process: types of fission, resolution, GC/MS, interpretation of spectra and applications for identification and structure determination. | | | |
| **Module 5** | **Content** | **Contact Hours** | **Blooms Taxonomy** |
| **NMR:** Theory, instrumentation, chemical shift, shielding and de-shielding effects, splitting of signals, spin-spin coupling, proton exchange reactions, coupling constant (J), nuclear over Hauser effect (NOE), 13CNMR spectra and its applications, 2D-NMR, COSY and applications | | **8 Hrs** | **L-1, L-2, L-3,** |

**COURSE OUTCOME**: The appreciable knowledge will be gained by the students in the Modern Analytical Techniques and can apply the theories involved in the Analysis of various bulk drugs and their formulations. The students will also be in a position to apply their knowledge in developing the new methods for the determination and validate the procedures.

**GRADUATE ATTRIBUTES:**

1. Problem analysis.
2. Design/development of solutions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS**

1. Instrumental Methods of Chemical Analysis by B.K Sharma
2. Organic Spectroscopy by Y.R Sharma

**REFERENCE BOOKS:**

1. Text book of Quantitative Chemical Analysis by Vogel's A.I.
2. Organic Spectroscopy by William Kemp

## CHEMICAL ENGINEERING DRAWING LAB

**Sub Code : 17CHL47** **CIE Marks: 40**
**Hrs/Week : 1I + 2P** **SEE Marks: 60**
**Total Hrs : 42** **Exam Hours: 03**
**Credits: 02**

| | **Content** | **Contact Hours** | **Blooms taxonomy** |
|---|---|---|---|
| **SECTIONAL VIEWS**:<br>Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views. | | **02Hrs** | |

| | Content | Contact Hours | Blooms taxonomy |
|---|---|---|---|
| **PROPRTIONATE DRAWINGS**<br>Equipment and piping symbols, Vessels components: Vessel openings, Manholes, Vessel enclosures, Vessel support, Jackets, Shell and tube heat exchanger, Reaction vessel and different types of Evaporators. P & I Diagrams | | **20Hrs** | |
| | **Content** | **Contact Hours** | **Blooms taxonomy** |
| **ASSEMBLY DRAWINGS:**<br>**Joints:** Cotter joint with sleeve, Socket and Spigot joint, Flanged pipe joint, Union joint, Stuffing box and Expansion joint (Screw type or flanged type) | | **20Hrs** | |

**Note:**

1. Assignments to be given to students to practice all the drawings and weightage shall be given to these assignments while awarding IA marks.
2. Minimum of Ten drawings are to be conducted.
3. Examination consists of one question on proportionate drawing (30 marks) and one question on Assembly drawing (70 marks).
4. **Examination to be conducted like other lab exams. Question paper should be prepared jointly by Internal and External examiners.**
5. Computer Aided drawing Software: Solid Edge or Equivalent Software.

**TEXT BOOKS:**


1. Gopal Krishna K.R., "Machine Drawing", 2nd revised edn., Sudhas stores, Bangalore, 1998
2. Bhat N.D., "Machine Drawing", 22ndedn., Charoter Publishing House, Anand, 1987
3. Joshi M.V., "Process Equipment Design", 3rdedn., Macmillan India publication", New Delhi, 1999


**REFERENCE BOOKS:**


1. Walas S.M., "Chemical Process Equipment", Butterworth Heinemann Pub., 1999
2. Ludwig E.E., "Applied Process Design", 3rdedn., Gulf Professional Publishing, New Delhi, 1994


## MECHANICAL OPEARATIONS LAB

**Sub Code : 17CHL48** **CIE Marks: 40**
**Hrs/Week : 1I + 2P** **SEE Marks: 60**
**Total Hrs : 42** **Exam Hours: 03**
**Credits: 02**

Experiments based on the following topics,

1. Ball mill
2. Batch sedimentation
3. Free settling
4. Drop weight crusher
5. Screen effectiveness
6. Sieve analysis
7. Jaw crusher

8. Leaf filter
9. Air elutriation
10. Air permeability
11. Grindability index
12. Gyratory crusher
13. Froth floatation
14. Plate and frame filter press
15. Cyclone separator

**Minimum of 10 experiments are to be conducted**

**KANNADA**

**Sub Code : 17KL39/49** **CIE Marks:20**
**Hrs/Week : 01** **SEE Marks:30**
**Total Hrs : 16** **Exam Hours:**
**01Credits: 01**

[COMMON TO ALL BRANCHES]

# OR

**CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND HUMAN RIGHTS**

**Sub Code : 17CPH39/49** **CIE Marks:20**
**Hrs/Week : 01** **SEE Marks:30**
**Total Hrs : 16** **Exam Hours:**
**01Credits: 01**

[COMMON TO ALL BRANCHES]

# CHOICE BASED CREDIT SYSTEM (CBCS)

**SEMESTER V**

| PROCESS INDUSTRY MANAGEMENT (Common to CH & PC) | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH51** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:** The students will be able to

1. Understand the roles of managers and historical evolution of various approaches to the study of management.
2. Demonstrate the process of planning which can be used as a tool for decision-making in organizations.
3. Create logical relationships between various organizational structures and designs.
4. Implement leadership practices towards the management and development of people within organizations.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Organization and Management:**Forms of Business Organization, Basic concepts of management-classification, characteristics, objectives, Functions of management-planning, organizing, staffing, directing, Organization Structure-linear, functional, line and staff, staff and functional, Management by objectives, Management information system. | 10 | L1, L2 |
| **Module 2** **Content** | | |
| **Personnel (Human Resource) Management:** Acquisition of manpower-functions and objectives of personnel management, manpower planning, Job analysis and evaluation, Induction, Orientation, Training and development, Maintenance of human resource. Industrial relations, Trade Unionism. | 10 | L1, L2 |
| **Module 3** **Content** | | |
| **Entrepreneurship and Project Management:** Entrepreneurship- Types, Growth, functions, qualities, Project Planning-project implementation, monitoring and control, evaluation strategies, Gantt charts, Critical path method, Performance evaluation and review technique, application of network techniques. | 10 | L2, L3, L4 |
| **Module 4** **Content** | | |
| **Operation Research:** Introduction, phases, scope, methodology, O R Models, techniques, applications of O R, Linear Programming, graphic method, simplex method, waiting line theory, game theory, Monte Carlo technique. Dynamic programming. | 10 | L2, L3. |
| **Module 5** **Content** | | |
| **Materials Management:** Purchasing, make or buy decision, stores management, inventory control, spare parts management, value engineering.<br>**Marketing:** Marketing research, marketing management, consumer behavior and market promotion. | 10 | L1, L2 |

**Course outcomes: Students after completion of course are expected to**

1. Understand the principles of management theory &recognize the characteristics of an organization.
2. Demonstrate the importance of key performance areas in strategic management & decision-making process.
3. Design appropriate organizational structures and possess an ability to conceive organizational dynamics.
4. Evaluate attitudes and personality traits for inter personal effectiveness and development within organizations.
5. 5. Implement the right leadership practices in organizations that would enable systems orientation.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools

4.Life - long Learning

**TEXT BOOKS:**

1. T R Banga S C Sharma Industrial Organization and Engineering Economics Khanna Publications 24th Edition ISBN No. 81-7409-078-9
2. Dr. Vilas Kulkarni &HardikBavishiEngineering Economics & Management:Vikas Publishing

**REFERENCE BOOKS:**

1. Stephen Robbins, Mary Coulter &Neharika Vohra, Management, Pearson Education Publications, 10th edn, ISBN: 978-81-317-2720-1.
2. James Stoner, Edward Freeman & Daniel Gilbert Jr, Management, PHI, 6th Edition, ISBN: 81-203-0981-2.

| MASS TRANSFER OPERATIONS-I (Common to CH & PC) | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH52** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:**

The students will

1. Be able to formulate equations for estimation of diffusivities in fluids & solids using first principles of engineering sciences.
2. Be able to apply mass transfer fundamentals to calculate mass transfer rates and design the mass transfer equipment.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Bloom s Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| Typesof diffusionin fluids.Typesofdiffusionin solid.Measurementand calculationsofdiffusivities. Masstransfercoefficientsandtheircorrelations.TheoriesofmassTransfer. Interphasemasstransfer. M**a**terialbalanceforco-current,cross-currentandcounter-current operations.Conceptofstages,cascadesoperation,NTUandHTU concepts. | 10 | L1,L2, L3 |
| **Module 2** **Content** | | |
| **Humidification:** General theory, Psychrometricchart. Concepts in humidification, dehumidification.Designofcoolingtowers. | 10 | L2,L3, L4 |
| **Module 3** **Content** | | |
| **Drying:**Introduction,Equilibria,Dryingratecurves.Mechanismofdrying,typesofdryers. Designofbatch andcontinuousdryers. | 10 | L3,L4, L5 |
| **Module 4** **Content** | | |
| **Adsorption:**Theoriesofadsorption.Isotherms,Industrialadsorbents.Equipment,Batch&continuousmultistageadsorption. | 10 | L4,L5, L6 |
| **Module 5** **Content** | | |
| **Crystallization:**Factorsgoverningnucleationandcrystalgrowthrates.Controlledgrowthof crystals.Incorporationofprinciplesintodesignofequipment.Differenttypesofcrystallizer equipment. **IntroductiontoNovelSeparations:**Ionexchange**,**Membraneprocesses-ReverseOsmosis, Dialysis,UltraandMicro-filtrations,Super-criticalfluidextraction.(Workingprincipleand operationsonly) | 10 | L2,L3, L4 |

**Course outcomes:**

After studying this course, students will be able to:

1. Estimate mass transfer co-efficients and provide valid conclusions on suitability of the operation.
2. Apply the analogies in transport processes for validating and reaching substantiated conclusions.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**

1. **MassTransferOperations**-RobertE Treybal,3rdedn,McGrawHill,1981.
2. **UnitOperationsof ChemicalEngineering**-McCabe&Smith,6thedn,McGrawHill, 2001.

**REFERENCE BOOKS:**

1.**Chemical Engineering VolI, II, IV and V** - Coulson and Richardson, 4thedn,PergamonPress,1998.
2. **IntroductiontoChemicalEngineering**-Badger&Banchero,TMH6thReprint1998.
3. **Principlesof UnitOperations**-Foust*et.al.*,2ndedn,JohnWiley,1994.
4. **TransportProcessesandUnitOperations**-GeankoplisCJ,PrenticeHall(I),2000.
5. **AppliedProcessDesignforChemicalandPetrochemicalPlant**Ludwig,2ndedn,Gulf Publishing,2002.

| **CHEMICAL REACTION ENGINEERING-I (Common to CH & PC)** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH53** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:**

The students will be able to

1. Analyze and interpret the data to determine rate equation and estimate the performance equation of ideal systems.
2. Formulate and analyze the rate equations for various reactions using suitable mechanisms.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Introduction:** ScopeofChemicalReactionEngineering.Classificationofreactions.Rate equationandrateofreaction.Factorsaffecting rateofreaction.Chemicalkineticsand ThermodynamicsEquilibrium.Temperaturedependency ofrateconstantfromArrhenius, CollisionandTransitionstatetheories.Molecularityandorderofreaction. **Non-ElementaryReactions:**Differencebetweenelementaryandnon-elementaryreactions. Kineticmodelsandmechanismsfornon-elementaryreactions.Typesofreactors. | | 10 | L1,L2,L3 |
| **Module 2** | **Content** | | |
| **HomogeneousReactions:**Interpretationofbatchreactordata.Constant&Variable Volume batchreactor.Analysis:Differentialmethod,Integralmethod,half-lifemethod.Methodof excessandmethodofisolation(ForReversibleandIrreversible | | 10 | L2,L3,L4 |

| | | | |
|---|---|---|---|
| reactionsuptosecondorder). Autocatalyticreactions. | | | |
| **Module 3** | **Content** | | |
| **DesignofIdealReactors:**Conceptofideality.Developmentofdesignequationsforbatch, tubularandstirredtankreactorsforbothconstantandvariablevolumereactions.Evaluationof rateequationsfromdataobtainedinthesereactors. Numerical Problems. | | 10 | L3,L4,L5 |
| **Module 4** | **Content** | | |
| **ComparisonofIdeal Reactors:**Generalgraphicalcomparison. **MultipleReactorSystems:**Plugflowand/orMixedflowreactorsinSeries,parallelandseries parallel.Reactorsofdifferenttypesandsizesinseries. **DesignofReactorsforMultipleReactions:**DesignofBatchreactor,PlugandMixedflow reactorsforParallel,SeriesandSeries-Parallelreactions(Onlyirreversiblereactionsmustbe considered). | | 10 | L4,L5,L6 |
| **Module 5** | **Content** | | |
| **Non-IsothermalReactors:** Introduction,effectoftemperatureonequilibrium constant andheat ofreaction,MaterialandEnergybalances,conversionsinadiabaticandnon-adiabaticreactors. **AnalysisofNonIsothermalReactor:**Designprocedure (Forsingle/simplereactionsonly). OptimumtemperatureProgression. | | 10 | L3,L4,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge for interpretation of experimental data.
2. Acquire practical knowledge of reactors.
3. Know the use of reactors, problems associated and modifications.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**

1.**ChemicalReactionEngineering,**OctaveLevenspiel,3rd edn,JohnWiley&Sons,2001.
2. **ElementsofChemicalReactionEngineering,**H.ScottFogler,3rdedn,Prentice Hall 2001.

**REFERENCE BOOKS:**

1. **ChemicalEngineeringKinetics,**J.M.Smith,3rdedn,McGrawHill,1984.

| CHEMICAL EQUIPMENT DESIGN (Common to CH & PC) | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH54** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

Course Objectives:
Students will

1. Understand types in the design of Chemical equipment and its accessories.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Introduction**: Basic considerations in design. General design procedure. Equipment classification. Variouscomponents ofprocess equipment.Designparameters.Pressure vessel codes. **DesignConsiderations**:Materialselection.Factorsaffectingdesign.Stressesduetostatica nddynamicloads(Internal&External).Temperatureeffects.Economicconsiderations. **DesignofPressureVessels:**Designparameters,conditions&stresses.Designofshell,andot hervesselcomponents.Vesselatlow&highoperating temperatures.Designproblemsusing givenprocessparameters. | | 10 | L1, L2, L3 |
| **Module 2** | **Content** | | |
| **VesselComponentDesign:**Designofsupportsforvessels-Bracket,Leg,Saddleand Skirtsupports. Designofflanges&nozzles,Classificationofflanges.Flangethickness calculation,Gasketselection,Boltselection,NozzleSelection. Design ofvesselclosures-Flatplates,Formedheads,Elliptical&Hemisphericalheads. | | 10 | L2, L3, L5 |
| **Module 3** | **Content** | | |
| **StorageVessels:**Processconditionsanddesignparametersforstorageofvolatile,non-volatilefluids&gases.Designofcylindricaltankswithfixedroofs.Designofpartially filledspherical tanks.Designofcomponents, supports andselectionofvesselsaccessories&mountings. Numericalproblems. | | 10 | L2, L3, L5 |
| **Module 4** | **Content** | | |
| **ReactionVessels:**Designof reactiontanks withagitationand jacket. Types of agitators,baffles. Powerrequirementcalculations.Designoftankdimensions andagitation systemcomponents. Drivecalculations&selectionofaccessories.Designofjackets.Support calculationsforthe system.Numericalproblems. | | 10 | L1, L2, L3, L4 |
| **Module 5** | **Content** | | |
| **Tall Vertical Vessels:** Vessels subjected to various loads, Multi shell constructions. Determinationofshellthickness.Supportsforcolumns. **Pipe LineDesign:**Pipeline sizing,Condensateandsteam pipedesign,optimumsize of deliverylineinpumpingoperations. | | 10 | L3, L4, L6 |

**Course outcomes:**
After studying this course, students will be able to:

1. Summarize on advances in process engineering design of many process equipment relating to heat and mass transfer.
2. Will handle process parameters toalter and design process Equipments.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning
5. Collaborative and multidisciplinary work

**TEXT BOOKS:**

1. **ProcessEquipmentDesign-**M.V.Joshi,3rd edn.,Macmillan&Co. India,Delhi, 1998.
2. **ProcessEquipmentDesign–VesselDesign,**Brownell&Young,JohnWilley,1959.
3. **Process Design of Equipment – Vol 1,** S. D. Dawande, 3rd edn, Central Techno Publications.2003.

**REFERENCE BOOKS:**

1. **ChemicalEngineersHandbook,**Perry&Green,7th edn,McGrawHill,1997.
2. **PressureVesselCode–IS2825,**ISCode,B.I.S.,NewDelhi,1969.
3. **Flowof FluidsthroughValves,Fittings&Pipes**,CraneAmazon,2006.

**Profession Elective-I**

| **OILS AND FATS TECHNOLOGY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH551** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will be able to

1. Understand Structure of fats and oils, Sources and classification of fats and oils, Chemical and physical characteristics.
2. Know its importance in industry and nutrition.
3. Process of fats and oils, Pre-extraction operations, extraction/processing, filtering and refining. Quality and nutritive values of processed products.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |

| | | | |
|---|---|---|---|
| **Introduction:**Classificationoffatsandoil.Characteristicofoils. Utilizationoffatandoils. Compositionofoils(general). **Obtaining Oils and Fats from Source Materials:** Mechanical pretreatment. Mechanicalexpression.Solventextraction(twotypesofextractors). | | 8 | L1, L2, L3 |
| **Module 2** | **Content** | | |
| **ProcessTechniques:**Refiningandhydrogenation($H_2$productionandcatalyst). **ProcessTechniques(contd.):**Degumming.Alkalirefiningandbleaching. | | 8 | L2, L3, L4 |
| **Module 3** | **Content** | | |
| **Deodorization:**Theoreticalconsiderationandoperationofcommercialdeodorizer. **Vegetable Oils:** Composition. Extraction. Refining processes and uses of coconut oil, cottonseedoil. | | 8 | L2, L5, L6 |
| **Module 4** | **Content** | | |
| **Vegetable Oils:** Composition. Extraction. Refining processes and uses of coconut oil, cottonseedoil. **VegetableOils:**Refiningprocessesandusesofpalmoil,Soyabeanoil,peanutoil,sunfloweroil. | | 8 | L3, L4, L6 |
| **Module 5** | **Content** | | |
| **MarineOils:**Composition.Extraction.Refiningprocessesandusesoffishoils. | | 8 | L3, L4, L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Work on isolation and purification of fats and oils.
2. Develop new skills in fat and oil products development.
3. Experiment on physical and chemical changes occurring in fat and oil products.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**

1. **Bailey's IndustrialOilandFatProducts–VolItoV,**Y.H.HeryJohnWileyInternational, 2nd edn,1976.

**REFERENCE BOOKS:**

1. **ChemistryandTechnologyof Oil and Fats,**DevineJandWilliamsP.N,1961.
2. **Chemical process Industries,** Austin G. T., Shreve's 5th edn, McGraw-Hill internationalBookCompany,Singapore,1984.
3. **OutlinesofChemicalTechnology,**Dryden C.E.,Edited by GopalaRao.MandM.Sittig, 2nd edn, AffiliatedEastWestPress,1993.
4. **HandBookofIndustrialChemistry**,KentJ.A(Ed) Riegel'sVanNostrandReinhold, 1974.

| PETROLEUM REFINERY ENGINEERING | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH552** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will able to

1. Understand history, classification of petroleum crudes.
2. Understand the extraction and production of oil and gas to meet energy needs, as well as refining of crude oil for a widespectrum of useful products such as petrochemicals, Chemicals, Plastics.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Indian Petroleum Industry**: Prospects &Future. Major companies. World production, Markets,Offshoreandonshore,Oilwelltechnology. **Compositionof Crude:**Classification.Evaluationofpetroleum.UOP-kfactor.TBP analysis. EFVanalysis.Averageboilingpoint.ASTMcurves.Thermalpropertiesof petroleumfractions. **ProductPropertiesandTestMethods:**Gas.VarioustypesofgasandLPG.Reidvapor pressureanalysis.Gasoline andnaptha.OctaneNo.Oxidation stability.Additives forgasoline. Kerosene.Characterizationforflashpointorfirepoint,volatility,burning qualitiesetc,Diesel, octanetesting,viscosity etc.Gradesofdieselse.g.HSD,LDO.Dieseladditives.Lubeoils:Types,tests-carbonresidueandviscosityindex. | 8 | L1, L2, L3 |
| **Module 2** **Content** | | |
| **CrudePretreatment:**Pumpingof crude oils. Dehydrationof crude bychemical, gravity, centrifugal,electricalde-salterandcomparisonofeach.Heatingofcrude-heater, different typesofpipestillheatersincluding boxtype,cylindricaletc.Crudedistillation,arrangementof towersforvarioustypesofreflux.Designaspectsforatmospheric andvacuumcolumn. Atmosphericdistillationdistillationunit:internalsandoperational. | 8 | L1, L2, L3 |
| **Module 3** **Content** | | |
| **TreatmentTechniques:**Typesofimpuritiespresentandvariousdesulfurisationprocesses. ProductionandtreatmentofLPG.LNGtechnology.Sweetening operationsforgasesincluding merox,ethanolamine,copperchloride,stertfordetc.Catalyticdesulphonisation. Treatmentof kerosene, De-aromatisation and merox. Treatment of diesel, naptha: desulpurisation by hydrogenandcatalysts.Treatmentoflubes:sulphuricacid,clay treatment,solventtreatment- phenol,furfural. | 8 | L2, L3, L4 |
| **Module 4** **Content** | | |
| **ThermalProcesses:**Thermalcrackingreactions-theoryofthermalcracking.Propertiesof crackedmaterials | 8 | L2, L3, L4 |

| | | | |
|---|---|---|---|
| andfactorsinfluencingthe propertiesof crackedmaterials.Visbreaking, dubbstwocoil crackingprocess.<br>**Catalytic Reforming:** Theory of reforming. Factors influencing reforming, reforming catalysts,feedstockrequirements.Plat-forming,hondi forming,flexiformingetc. | | | |
| **Module 5** | **Content** | | |
| **CatalyticCracking:**Comparisonofthermalandcatalyticcracking.Carboniumionchemistry.<br>Feedbackrequirements.Crackingconditions.Commercialcrackinganalysis.Variouscatalytic crackingprocesses.Fixedbedcrackers.Moving bedcrackers.Fluidcatalyticcracking-flexi cracking-ortho-flow reactor.Theoryofcoking:varioustypesofcokingprocesses.Delayed coking,fluid coking,contactcoking,flexicoking. Napthacracking,naptha crackingfor ethylene asfeedselectionandgasyield.Hydrocracking.Theory ofhydrocracking.Catalystsforhydro cracking. | | 8 | L2, L4, L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Introduce the petroleum refinery sector worldwide.
2. Develop knowledge of different refining processes
3. Develop knowledge of safety and pollution control in the refining industries.
4. To find the suitable refining technology for maximizing the yield.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**

1. **PetroleumRefineryEngineering**,Nelson,4th ednMcGrawHill,14thReprint,1982.
2. **Modern Petroleum Refining Processes,** Bhaskara Rao, 3rd edn, Oxford &IBH Publication,Reprint,1999.

**REFERENCE BOOKS:**

1. **PetroleumRefiningTechnology,**Ram Prasad,1st edn,KhannaPublishers,2000.
2. **Challengesin CrudeOil Evaluation,**NagnalJ.M.,Gate,McGrawHill, 1996.
3. **PetroleumProcessing,**BlandW.F.and DavidsonR.L.McGrawHill,1967.

| **PHARMACEUTICAL TECHNOLOGY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH553** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |

| Credits | : | 03 |
|---|---|---|

**Course Objectives:**

Students will

1. Learn formulations, tablet and capsule making.
2. Learn development, testing of cosmetics.
3. Learn manufacturing technology.
4. Learn patent intellectual property rights and regulatory affairs.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| Modules | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **ElectrophilicSubstitutionReaction:**Preparationofcycloalkane.Bayer'sstraintheoryand orbitalpictureofanglestream. **ElectrophilicSubstitutionReactionMechanism&Application**:Dehydrogenationofalkylhalides. 1-2 elimination kinetics: E2 and E1mechanisms. Isotope effect. Dehydration of alcohols.Easeofdehydration. | 8 | L1, L2, L3 |
| **Module 2** **Content** | | |
| **Nucleophilic Addition Reaction:** Mechanism. Important chemicals.Oxidation-Reductionreactions. Rheologyof FluidsinMixingand Blending. | 8 | L2, L3, L4 |
| **Module 3** **Content** | | |
| **Preparation:**TestforpurityandmedicalusesofChlorobutal,Dimercopral,Glycerolt rinitrate. | 8 | L3, L4, L5 |
| **Module 4** **Content** | | |
| **Preparation:**TestforpurityandmedicalusesofUrea,ethylenediaminedihydrate,vanillin, paraldehyde. **Preparation:**Testforpurityandmedicalusesoflacticacid,citricacid,salicylicacid,saccharinsodium | 8 | L3, L4, L6 |
| **Module 5** **Content** | | |
| **Preparation:**Test forpurityandmedicalusesof Ethylborate,dimethylphthalate,aspirin. | 8 | L4, L5, L6 |

**Course outcomes:**

After studying this course, students will be able to:

1. Explain various formulations and formulate tablet and capsule.
2. Develop manufacturing technologies and apply for various cases.
3. Practice industrial safety and involve in patent intellectual property rights and regulatory affairs.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Research skill
5. Life-long learning

**TEXT BOOKS:**


1. **OrganicChemistry,**T.R.MorissonandR.Boyd,6th edn,PrenticeHallofIndiaPvtLtd.,NewDelhi,1992.
2. **The Theory and Practice of Industrial Pharmacy,** Liberman, and Lachman, 3rd edn, Lea & Febiger, Philedelphia, 1986.
3. **Pharmaceutical Product Development,** Jain N.K, CBS Publications and Distributions, New Delhi, 2006.


**REFERENCE BOOKS:**


1. **OrganicChemistryFundamentals,**I.L.Finar,2nd edn,ELBS,PergamonPress,1965.
2. **Good Manufacturing of Pharmaceuticals,** Sidnay H. Willing, Murray M. Tuckerman, and Williams Hitchings, 3rd edn, Marcell Dekker Inc., NY, 1982.


| **POLYMER TECHNOLOGY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH554** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Able to understand broad and fundamental knowledge of the polymers and their chemical, physical and mechanical behavior.
2. Able to emphasize the processing techniques, along with the production of polymers and correlate structureprocessingproperties relationships for polymers and blends.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **PrinciplesofProcessingofPolymers:**Meltprocessing ofthermoplastics.Classificationof processes.Thermosetplasticsprocessing,crystallization,orientation &shrinkage, copolymers blendings,compounding forengineeringapplication,stress–strainbehavior,WLFequation, practicalassessmentforlongtermbehavior. | | 8 | L1,L2, L3 |
| **Module 2** | **Content** | | |
| **PolymerExtrusion**:RequirementsofPolymerforextrusion.Singlescrewanddoublescrewplasticatingextruderzonesinextrusion, breakerplates,extruderscrew,powercalculation.PVC extruder.Dieandcalibrationequipmentprimemoverforextrusion, coextrusion, extrusion coating,extrusionfilmblowing reactiveextrusion.ExtrusionblowmouldingforPETbottles, wiredrawing-PVC, spinning–varioustypesandapplications.Applicationofvariousextruded | | 8 | L2,L3, L5 |

| | | | |
|---|---|---|---|
| products.Rheologicalaspectsofextrusionandextrusiondefects.Operationalandmaintenance ofextrusionequipment,pultrusion. | | | |
| **Module 3** | **Content** | | |
| **Injection Moulding**: Polymer characteristics for injection moulding. Reciprocating screwinjectionmoulding.Singleimpressionmould.Multiimpressionmoulds.Coolingrequirements inmoulds.Hotrunner moulds,gate,mouldclampingforce calculations. Controlofpressure, temperatureandtimeofinjectionthermostatandfiberreinforced polymerinjectionmoulding, sandwichmoulding andinjectionblowmoulding. Rheologicalaspectsanddefectsofinjection. Comparisonofinjectionmouldingandextrusion ofinjection.Operationalandmaintenanceof injectionmouldingequipment.Reactioninjectionmoulding.Applications. | | 8 | L2,L3, L4 |
| **Module 4** | **Content** | | |
| **Compression Moulding:** Applications. Principles. Comparison with other processing methods.Derivationofcompressionmouldthicknessorcompactionforce.Transfer moulding. **Calendering**: Characteristics of polymer for calendering. Principles and operation of calendaring.Derivationoffilmthickness andpressurerequiredforrollers.Guagecontrolduring calendaring.ApplicationofPVCcalenderedproducts. | | 8 | L3,L4, L5 |
| **Module 5** | **Content** | | |
| **Thermoforming:** Basic principles. Vacuum forming. Pressure forming. Description ofoperations.Productdesign.Application.Derivationofthermoformedproductthickness. **RotationalMoulding:**Principles.Operation&applications.Thickness.Coolingcalculations. **TestingofPlastics:**Thermal,electrical,optical,mechanicalpropertiestesting. | | 8 | L2,L4, L5, L6 |

**Course outcomes:**

After studying this course, students will be able to:

1. Explain the techniques and their characteristics /limitations of synthesis of polymers.
2. Explain the structure property relationship of polymers and apply the various processing and manufacturing techniques.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Research Skill
5. Life-long learning

**TEXT BOOKS:**

1. **Principlesof PolymerProcessing,**MortonJohneschapman,Hall1989.
2. **PlasticEngineering,**R.J.Crawford,3rd edn,ResearchStudies,1996.

**REFERENCE BOOKS:**

1. **Principlesof PolymerEngineering,**N.G.McCrum,Vol.1,C.P.BuckleyOxfordUniversity Press,1988.
2. **PolymerMaterials–**Vols.1, 2&3,ManasChanda,Springer,UnivPress,1997.

**Open Elective-I**

| **PROCESS WASTE WATER MANAGEMENT** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH561** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Understand the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic, industrial or commercial activities prior to its release into the environment or its re-use.
2. Understand various terms used in industrial wastewater treatment and to acquaint with different steps involved in treatment of industrial wastewater.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| Effects of Industrial Wastes on sewerage system and sewage treatment plants and receiving water bodies. Effects of waste additions on physical and chemical properties of soil.<br>Effluent standards and receiving water quality standards. Different aspects and choices of various disposal alternatives. | 8 | L1, L2, L3 |
| **Module 2** **Content** | | |
| Industrial Wastes survey-Process flow charts, condition of waste stream. Material balance, Sampling – Grab, Composite and integrated samples. Continuous monitoring – pH, Conductivity, Bio monitoring. | 8 | L2, L3, L4 |
| **Module 3** **Content** | | |
| Pretreatment of Industrial Wastewater – Volume reduction, Strength reduction, Neutralization, Equalization and Proportion, Removal of Organic and inorganic dissolved solids. Wastewater Treatment in specific industries: Distillery, Sugar, Pulp and paper, Cement, Textile, Dairy, Fertilizer, Pesticides, Pharmaceutical. | 8 | L2, L3, L4 |
| **Module 4** **Content** | | |
| Design of complete treatment systems & disposal for industries: Distillery, diary, textile, paper and pulp mill to meet P.C.B. norms.<br>Radioactive wastes treatment- Low activity and high activity radiation, application of radioactive techniques for wastewater treatment. Bio-Remediation of contaminated soils. | 8 | L4, L5, L6 |
| **Module 5** **Content** | | |

| | | |
|---|---|---|
| Environmental Auditing: Cost of Pollution, Environmental audit solutions, Financial and Managerial opportunities. Criminal and Regulatory liabilities. | 8 | L4, L5, L6 |

**Course outcomes:**

After studying this course, students will be able to:

1. Develop physical/chemical/biological characteristics of and the evaluation technique for various industrial wastewater
2. Express concepts in the theory, engineering application, and design technique for the industrial wastewater treatment unit processes.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Research Skill
5. Life-long learning

**TEXT BOOKS:**

1. **Liquid Waste of industry theories, Practices and Treatment,** Nemerow N.N., Addison Wiley New York.
2. **Industrial Wastewater Management Hand Book,** Azad N. S., McGraw Hill book Co., New York.
3. **Industrial Waste Disposal**, Ross R.D. Reinhold Environmental Series – New York.

**REFERENCE BOOKS:**

1. **Practical Waste Treatment and Disposal**, Dickinson, Applied Science publication, London.
2. **Pollution control in Process industries,** Mahajan S P,TMH, New Delhi.
3. **Industrial Water pollution Control,** Eckenfelder, - McGraw hill Company, New Delhi AmericanChemical Society, Washington D.C. USA.

| **PROCESS AIR POLLUTION & CONTROL** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH562** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Understand knowledge on the principles and design of control of indoor/ particulate / gaseousair pollutant and its emerging trends.

| **Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating | | | |
|---|---|---|---|
| **Modules** | | Teaching Hours | Blooms Taxonomy |
| **Module 1** | **Content** | | |
| **INTRODUCTION**: Structure and composition of Atmosphere – History of Air pollution and episodes, Causes of air pollution and types, Introduction to meteorology toxicology and transport of air pollution, Sources and classification of air pollutants - Effects of air pollutants on human health, vegetation & animals, Materials & Structures – Effects of air Pollutants on the atmosphere, Soil & Water bodies – Long- term effects on the planet – Global Climate Change, Ozone Holes – Ambient Air Quality and Emission Standards – Air Pollution Indices – Emission Inventories. | | 8 | L1, L2, L3 |
| **Module 2** | **Content** | | |
| **AIR POLLUTION MONITORING AND MODELING:** Physicochemical processes governing the spread of pollutants from point, non-point, line, and area sources; Generation, transport and decay of air pollutants; Mathematical Modeling of dynamics of pollutants, Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants-Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport & Dispersion of Air Pollutants - Modeling Techniques – Air Sampling and monitoring methods. | | 8 | L1, L2, L4 |
| **Module 3** | **Content** | | |
| **CONTROL OF PARTICULATE CONTAMINANTS:** Factors affecting Selection of Control Equipment - Gas Particle Interaction, Working principle, Design and performance equations of Gravity Separators, cyclones, Fabric filters, Particulate Scrubbers, Electrostatic Precipitators - Operational Considerations - Process Control and Monitoring - Costing of APC equipment - Case studies for stationary and mobile sources. | | 8 | L1, L2, L5 |
| **Module 4** | **Content** | | |
| **CONTROL OF GASEOUS CONTAMINANTS:** Control Equipment, Factors affecting Selection of Control Equipment - Working principle, Design operation and performance of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters - Process control and Monitoring - Operational Considerations - Costing of APC Equipment - Case studies for stationary and mobile sources. | | 8 | L1, L2, L5, L6 |
| **Module 5** | **Content** | | |
| **AUTOMOBILE AND NOISE POLLUTION:** Vehicular Pollution: Automobile emission - Types of emissions - Exhaust emissions, evaporative emissions, crank-case emissions- Prevention and control of vehicular pollution. Noise Pollution: Sources and Effects of Noise Pollution - Measurement - Standards - Control and Preventive measures. Sources types and control of indoor air pollutants, sick building syndrome types - Radon Pollution and its control. Air pollution legislation and regulations. Case studies of a few industrial pollution control systems. | | 8 | L1, L2, L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply sampling techniques
2. Suggest suitable air pollution prevention Equipment andtechniques for various gaseous and particulate pollutants.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**


1. **Air Pollution Control Engineering,** Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, Tokyo, 2004.
2. **Air Pollution Control Engg,** Noel de Nevers, Mc.Graw Hill, New York, 1995.
3. **Air Pollution**, David H.F. Liu, Bela G. Liptak, Lewis Publishers, 2000.


**REFERENCE BOOKS:**


1. **Air Pollution & Control Technologies,** Anjaneyulu. Y, Allied Publishers (P) Ltd. India, 2002.
2. **Air Pollution** (Vol.I – Vol.VIII), Arthur C.Stern, Academic Press, 2006.
3. **Air Pollution Engineering Manual**, Wayne T.Davis, John Wiley & Sons, Inc., 2000.
4. **Fundamentals of Air Pollution**, Daniel Vallero, Fourth Edition, 2008.


| **SOLID WASTE MANAGEMENT IN PROCESS INDUSTRIES** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH563** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Understand solid waste management from an environmental public health perspective.
2. Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system.

| **Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating | | | |
|---|---|---|---|
| **Modules** | | Teaching Hours | Blooms Taxonomy |
| **Module 1** | **Content** | | |
| **Introduction:**Definition,characteristicsandperspectivesofsolidwaste.Typesofsolidwaste. Physicalandchemicalcharacteristics.Variationofcompositionandcharacteristics.Municipal, industrial,specialandhazardouswastes. **GeneralAspects:**Overviewofmaterialflowinsociety.Reductioninrawmaterialusage. Reductioninsolidwastegeneration. Reuseandmaterialrecovery.Generaleffectsonhealthand environment.Legislations. | | 8 | L1, L2, L3 |
| **Module 2** | **Content** | | |
| **EngineeredSystems:**Typicalgenerationrates.Estimationandfactorsaffectinggenerationrates.Onsitehandling.Storageandprocessing.Collectionsystemsanddevices.Transferandtransport. | | 8 | L2, L3, L4 |
| **Module 3** | **Content** | | |
| **Processing Techniques:** Mechanicalvolumereduction.Thermalvolumereduction. Componentseparation.Land fillingandlandforming.Deepwellinjection. | | 8 | L2, L3, L4 |
| **Module 4** | **Content** | | |
| **MaterialRecovery:**Mechanicalsizealteration.Electromagneticseparation.Drying and dewatering. Other material recoverysystems. Recovery of biological conversion products. Recoveryofthermalconversionproducts. **EnergyRecovery:**Energyrecoverysystemsandefficiencyfactors.Determinationofoutputandefficiency.Detailsofenergyrecoverysystems.Combustionincinerationandheatrecovery. Gasificationandpyrolysis.Refusederivedfuels(RDF). | | 8 | L2, L3, L4 |
| **Module 5** | **Content** | | |
| **HazardousWastes:**Classification.Originandreductionatsource.Collectionandhandling. Managementissuesand planningmethods.EnvironmentalActs. **Case Studies:**Major industries andmanagementmethods usedintypical industries– Coalfiredpowerstations,textileindustry,oilrefinery,distillery,sugarindustry,andradioactivewaste generationunits. | | 8 | L2, L3, L4, L6 |

**Course outcomes:**

After studying this course, students will be able to:

1. Have the working knowledge of all unit operations involved in solid waste management.
2. Will be familiar with design and policy considerations regarding alternatives for solid waste management.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking

2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**

1. **IntegratedSolidWasteManagement,**GeorgeTchobanoglous*etal*.,2nd edn,McGrawHill&Co,1993.
2. **IndustrialSolidWasteManagementandLandFillingPractice,**Dutta*etal*.,NarosaPublishingHouse, 1999.

**REFERENCE BOOKS:**

1. **WasteTreatmentPlants,**SastryC.A.*et al*,NarosaPublishingHouse,1995.
2. **HazardousWasteManagement**,Lagrega,McGrawHill,1994

| **PROCESS SAFETY AND ENVIRONMENTAL MANAGEMENT** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH564** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Understand and recognize hazardous conditions and practices affecting people, property and the environment.
2. Understand the importance of plant safety and safety regulations, different types of plant hazards and theircontrol, personal protective equipment, principles and procedures of safety audit.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| Hazard identification methodologies,risk assessment methods-PHA,HAZOP,MCA, ETA, FTA.<br>Consequence analysis, Probit Analysis. Hazards in work places. Workers' exposures tohazardouschemicals.Hazardsinindustries. | | 8 | L1, L2, L3 |
| **Module 2** | **Content** | | |
| Guidelines for safeguarding personnel. Safety education and training-Safetymanagements, fundamentalsofsafetytenets.<br>Measuring safety performance, motivating safety performance, legal aspects of industrialsafety,safetyaudits. | | 8 | L2, L3, L4 |
| **Module 3** | **Content** | | |
| Introduction and need for impact assessment. Legislation and pollution control acts andRegulations.Methodologies-collectionofdataand analysis,costbenefitanalysis. | | 8 | L2, L3, L4 |
| **Module 4** | **Content** | | |
| ApplicationsofImpactassessmentmethodsinspecificdevelopedprojects,advantagesanddisadvantagesofdifferentmethods. | | 8 | L2, L3, |

| | | | |
|---|---|---|---|
| Applicabilityofspecificmethodswithexamples. | | | L4 |
| **Module 5** | **Content** | | |
| CleantechnologyOption:Cleantechnologyandcleanuptechnology,materialreuse,wastereductionat sourceand cleansynthesis. | | 8 | L2, L3, L4, L6 |

**Course outcomes:**

After studying this course, students will be able to:

1. Carry out Hazard analysis, Risk assessment techniques (HAZOP, HAZON, Fault Tree Analysis, Consequence Analysis), Onsite and offsite emergency management, Human error Analysis and Accident Analysis.
2. Recognize that the practice of safety requires ongoing learning, and undertake appropriate activities to address this need.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning
5. Research Skill

**TEXT BOOKS:**

1.**Losspreventioninprocessindustries,**F.P.Lees,2nd edn,Butterworth-Heinemann,1996.
2.**EIA,TheoryandPractice**,PeterWathern,UnwinHymanLtd.,1988.

**REFERENCE BOOKS:**

1. **Environmental Health and Safety Auditing Handbook,** Lee Harrison, 2nd edn, McGrawHill, Inc.,NewYork,1994.

| **ESSENTIALS OF NCC** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17NC565** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**SYLLABUS COMMON FOR ALL BRANCHES OF ENGINEERING.**

**HEAT TRANSFER LABORATORY**

| | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHL57** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **1I + 2P** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **42** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **02** | | | |

**Course Objectives:**

The Students will

1. Experimentally verify the Heat Exchanger concepts studied in theory.
2. Carry out experiment and make observations for various heat transfer equipment.
3. Study the effect of U, hi and ho in design of equipment.
4. Evaluate the performance characteristic for different heat transfer cases.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| The following experiments are to be carried out; the data are to be analyzed based onthe theoretical aspects, and recorded with comments. | Blooms Level |
|---|---|
| 1. Natural Convection in Bare and Finned tube | L3,L4,L5 |
| 2. Vertical Shell and tube Heat exchanger (Condenser) | L3,L4,L5 |
| 3. Horizontal Shell and tube Heat exchanger (Condenser) | L3,L4,L5 |
| 4. Helical Coil Heat exchanger | L3,L4,L5 |
| 5. Emissivity Determination | L3,L4,L5 |
| 6. Effect of Geometry on Natural convection | L3,L4,L5 |
| 7. Heat Transfer in Packed Beds | L3,L4,L5 |
| 8. Double Pipe Heat Exchanger | L3,L4,L5 |
| 9. Heat Transfer in Jacketed Vessel | L3,L4,L5 |
| 10. Determination of Insulation Thickness | L3,L4,L5 |
| 11. Transient Heat Conduction | L3,L4,L5 |
| 12. Heat Transfer in Fluidized Beds | L3,L4,L5 |
| 13. Evaporator | L3,L4,L5 |
| 14. Solar Heater | L3,L4,L5 |
| 15. Spiral Plate Heat Exchanger | L3,L4,L5 |
| 16. Cross Flow Heat Exchanger | L3,L4,L5 |

**Course Outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge of various Heat exchanger, evaporators and fins.
2. Acquire practical knowledge of Heat Transfer Equipment.
3. Know the use of Heat Exchanging equipment.

**Conduct of Practical Examination:**

1. Minimum of 10 experiments are to be conducted andall 10experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedurepart to be made zero.

**Graduate Attributes**

1. Critical Thinking
2. Usages of Modern Tools
3. Collaborative and Multidisciplinary Work
4. Life Long Learning
5. Independent and Reflective Learning

**TEXT BOOKS:**

1. **Process Heat Transfer**, Kern D.Q. McGraw Hill., New York, 1965

2. **Unit Operations of Chemical Engineering,** McCabe W.L., et.al., 5th edn., McGraw Hill, NewYork, 2000

1. **Unit Operations of Chemical Engineering,** Coulson J.M. and Richardson J.F., Vol-I, 5th edn. Chemical Engg, Pergamon & ELBS, McGraw Hill, New York, 2000

**REFERENCE BOOKS:**

1. **Heat Transfer**, Rao Y.V.C., 1st edn., Universities Press (India) Ltd., New Delhi, 2001.
2. **Heat Transfer: Principles and Applications**, Dutta, Binay K., PHI Learning. 2000.

| **POLLUTION CONTROL &INSTRUMENTAL ANALYSIS LABORATORY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHL58** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **1I + 2P** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **42** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **02** | | | |

**Course Objectives:**

The Students will

1. Experimentally verify the principles and working of instruments studied in theory.
2. Carry out experiment and make observations for various parameters.
3. Study and use various analytical instruments for analysis of various parameters.
4. Evaluate the data and compare with reported literature.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| The following experiments are to be carried out; the data are to be analyzed based onthe theoretical aspects, and recorded with comments. | Blooms Level |
|---|---|
| 1. Analysis of effluents for pH, alkalinity and turbidity | L4,L5 |
| 2. Determination of COD and BOD | L4,L5 |
| 3. Volatile, Fixed, Filterable and Dissolved solid analysis | L4,L5 |
| 4. Analysis by ion selective electrode (any two anions) | L4,L5 |
| 5. Measurement of particulate matter in Air | L4,L5 |
| 6. Measurement of $SO_2$ in air | L4,L5 |
| 7. Analysis of exhaust by Orsat apparatus | L4,L5 |
| 8. Analysis of flue gases by Gas chromatograph | L3,L4,L5 |
| 9. UV Spectrophotometer | L3,L4,L5 |
| 10. KF Auto titrator | L4,L5 |
| 11. Flame photometer | L4,L5 |
| 12. Turbidometer | L4,L5 |
| 13. Dissolved Oxygen measurement | L4,L5 |
| 14. Bomb calorimeter | L4,L5 |
| 15. Viscometer | L4,L5 |
| 16. Polarograph | L4,L5 |
| 17. Potentiometer titration | L4,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge of various Analytical Instruments.
2. Acquire practical knowledge of preparation of solutions, standardization and calibration of instruments.
3. Know the use of skills in handling various analytical instruments.

**Conduct of Practical Examination:**

1. Minimum of 10 experiments are to be conducted andall 10 experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup

| |
|---|
| of marks.<br>4. Change of experiment is allowed only once and 15% Marks allotted to the procedurepart to be made zero. |
| **Graduate Attributes**<br>1. Critical thinking<br>2. Usages of modern tools<br>3. Collaborative and multidisciplinary work<br>4. Life long learning<br>5. Independent and reflective learning |
| **TEXT BOOKS:**<br>1. **Air Pollution Engineering Manual**, Wayne T. Davis, John Wiley & Sons, Inc., 2000. |
| **REFERENCE BOOKS:**<br>2. **Practical Waste Treatment and Disposal**, Dickinson, Applied Science publication, London.<br>3. **Pollution control in Process industries,** Mahajan, TMH, New Delhi. |

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM**
**SCHEME & SYLLABUS OF TEACHING AND EXAMINATION**
**2017-2018**
**CHOICE BASED CREDIT SYSTEM (CBCS)**

**SEMESTER VI**

| **CHEMICAL REACTION ENGINEERING-II (Common to CH & PC)** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH61** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

Course Objectives:
The students will be able to
1. Understand and apply the principles of non-ideal flow in the design of reactor.
2. Develop rate laws for heterogeneous reactions.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Basics of Non Ideal Flow:** Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. Dispersion model. Tanks in series model. Conversion in non- ideal flow reactors for simple systems. | | 10 | L1,L2,L3 |

| | | | |
|---|---|---|---|
| **Module 2** | | | |
| **Introduction to Heterogeneous Systems:** Rate equations, contacting patterns, fluid-particle non catalytic reactions, URC model, Spherical particles of unchanging size, shrinking spherical particles, determination of rate controlling steps.<br>**Fluid-Fluid Non Catalytic Reactions:** Kinetic regimes for mass transfer and reaction; rate equations. | | 10 | L2,L3,L4 |
| **Module 3** | | | |
| **Catalysis:** Introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, inhibitors etc, Mechanism of catalysis. Rate equations for different rate controlling step.<br>**Deactivation:** Deactivating catalyst. Mechanism, rate & performance equation. | | 10 | L3,L4,L5 |
| **Module 4** | | | |
| **Solid Catalyzed Reactions:** Heterogeneous reactions- Introduction, Kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Thiele modulus and enhancement factor, Porous catalyst particles. Heat effects during reaction. | | 10 | L4,L5 |
| **Module 5** | | | |
| **Solid Catalyzed Reactions (Contd.):** Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates. Packed bed catalytic reactor & reactors with suspended solid catalyst. Fluidized reactors of various type.<br>Gas-Liquid Reactors: Trickle bed, slurry reactors. Three phase fluidized bed. | | 10 | L3,L4,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge to distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information.
2. Acquire practical knowledge about design of reactors for non-catalytic and catalytic reactions.
3. Know the use of reactors for gas–liquid operations with and without chemical reaction.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

5. Critical Thinking
6. Problem solving
7. Use of modern tools
8. Life - long Learning

**TEXT BOOKS:**

1. **ChemicalReactionEngineering,**OctaveLevenspiel,3rd edn,JohnWiley&Sons, 2001.
2. **ChemicalEngineeringKinetics,**J.M.Smith,3rdedn,McGrawHill.
3. **ElementsofChemicalReactionEngineering,**H.ScottFoggler,3rdedn,PrenticeHall, 2001.

**REFERENCE BOOKS:**

1. **Chemical&CatalyticReactionEngineering,**JamesJ.Carberry,McGrawHill,1976

| MASS TRANSFER OPERATIONS-II (Common to CH & PC) | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH62** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

Course Objectives:

The students will

1. Be able to understand different separation techniques.
2. Be able to design distillation column, absorber and calculations involved in liquid liquid extraction.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Gas Liquid Contacting Systems:** Types, construction and working of plate and packed columns, types and properties of industrial packing's, plate efficiencies, HETP and HTU concepts.<br>**Absorption:**<br>Absorption.Solventselectionforabsorption.Materialbalanceandconceptof drivingforceandminimumsolventrates.<br>Multistageabsorptioncolumns.DesignofPlate columns.Absorptionanddesorptionfactors. | | 10 | L1,L2,L3 |
| **Module 2** | **Content** | | |
| **PackedTowerAbsorption**:Liquidphaseholdupandpressuredropinabsorptionto wers. Designofpackedtowers(processdesign-heightanddiameter).Multi-componentabsorption. Absorptionwithchemical reaction.<br>**Distillation:**Introduction.Vapourliquidequilibria(T-x,y,P-x,y.H-x,yandx-ydiagramsfor binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult'slaw.VLEformulti-component systems.Non-idealsystems. Azeotropes.Immiscible systems.Atmosphericdistillation**,**Flashandsimpledistillation. | | 10 | L2,L3,L4 |
| **Module 3** | **Content** | | |
| **Distillation (Contd.):**.Multi-stage rectification column. Design using McCabe Thiele and Lewis-Sorelmethodsforbinarymixtures.<br>**Distillation(Contd.):**Ponchon-Savaritmethod.IntroductiontoMulticomponentdistillation, Vacuum,molecular,extractiveand azeotropicdistillations. | | 10 | L3,L4,L5 |
| **Module 4** | **Content** | | |
| **Liquid-LiquidExtraction**:Ternaryequilibrium.Solventselection.Singlestage.Multi-stage cross-current,counter-currentextraction.Equipmentforliquid-liquidextraction. | | 10 | L3,L4, L5 |
| **Module 5** | **Content** | | |

| | | |
|---|---|---|
| **LeachingOperation:**Equipmentforleaching.Preparationofsolidsforleaching.Equilibrium diagrams.Calculationof singlestage andmulti-stageleachingoperation. | 10 | L2,L3,L4 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge for separation of components.
2. Acquire practical knowledge about design of mass transfer equipment.
3. Differentiate various separation techniques.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**

1. **MassTransferOperations**-RobertE Treybal,3rd edn,McGrawHill,1981.
2. **UnitOperationsin ChemicalEngineering**-McCabe&Smith,6th ednMcGraw Hill,2001.

**REFERENCE BOOKS:**

1. **Chemical Engineering Vol I, II, IV and V** - Coulson and Richardson, 4th edn, PergamonPress,1998.
2. **IntroductiontoChemicalEngineering**-Badger&Banchero,TMH6th Reprint1998.
3. **Principlesof UnitOperation**-Foust*et.al*.,2nd edn,JohnWiley,1994.
4. **TransportProcessesandUnitOperation**-GeankoplisCJ,PrenticeHall(I),2000.
5. **AppliedProcessDesignforChemicalandPetrochemicalPlant**Ludwig,2nd edn, Gulf Publishing,2002.

| **INDUSTRIAL POLLUTION CONTROL** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH63** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

Course Objectives:

The students will be able to

1. Understand various concepts of water usage and importance.
2. Understand about air, soil and noise pollution and its control.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating and L6 – Creating.

| **Modules** | Teaching Hours | Blooms Taxono |
|---|---|---|

| | | | my |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Introduction:**Importanceofenvironmentformankind.Biosphereandlayersofatmosphere. Hydrologicalcycleandnutrientcycles.Typesofpollution. Damagesfromenvironmental pollution. Needofenvironmental legislationsandenvironmentalActsinIndia.Functions of centralandstatepollutioncontrolboards. **Sources,Sampling andAnalysis ofWastewater:**Waterresources.Originofwastewater. Evaluation, classificationandcharacterizationofwastewater. Physicalandchemical characteristics.BOD,CODandtheirimportance.Types ofwaterpollutants andtheireffects. Samplingandmethodsofanalysis. | | 10 | L1,L2,L3 |
| **Module 2** | **Content** | | |
| **WastewaterTreatment:**Preliminary,primary,secondaryand tertiarytreatments of wastewater. Sludgetreatmentanddisposal.Advancedwastewatertreatment.Recoveryofmaterials from processeffluents. **ApplicationstoIndustries:**Normsandstandardsoftreatedwater.Origin,characteristics,and treatment methodsintypical industries–petroleum refinery,pulpand paper,fertilizer,distillery, tannery,andtextileprocessing. | | 10 | L2,L3,L4 |
| **Module 3** | **Content** | | |
| **AirPollutionAspects:**Natureofairpollution.Classificationofairpollutants.Sourcesofair pollutants.Airqualitycriteriaandstandards.Plumebehavioranddispersionofairpollutants. Effectsof airpollutiononhealth,vegetation,and materials. | | 10 | L3,L4,L5 |
| **Module 4** | **Content** | | |
| **Air Pollution Control:** Sampling of pollutants. Methods of estimation of air pollutants. Automobile pollution.Controlmethodsforparticulatesandgaseouspollutants.Origin,control methods,andequipmentusedin typicalindustries – Thermalpowerplants,metallurgical industries,andcementindustries. | | 10 | L4,L5, L6 |
| **Module 5** | **Content** | | |
| **SolidWasteTreatment:**Origin,Classificationandmicrobiology.Propertiesandtheirvariation. Engineered systemsforsolidwastemanagement– generation,onsitehandling,storage, collection,transferandtransport,composting,sanitarylandfilling. **NoiseControl:**Sourcesanddefinitions.Determinationofnoiselevels.Noisecontrol criteria and noise exposure index. Administrative and engineering controls. Acoustic absorptive materials. | | 10 | L3,L4,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply, analyze and identify the environmental problems.
2. Acquire practical knowledge to plan strategies for control and reduce pollution.
3. Apply environmental management systems to industrial activities.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning
5. Collaborative and multidisciplinary work

**TEXT BOOKS:**


1. **EnvironmentalPollutionControlEngg,** C.S.Rao, 2nd edn, NewAgeInternational Reprint, 2002.
2. **PollutionControlinProcessIndustries,** S.P.Mahajan, TataMcGrawHill, 22nd Reprint, 1999.


**REFERENCE BOOKS:**


1. **PrinciplesandPracticesofAirPollutionControlandAnalysis,** J.R.Mudakavi, I.K. InternationalPublishingHomePvt.Ltd., NewDelhi, 2010.
2. **Air Pollution,** H.C.Perkins, McGrawHill, 1974.
3. **SolidWasteManagement,** D.J.Hager*yet.al*., VanNostrandReinhold, 1973.
4. **IndustrialPollutionControlHandbook,** Lund, H.F., 6th edn, Vol.1, McGrawHill, 1971.
5. **NoiseAbatement,** Duerden, Buttreworth, 1970.
6. **IntroductiontoEnvironmentalEngg,** Davis., 3rd edn, McGrawHill, 1998.
7. **WasteWaterEngineeringTreatmentDisposalReuse,** Metcalf and Eddy, 4th edn, Tata McGrawHill, 2003.
8. **EnvironmentalEngineering, G.N**. Pandey and G.C. Carney, Tata McGraw Hill, 11th Reprint, 2002.
9. **IntegratedSolidWasteManagement,** GeorgeTchobanoglous*etal*, 2nd edn, McGraw Hill&Co, 1993.


| **PROCESS EQUIPMENT DESIGN AND DRAWING (Common to CH & PC)** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH64** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:**

The students will be able to

1. Understand advances and types in the design of heat and mass transfer equipment and its accessories.
2. Develop modifications based on design.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| | | |
|---|---|---|
| Detailed chemical engineering process design of the following equipment should be studied. Standard code books are to be used. The detailed proportionate drawings shall include sectional front view, full top/side view depending on equipment and major components.<br>1. **Class work:** Students are to design the equipment. They shall also be trained to draw free hand proportionate sketches.<br>2. **Final Examination:** Students have to answer any one of the two questions given in the examination. After completing the design, free hand proportionate sketches are to be drawn as required. | Teaching Hours | Blooms Taxonomy |

| Content | | |
|---|---|---|
| 1.Double Pipe Heat exchanger<br>2.ShellandTubeHeatexchanger<br>3.Condenser–Horizontal<br>4.Evaporator–Singleeffect<br>5.Sieve Tray Distillation Column<br>6. Packed Bed Absorption Column<br>7. Rotary Dryer. | 08<br>07<br>07<br>07<br>07<br>07<br>07 | L1,L2,L3,<br>L4,L5,L6 |
| **Course outcomes:**<br>After studying this course, students will be able to:<br>1. Design and modify process equipment relating to heat and mass transfer.<br>2. Will handle process parameters to alter and design process Equipment. | | |
| **QUESTION PAPER PATTERN:**<br>• The question paper will have TWO questions.<br>• Each full question consisting of 100 marks. Students have to answer any one full question.<br>• Use of Chemical Engineers Handbook - Perry and Green, IS Code book: 2825 and 4503 are permitted in the Final examination and internal test.<br>• The examination duration is 4 hours. | | |
| **Graduate Attributes**<br>1. Critical Thinking<br>2. Problem solving<br>3. Use of modern tools<br>4. Life - long Learning<br>5. Collaborative and multidisciplinary work | | |
| **TEXT BOOKS:**<br>1. **Process Equipment Design**-M.V. Joshi, 3rd edn., Mac Millan &Co. India, Delhi, 1998.<br>2. **Process Equipment Design-Vessel Design,** Brownell & Young, John Wiley, 1959.<br>3. **Process Design of Equipment – Vol 1,** S. D. Dawande, 3rdedn, Central Techno Publications.2003. | | |
| **REFERENCE BOOKS:**<br>1. **ChemicalEngineersHandbook,**Perry&Green,8thedn,McGrawHill,1997.<br>2. **PressureVesselCode–IS2825,** IS Code, B.I.S., New Delhi,1969.<br>3. **Flow of Fluids through Valves, Fittings & Pipes**, Crane Amazon,2006. | | |

**Professional Elective-II**

| ELECTROCHEMICAL TECHNOLOGY | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH651** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

Course Objectives:
The students will be able to
1. Understand the operation of various types of electrochemical systems.
2. Understand electrochemical corrosion of metals and corrosion protection methods.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **IntroductionToTheoreticalAspects:**Faradayslaws,mechanismofconductionin solids, liquidsand gases andinionicmelts.Conductioninmetals andsemiconductors. Reversibleelectrodesandpotentials,electrodeprocessesandelectrodekinetics. | | 8 | L1,L2,L3 |
| **Module 2** | **Content** | | |
| Varioustypesofoverpotentials.Polarisation. Butler-volmerforoneelectronandmuteelectronsteps.ModelsofelectricalDoublelayer. | | 8 | L2,L3,L4 |
| **Module 3** | **Content** | | |
| Appliedaspects:Potentiometryandion-selectiveelectrodes.Polarography. | | 8 | L2,L3,L4 |
| **Module 4** | **Content** | | |
| Electrodedepositionofmetals andalloys. PrimaryandSecondaryFuelCells. | | 8 | L1,L2,L3 |
| **Module 5** | **Content** | | |
| **CorrosionanditsPrevention:**Electrowinning.Electroorganicandinorganicsynthesis(and sometypicalexamples).Environmentalelectrochemistry.Bio-electrochemistry**.** | | 8 | L2,L3,L4 |

**Course outcomes:**
After studying this course, students will be able to:
1. Apply and control techniques for the electrochemical surface treatment of metals, such as plating and anodizing, with the aim of improving their properties.
2. Understand the mechanism of electrochemical corrosion of metals, use of appropriate design criteria and apply corrosion protection techniques in order to limit corrosion of metals.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**

1. **ModernElectrochemistry,**J.O.M.,Bockris&A.K.N.Reddy,Vol.1&2,Plenum,New York2002.
2. **IndustrialElectrochemicalProcesses,**A.Kuhn,Elsevier,Amsterdam,1971.

**REFERENCE BOOKS:**

1. **ElectroAnalyticalChemistry,**J.J.Lingane,Wiley, NewYork,1958.
2. **Electrochemistry,PrinciplesandApplications,**E.C.Potter,CleaverhumePress,London 1956.
3. **OrganicElectrochemistry,**M.M.Baizer,MarcelDekker,3rdEdition,NewYork,1991.

| **PETROCHEMICALS** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH652** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

Course Objectives:

The students will be able to

1. Understand the various types of Carbon compounds and their properties.
2. Understand preparation of petrochemical compounds from different sources.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Definition of Petrochemicals:** Petrochemical industries in India. Principal raw materials. Introductionto chemicalsfrom$C_1$,$C_2$,$C_3$ and$C_4$compounds. **Chemicalsfrom$C_1$Compounds:**Manufactureofmethanolandchloromethanes.Manufacture ofperchloroethylene. | | 8 | L1,L2,L3 |
| **Module 2** | **Content** | | |

| | | | |
|---|---|---|---|
| **Chemicals from $C_2$ Compounds:** Feed stock, technology, engineering problems and usage of Ethyleneandacetylene,ethanol,polyethylene,acetaldehyde,ethanolamines,acetic acid. | | 8 | L2,L3,L4 |
| **Module 3** | **Content** | | |
| **Chemical from $C_3$ Compounds:** Isopropanol, acetone, acrylonitrile,polypropylene,propyleneoxide. | | 8 | L2,L3,L4 |
| **Module 4** | **Content** | | |
| **Chemical from $C_4$ Compounds:** Butadiene dehydrogenation of butane (Houdry). Dehydrogenationof butylenes.Dehydrogenation-dehydrationofethanol.Steam crackingof hydrocarbons. **ChemicalsfromAromatics**:Primaryrawmaterial.Hydroalkylation. | | 8 | L2,L3,L4 |
| **Module 5** | **Content** | | |
| Manufactureofphenol–2methods.Styrene–2methods.Phthalicanhydridemaleic anhydride, nitrobenzene,aniline. Manufactureofindustrialdyesbasedonpetroleumfeedstocks**.** | | 8 | L2,L3,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Differentiate varieties of carbon compounds and their properties.
2. Explain the mechanism of preparation of primary and secondary compounds.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**

1. **Petrochemicals,**B.K.BhaskarRao,CRC Press,1990.
2. **ChemicalsfromPetroleum,**A.L.Waddams,2nd edn,ELBS, London,1970.

**REFERENCE BOOKS:**

1. **Dryden'sOutlinesofChemicalTechnology,**GopalRaoMand MarshallSittig,3rd edn, East-WestPress,1997.
2. **ChemicalProcessIndustries,**5th edn,ShreveandAustin,McGrawHill,1984.
3. **ChemicalTechnology,**G.N.Pandey,3rd edn,VikasPublishingHousePvt.Ltd.,1977.
4. **ChemicalTechnology,**Mukhlyonov,MirPublications,1982.

| **FERMENTATION TECHNOLOGY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH653** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |

| | | | | | |
|---|---|---|---|---|---|
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Be able to understand role of microorganisms in fermentation.
2. Be able to understand the various fermentation technologies used.
3. Be able to learn the production of important products through fermentation.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Introduction to fermentation & Microbial Growth Kinetics**: History and development of fermentation, general requirements of the fermentation, range of fermentation processes, parts of a fermentation process- upstream and downstream processing, aerobic and anaerobic fermentation, solid state and submerged fermentation. Batch culture (Quantifying cell concentration, Growth patterns and Kinetics), Continuous culture, Comparison of batch and continuous cultures in industrial processes, Fed batch culture, Examples of use of fed batch cultures. | 8 | L1,L2,L3 |
| **Module 2** **Content** | | |
| **Isolation, preservation Pathways and improvement of industrial Microbes**: Isolation, preservation Improvement of industrially important microorganisms, DNA techniques Induction, carbon catabolite repression, crab tree effect, feedback Inhibition and repression | 8 | L2,L3,L4 |
| **Module 3** **Content** | | |
| **Media, Sterilization inoculum for industrial fermentations:** Introduction, Typical media, Energy sources, Carbon sources, Nitrogen sources, Buffers, Oxygen requirements, Antifoams, Medium optimization, Medium sterilization: The design of batch sterilization processes, The design of continuous sterilization processes, Sterilization of the fermenter, feeds and air, Filter sterilization The development of inocula for yeast , bacterial and fungal processes, The aseptic inoculation of plant fermenters | 8 | L2,L3,L4 |
| **Module 4** **Content** | | |
| **Aeration agitation & Design of fermenter:** The oxygen requirements and supply of industrial fermentations, Determination of $K_{La}$, Factors affecting $K_{La}$ values, balance between oxygen supply and demand, Basic function of a fermenter for microbial or animal cell culture, body construction, and various parts of a fermenter. | 8 | L2,L3,L5 |
| **Module 5** **Content** | | |
| **Important products through Fermentation:** Organic acids: citric and acetic acid; enzymes: amylase, protease, lipase; antibiotics: penicillin; vitamins: vitB12; amino acids: lysine, Glutamic acid; organic solvents: ethanol, acetone butanol; alcoholic beverages: wine, beer; biomass: baker's yeast ; bio fertilizers; bio pesticides; bio surfactant; steroid transformation; biopolymers | 8 | L2,L3,L4 |

**Course outcomes:**

After studying this course, students will be able to:

1. Appreciate the use of microorganisms for the production of value added commodities.
2. Describe key industrial bioprocesses, from the traditional to the recently evolved.
3. Integrate biological and engineering principles involved in the production and recovery of commercial products.
4. Develop critical thinking skills and learn to employ a quantitative, scientific approach towards conversion of biological materials to value added products.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**

1. **Biochemical Engineering,** Bailey & Ollis, McGraw Hill.

**REFERENCE BOOKS:**

1. **Principles of Fermentation Technology** – Stan bury P.F., Whitaker A, Hall S. J.
2. **Bioprocess Engineering: Basic concepts** – Shuler M.L., Kargi F. (PHI)

| **PULP AND PAPER TECHNOLOGY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH654** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will be able to

1. Understand the wood chemistry, basic pulp and papermaking processes from different raw materials.
2. Acquainted with raw material characteristics, physical and mechanical concepts, nomenclature and procedures related to evaluating paper and paper board product properties
3. Learn Chemical recovery systems and bleaching of mechanical pulps. Treatment of effluent.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |

| | | | |
|---|---|---|---|
| **WoodChemistry:** Chemicalcomposition-cellulose,hemicellulose,lignin,woodextractives, rawmaterial.Qualityparametersunderevaluation.Yieldofrawmaterial.<br>**Pulping:**Generalprinciple ofpulping.Typesof pulpingprocesses:mechanical,chemical,semi-chemical,sulphate process, Kraftprocess. Processcalculations. Rawmaterialutility requirements.Processflowsheetanddescription. Washingandbleaching.Commonunit operation.Woodtreatment,digestion,evaporation,dryingwithequipmentused. | | 8 | L1,L2,L3 |
| **Module 2** | **Content** | | |
| **TreatmentofPulp**:Screening,washing,refining,thickeningofpulp.Bleaching-conventional andnon-conventionalbleachingtechniques.<br>**PaperMaking:**Preliminaryoperationsonpulp.Beatingandrefiningofpulp.Non-fibrous materials. Fillers and loadingmaterial.Internalsizing.Wetand additivesurfacetreatment.Paper coloring.Surfacesizing. | | 8 | L2,L3,L4 |
| **Module 3** | **Content** | | |
| **Paper Drying and Finishing:** Types of dryers. Calendaring. Reeling and winding.Paper machinedrives,cutting,windingand rewinding.Conversionofpapers. | | 8 | L2,L3,L4 |
| **Module 4** | **Content** | | |
| **PaperQualityofGrades:**Differentgradesofpaperquality.Parametersandtheireva luation. Saturationofpaper.Specialgradepapers.Recyclingof wastepapers. | | 8 | L2,L3,L5 |
| **Module 5** | **Content** | | |
| **SupportiveOperations:**Chemicalrecovery– waterbalance,oxidation,evaporationofblack liquor,lime recovery.Qualitycontrolandsafetyaspects.<br>**Environmental Aspects:** Effluent characteristics of pulp and paper industries. Treatment methods. | | 8 | L2,L3,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the fundamental chemical principles of making pulp and paper in the industry.
2. Optimize pulping operations to achieve maximum pulp bleaching ability and strength properties.
3. Advice pulp and paper makers on how to control environmental pollution.
4. Identify requirements for process control and quality assurance in pulp and paper manufacturing processes.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools

| |
|---|
| 4. Life - long learning<br>5. Collaborative and multidisciplinary work |
| **TEXT BOOKS:**<br>1. **Pulpand PaperChemistryandTechnology**,Casey,J.P.,2nd edn,InterScience,1960 |
| **REFERENCE BOOKS:**<br>1. **Handbookof Pulp andPaperTechnology**,BrittK.W.,ReinholdPublicationCorp., 1964.<br>2. **Pulpand PaperScienceandTechnology**,LibbyC.E.Vol1to3,McGrawHill,1962. |

## Open Elective-II

| **FOOD TECHNOLOGY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH661** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will be able to

1. Impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation, food poisoning, food related hazards and safety.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 – Creating.

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **IntroductionandQualityAttributesofFood:**Functionoffoods.Foodinrelationto health. Aimoffoodscienceandtechnology.Quality attributes– Appearancefactors,Texturalfactors, Flavorfactors.Visualandobjectively measurableattributes.Aromaoffoods–introductory ideas,formation,chemistryandanalysis.Taste–introductory ideas, formationandchemistry. Additionalquality;qualitystandards,qualitycontrol. Introduction tosensory evaluationof foodsandbeverages. **ModernTrendsInFoodScience:**Biotechnologyinfood.Biofortification,Nutraceuticals. Organic foods.Lowcostnutrientsupplements.Packagingoffoods andnutritionlabeling.Careers in foodscience andfoodindustries. | 8 | L1,L2,L3 |
| **Module 2** **Content** | | |
| **FormationandChemistryofFood:** Carbohydrates.Proteins.Lipids.Vitamins.Minerals. Water.Biotin.Choline.Phytochemicals. **FoodProcessingandPreservation:**Fooddeterioration– Causes.Aimsandobjectivesof preservationandprocessing. Unitoperationsinprocessing.Differentmethodsoffood preservation– lowtemperature,hightemperature, preservatives,osmoticpressure,dehydrations. foodirradiation;processingandpreservations ofmilkanddairy,vegetablesandfruits,cereals, legumesandnuts,meatandmeatproducts, fatsandoils,beverages,sugars,sweeteners,honey andconfectionary,saltandspices. | 8 | L2,L3,L4 |

| Module 3 | Content | | |
|---|---|---|---|
| **EnzymaticandNon-EnzymaticReactionsDuringStorages:**Introduction toenzymes.Nature andfunction ofenzymes.Classificationofenzymes.Hydrolases–Esterace,amylases, pectic enzymes.Proteases.Oxidoreductases – phenolases,glucoseoxidase,catalose,peroxidase, lipoxygenase,xantineoxidase.Immobilizedenzymes.Usesandsuggestedusesofenzymein foodprocessing.Non-enzymaticreactions. | | 8 | L2,L3,L4 |
| **Module 4** | **Content** | | |
| **FoodAdditives:**Introduction andneedforfoodadditives.Typesofadditives– antioxidants, chelating agents,coloring agents,curingagents,emulsions,flavorsandflavorenhancers,flavor improvers,humectantsandantichokingagents,leavening agents,nutrientsupplements, non-nutritivesweeteners,pHcontrolagents.Preservatives – typesandapplications.Stabilizersand thickeners,other additives.Additivesandfoodsafety. **FoodContaminationandAdulteration:**Typesofadulterantsandcontaminants.Intentional adulterants. Metallic contamination.Incidentaladulterants. Natureandeffects.Food lawsand standards | | 8 | L2,L3,L5 |
| **Module 5** | **Content** | | |
| **Environmental ConcernsandFoodSafety:**Waterinfoodproduction.Propertiesand requirementsofprocessing water.Environmentalconcerns– solidwastedisposal,wastewater properties,wastewatertreatment.Safetyhazardsandrisks.Foodrelatedhazards. Processingand handling.Cleaningandsanitizing. | | 8 | L2,L3,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Explain the various causes of food deterioration and food poisoning.
2. Identify appropriate processing, preservation, and packaging method.
3. Analyze product quality and effect of processing technique on it.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools

**TEXT BOOKS:**

1. **FoodScience,**B.Srilakshmi,4th edn,NewAge International,2007.
2.**Foods:FactsandPrinciples,**N.ShakuntalaManayandM.Shadaksharamurthy,NewAge Publishers,2005.

**REFERENCE BOOKS:**

1.**IntroductiontoFoodScience,**RickParker,ThomsanDetmer,2001.
2.**FoodProcessingandPreservation,**G.SubbulakshmiandShobhaA.Udupi,NewAge

International,2001.
3.**FoodScience,**NormanN.PotterandJosephH.Hotchkin, 1st edn,AviPublishingCo, 1968.
4.**Principlesof FoodChemistry,**JohnMDeMan,3rd edn,Springer,1999

| SUGAR TECHNOLOGY | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH662** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will be able to

1. Understand scenario of Indiansugar industry.
2. Acquaint with raw material characteristics, physical and chemical properties.
3. Learn methods and analyze products and byproducts.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **SugarIndustry inIndia:**Chemicalandphysicalpropertiesofsucroseandreducing sugars. Sourcesforsucrose. Formationof sucroseplants.Non-sugarcompoundsof sugarcane.Inorganic constituentsofsugarcanejuicesandsugarsanalyticalmethodsusedinsugarindustry. **Purification**: Chemical technologyof thepurification process. Fundamental reactions and physicalchemistry aspectsofclarification,liming,sulphitation andcarbonation process. Filtrationofsugarjuice. | 8 | L1,L2,L3 |
| **Module 2** **Content** | | |
| **Evaporation:**Evaporationofsugarjuice.Heattransferinevaporators. Evaporationequipment andauxiliaries. **Evaporation(Contd..):**Methodsofobtainingsteam,andqualityofsteam.Steameconomy. Chemistryoftheevaporationprocess. | 8 | L2,L3,L4 |
| **Module 3** **Content** | | |
| **Crystallography:**Solubilityofsucrose.Nucleationinsupersaturatedsolutions–kineticsand growthofcrystallization.Chemistryofcrystallization. Controlmethodsandequipmentinsugarcrystallization,technologyofsugar crystallization.Evaporationandcirculationinvacuumpans. | 8 | L2,L3,L4 |
| **Module 4** **Content** | | |
| **Centrifugation:**Theoryofthecentrifugalprocess,centrifugaloperation. | 8 | L2,L3,L5 |
| **Module 5** **Content** | | |
| **Centrifugation:**Engineeringprinciplesofsugarcentrifugalandthecentrifugalequipmentand auxiliaries. Productionoffinal molassesand molasses'sutilization.Gradingof sugar. | 8 | L2,L3,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the fundamentals in production of sugar.
2. Evaluate the yield of the sugar based on different raw materials.
3. Grade sugar and byproducts.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning
5. Collaborative and multidisciplinary work

**TEXT BOOKS:**


1. **PrinciplesofSugarTechnology,**HoningP.,Vol.ItoIII,ElsevierPublishingCompany, 1953.
2. **IntroductiontoCaneSugarTechnology,**Jenkinos.G.H,Elsevier,1966.


**REFERENCE BOOKS:**


1. **HandbookofCaneSugarTechnology,**MathurR.B.L,2nd edn,OxfordandI.B.H. PublishingCo.,1997.
2. **HandbookofSugars,**Pancoast,H.M,andJunk,W.R.,2nd edn,AVIPublishingCo. Inc.,Connecticut,1981.


| **PETROCHEMICAL ENGINEERING** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH663** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will be able to

1. Study the Prospects, Growth, Economy related to Petrochemical Industry.
2. Study various feed stocks employed.
3. Study heat & mass transfer operations related to Petrochemical Industry.
4. Study reactors employed and engineering problems encountered at Petrochemical Industry.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| Introduction: The growth of petrochemical industry, Global & Indian scenario, Feed stocks for Petrochemicals, Natural gas, Refinery gases, Sources, Composition of natural gas, Properties, Storage Heating value and flammability limits of natural gas. Refinement of Natural Gas: Acid gas removal: Amine process, Carbonate washing process, Sulphur recovery process. Dehydration, Technology of Liquefied Natural Gas | 8 | L1,L2,L3 |

| Module 2 | Content | | |
|---|---|---|---|
| CRACKING: Thermal, Catalytic, Product distribution, Steam cracking, Thermodynamics of Steam cracking of Natural gas, Naphtha and Heavy distillates, Products of steam cracking, Production of Hydrogen, Synthesis gas, Methanol, Reaction features. Reactors for steam cracking. Engineering Problems associated | | 8 | L2,L3,L4 |
| **Module 3** | **Content** | | |
| Thermodynamical and Technological principles involved in Alkylation, Oxidation, Nitration Hydrolysis processes employed at petrochemical industry. | | 8 | L2,L3,L4 |
| **Module 4** | **Content** | | |
| Thermodynamical and Technological principles involved in Sulphonation, Sulfation and Isomerization processes employed at petrochemical industry | | 8 | L2,L3,L5 |
| **Module 5** | **Content** | | |
| Petro Chemicals from Aromatics: Feed stocks, Hydro alkylation. Thermodynamics, Kinetic Reactors features Product distribution Engg. problems associated | | 8 | L2,L3,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Explain the various technologies of petrochemical engineering.
2. Evaluate the thermodynamical and kinetic aspects.
3. Explain the various engineering problems associated with petrochemical industries.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning
5. Collaborative and multidisciplinary work

**TEXT BOOKS:**


1. Bhaskara Rao, B.K., “A Text on Petrochemicals”, Khanna Publishers, 2000.
2. Sukumar Maiti, “Introduction to Petrochemicals”, 2nd edn, Oxford and IBH Publishers, 2002.
3. Dryden, C.E., “Outlines of Chemical Technology”, 2nd edn, Affiliated East-West press, 1993


**REFERENCE BOOKS:**


1. Margaret Wells, “Handbook of Petrochemicals and Processes”, 2nd edn, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., “Chemistry of Petrochemical Processes”, 2nd edn, Gulf Publishing Company, 2000.

| POLYMER AND PLASTIC ENGINEERING | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH664** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will be able to

1. Understand the basics of polymers, sources, structure, properties.
2. Understand plastics, manufacturing aspects, properties and uses.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| POLYMER BASICS– Classifications based on occurrence, types, process, and end uses. Polymerization Kinetics and mechanism of free radical, cationic, anionic, living polymers and coordination polymerization– Ziegler Natta catalysts, monometallic mechanism, stereo regular polymerization, chain transfer reaction and constant. | 8 | L1,L2,L3 |
| **Module 2** **Content** | | |
| STRUCTURE, PROPERTIES AND REACTION OF POLYMERS<br>Functionality, tactility of polymer, microstructure, chemical and geometrical structure, ladder, Star and telechelic polymers, interpenetrating networks-Polymers-crystalline amorphous nature,<br>Crystallizability-effect on properties.<br>Reactions of polymer molecules with specific groups OH,<br>CHO, C=O, COOH and $–NH_2$ and polymer–cross linking, cyclisation–polymer degradation,thermal, Mechanical, photo and radiation. Properties of Polymers. | 8 | L2,L3,L4 |
| **Module 3** **Content** | | |
| BIO AND INORGANIC POLYMERS<br>Naturally occurring polymers, starch, proteins, cellulose, Derivatives of cellulose polymers, Rayon, cellophane, cellulose acetate, butyrate and nitrate , ethyl cellulose, carboxy methyl<br>Cellulose-preparation, properties, application organo metallic polymers, co-ordination polymers, Polyamides, Inorganic polymers- phosphorous and nitrogen containing polymers, silicones, Hybrid polymers. | 8 | L2,L3,L4 |
| **Module 4** **Content** | | |
| PLASTICS: Feed stocks, Classifications, Resins, Plastics Natural & Synthetic, Code Identification. Olefins synthesis and production of LDPE, HDPE, CPE, homo and copolymers. Polypropylenes | 8 | L2,L3,L5 |
| **Module 5** **Content** | | |
| ENGINEERING PLASTICS: Acrylics, Polyamides, Poly-tetrafluoroethylene, feed stocks, Synthesis Processing & Applications | 8 | L2,L3,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the fundamentals in reactions of polymers.
2. Differentiate types of polymers based on application.
3. Apply knowledge of plastics and its properties in engineering applications.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning
5. Collaborative and multidisciplinary work

**TEXT BOOKS:**

1. **F.W. Billmayer**, Text Book of Polymer Science, 3rd edn, John Wiley and sons, New York, 2002.
2. **R.J. Young**, Introduction to Polymers, Chapman and Hall Ltd., London, 1999.

**REFERENCE BOOKS:**

1. **Gorge Odeon** – Principles of Polymerization, 4th edn, McGraw Hill Book Company, New York. 2004.
2. **Premamoy Ghosh**," Polymer Science and Technology, 2nd edn, McGraw-Hill Publishing Company Limited, New Delhi, 2003.
3. **V.R. Gowarikar**, Polymer Science, New Age International Pvt. Ltd Publishers, 2010.
4. **M G Aurora, M Singh**, Introduction to Polymer Science Amol Publications.

| **CHEMICAL REACTION ENGINEERING LABORATORY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHL67** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **1I + 2P** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **42** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **02** | | | |

**Course Objectives:**

Students will

1. Experimentally verify the principles and working of reactors studied in theory.
2. Carry out experiment and make observations for various parameters.
3. Study and use various reactors for determining rate constant and conversion.
4. Evaluate the data and compare with reported literature.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| The following experiments are to be carried out; the data are to be analyzed based on the theoretical aspects, and recorded with comments. | Blooms Level |
|---|---|
| 1. Batch Reactor | L4,L5 |
| 2. Isothermal plug flow reactor | L4,L5 |
| 3. Mixed flow reactor | L4,L5 |
| 4. Semi batch reactor | L4,L5 |
| 5. Heterogeneous catalytic Reactor | L4,L5 |
| 6. Segregated flow reactor | L4,L5 |
| 7. Adiabatic Reactor | L4,L5 |
| 8. Packed bed Reactor | L3,L4,L5 |
| 9. RTD Studies in Tubular Reactor | L3,L4,L5 |
| 10. Effect of temperature on Rate of reaction | L4,L5 |
| 11. Bio Chemical Reaction (Batch) | L4,L5 |
| 12. Enzyme catalyzed reactions in batch reactor | L4,L5 |
| 13. RTD Studies in mixed flow reactor | L4,L5 |
| 14. Sono-chemical reactor | L4,L5 |
| 15. Photochemical reactor | L4,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge of various types of reactors.
2. Acquire practical knowledge of reactors.
3. Know the use of skills in handling various reactors.

**Conduct of Practical Examination:**

1. Minimum of 10 experiments are to be conducted and all 10experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Lifelong learning
5. Independent and reflective learning

**TEXT BOOKS:**

1. **ChemicalReactionEngineering,**OctaveLevenspiel,3rd edn,JohnWiley&Sons, 2001.
2. **ChemicalEngineeringKinetics,**J.M.Smith,3rdedn,McGrawHill.
3. **ElementsofChemicalReactionEngineering,**H.ScottFoggler,3rdedn,PrenticeHall, 2001.

**REFERENCE BOOKS:**

1. **Chemical&CatalyticReactionEngineering,**JamesJ.Carberry,McGrawHill,1976

| **MASS TRANSFER OPERATIONS LABORATORY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHL68** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **1I + 2P** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **42** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **02** | | | |

**Course Objectives:**

Students will

1. Experimentally verify the mass transfer concepts studied in theory.
2. Carry out experiment and make observations for various mass transfer equipment.
3. Study the effect of mass transfer coefficients in design of equipment.
4. Evaluate the performance characteristic for different mass transfer cases.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| The following experiments are to be carried out; the data are to be analyzed based on the theoretical aspects, and recorded with comments. | Blooms Level |
|---|---|
| 1. Diffusion of organic vapours in air | L3,L4,L5 |
| 2. Simple Distillation | L3,L4,L5 |
| 3. Packed column/ plate column distillation | L3,L4,L5 |
| 4. Steam distillation | L3,L4,L5 |
| 5. Solid – liquid leaching | L3,L4,L5 |
| 6. Surface evaporation | L3,L4,L5 |
| 7. Tray dryer | L3,L4,L5 |
| 8. Adsorption studies | L3,L4,L5 |
| 9. Liquid-liquid/Vapour –liquid equilibrium | L3,L4,L5 |
| 10. Liquid extraction – (cross current: 1 and 2 or 3 stage) | L3,L4,L5 |
| 11. Hold up studies in packed columns | L3,L4,L5 |
| 12. Rotary/ vacuum dryers | L3,L4,L5 |
| 13. Wetted wall column | L3,L4,L5 |
| 14. Cooling tower | L3,L4,L5 |
| 15. Solid dissolution | L3,L4,L5 |
| 16. Gel-electrophoresis | L3,L4,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge of various mass transfer equipment.
2. Acquire practical knowledge of mass Transfer Equipment.
3. Know the handling of Mass transfer operations.

**Conduct of Practical Examination:**

1. Minimum of 10 experiments are to be conducted and all 10experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Life long learning
5. Independent and reflective learning

**TEXT BOOKS:**

1. **MassTransferOperations**-RobertE Treybal,3rdedn,McGrawHill,1981.
2. **UnitOperationsin ChemicalEngineering**-McCabe&Smith,6thedn,McGraw Hill,2001.

**REFERENCE BOOKS:**

1. **Chemical Engineering Vol I, II, IV and V -** Coulson and Richardson, 4th edn, PergamonPress,1998.
2. **TransportProcessesandUnitOperation-**GeankoplisCJ,PrenticeHall(I),2000.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# SCHEME & SYLLABUS OF TEACHING AND EXAMINATION
# 2017-2018
# CHOICE BASED CREDIT SYSTEM (CBCS)

**SEMESTER VII**

| **BIOCHEMICAL ENGINEERING** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH71** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:**
To enhance skills in the areas of biochemical processes to provide the fundamental background of biological systems, biomolecules, micro-organisms, fermentation processes, Bioreactors and kinetics.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Introduction:** Bioprocess engineering and technology. Role of a Chemical engineer in bioprocess industry. An introduction to basic biological sciences. Microbiology: Structure of cells: Prokaryotes and Eukaryotes. Classification of micro-organisms. Taxonomy, control of microorganisms – physical and chemical methods. | 10 | L1, L2, L3 |
| **Module 2** **Content** | | |
| **Biochemistry:** Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids. Vitamins, Biopolymers, Nucleic Acids: RNA, DNA and their derivatives (Structure, Biological function and Importance for life only to be studied).<br>**Enzymes and Proteins:** Detailed structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes. Kinetics and | 10 | L2, L3, L5 |

| | | |
|---|---|---|
| mechanism of Enzyme action: Michaelis–Menten, Briggs-Haldane approach. Derivation. | | |
| **Module 3** **Content** | | |
| **Kinetics of Enzyme Action:** Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Line weaver–Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods).<br>**Enzyme Inhibition:** Effect of Inhibitors (Competitive, noncompetitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalyzed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses. Methods of enzyme immobilization. | 10 | L2, L3, L5 |
| **Module 4** **Content** | | |
| **Fermentation Technology:** Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: Sources of nutrients. Alternate bioreactor configurations. Introduction to sterilization of bioprocess equipment. **Growth Kinetics of Microorganisms:** Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. Continuous culture: Optimum Dilution rate and washout condition in Ideal Chemostat. Introduction to Fed-batch reactors. | 10 | L1, L2, L3, L4 |
| **Module 5** **Content** | | |
| **Kinetics of Microorganisms:** Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. Continuous culture: Optimum dilution rate and washout condition in Ideal Chemostat. Introduction to Fed-batch reactors.<br>**Downstream Processing**: Strategies and steps involved in product purification. Methods of cell disruption, Filtration, Centrifugation, Sedimentation, Chromatography, Freeze drying / lyophilization. Membrane separation Technology: Reverse Osmosis, Ultra filtration, Micro filtration, Dialysis. | 10 | L3, L4, L5 |

**Course outcomes:**

1. Understanding of biological basics and bioprocessing.
2. Understanding the difference between bioprocesses and chemical processes.
3. Bioprocess design and operation.
4. Bioreactor configuration and choice of bioreactor
5. Heat & mass transfer considerations and scale up of bioprocesses
6. Introduction to bioprocess monitoring/control

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning
5. Collaborative and multidisciplinary work

**TEXT BOOKS:**


1. **Biochemical Engineering Fundamentals,** Bailey and Ollis, 2nd edn, McGraw Hill,1976.
2. **Bioprocess Engineering,** Shuler M. L. and Kargi F., 2nd edn, Prentice Hall, 2002.


**REFERENCE BOOKS:**


1. **Biochemical Engineering,** James Lee, Prentice Hall, 1992.
2. **Biochemical Reactors,** Atkinson B, Pion Ltd., London, 1974.
3. **Industrial Microbiology,** Casida, wiley, New York, 1968
4. **Principles of Fermentation Technology,** Stanbury and Whitekar, 2nd edn, Butterworth-Heinemann An Imprint of Elsevier


| **COMPUTER APPLICATIONS AND MODELING** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH72** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:**

To make the students understand physical systems inchemical engineering and to develop their mathematical models and solutions for these models. The students will also learn to use the commercial process simulators

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Review of Computational Methods:** Simultaneous linear algebraic equation – Gauss Jordan., Non-linear algebraic equation-Newton Raphson. Ordinary Differential Equation- R-K Method. Numerical Integration-Simpson's 1/3 Rule. Curve Fitting-Least Squares. | | 10 | L1,L2,L3 |
| **Module 2** | **Content** | | |

| | | |
|---|---|---|
| **Applications:** Vapor- Liquid equilibria for binary mixtures. Calculation of Bubble Pressure and Bubble Point. Dew Pressure and Dew point for Ideal Binary and multi-component system.<br>**Flash Vaporization:** for multi-component system. Design of Adiabatic Batch Reactor. Design of Adiabatic PFR, Adiabatic CSTR and Combinations. | 10 | L2,L3,L4 |
| **Module 3** **Content** | | |
| Design of Adiabatic PFR, Adiabatic CSTR and Combinations.<br>**Design:** Double Pipe Heat Exchanger (Area, Length and Pressure drop). Shell & Tube Heat<br>Exchanger (Area, Number of tubes, Pressure drop. | 10 | L3,L4,L5 |
| **Module 4** **Content** | | |
| **Absorption & Distillation Columns:** Calculations for Plate and Packed Columns. | 10 | L4,L5,L6 |
| **Module 5** **Content** | | |
| **Modeling:** Models and model building, principles of model formulations, precautions in model building, Fundamental laws: Review of shell balance approach, continuity equation, energy equation, equation of motion, transport equation of state equilibrium and Kinetics, classification of mathematical models. **Mathematical Modeling and Solutions to the Following:** Basic tank model – Level V/s time. Batch Distillation – Vapor composition with CSTRs in series time. | 10 | L3,L4,L5 |

**Course outcomes:**

1. Understand the important physical phenomena from the problem statement
2. Develop model equations for the given system
3. Demonstrate the model solving ability for various processes/unit operations
4. Demonstrate the ability to use a process simulation

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**


1. **Computer based Numerical Analysis,** M. Shantha Kumar, 1st edn, KPS Publisher,1987.
2. **Introduction to Chemical Engineering and Computer Calculations,** Myers, A.L and Seider W.D, Prentice Hall, 1976.
3. **Process Modeling Simulation and Control for Chemical Engineering,** William. L Luyben, 2nd edn., McGraw Hill, 1990.


**REFERENCE BOOKS:**


1. **Elements of Chemical Reaction Engineering,** H. Scott Fogler, 2nd edn, Prentice Hall, 2001.

2. **Introduction to Chemical Engineering Thermodynamics,** Smith J. M. and H. C. Vanness, 5th edn, McGraw Hill, 1996.

| PROCESS CONTROL AND INSTRUMENTATION | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH73** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:**
To gain the knowledge of different process instruments, To understand dynamic modeling of a physical process using first principles, To design various control schemes, To apply the control system in various processes.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Instrumentation:** Fundamentals Static and dynamic characteristics. Indicators and recorders. Pressure measurement- Bourdon, diaphragm and bellow type gages. Vacuum measurements. Temperature measurement- Bimetal and resistance thermometers, thermocouples and pyrometers. | | 10 | L1, L2 |
| **Module 2** | **Content** | | |
| **First Order Systems**: Thermometer, level, mixing tank, STR, Linearisation, I order systems in series. Response for various input forcing functions. **Second Order Systems**: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case – Terms associated with it. Transportation lag. | | 10 | L2, L3, L4 |
| **Module 3** | **Content** | | |
| **Closed Loop System**: Basic components. Servo and regulator control. Controllers – P, I, D and On –Off modes. Controller combinations - Final control elements - Valves, actuators and valve positioners. **Closed Loop Response:** Block diagram, Closed loop transfer function, Transient response ofservo and regulator control systems with various controller modes and their characteristics. | | 10 | L2, L3, L4 |
| **Module 4** | **Content** | | |
| **Stability:** Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams. | | 10 | L3, L4,L5 |
| **Module 5** | **Content** | | |
| **Control System Design By Frequency Response:** Bode criterion. Gain and Phase margins, Ziegler – Nichols controller tuning, Cohen-Coon controller tuning. **Root Locus:** Rules for plotting and problems. | | 10 | L3, L4,L5 |

**Course outcomes:**

1. Knowledge of field instrumentations
2. Dynamic modeling and system behavior study
3. Design of controllers
4. Application of control systems in processes

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1.Critical thinking
2.Problem solving
3.Use of modern tools
4.Life - long learning

**TEXT BOOKS:**

1. **Process System Analysis and Control,** Coughner & Koppel, 2nd edn, McGraw Hill, NewDelhi, 1991.

**REFERENCE BOOKS:**

1. **Process Modeling, Simulation & Control for Chemical Engineers,** Luyben, 2nd edn, McGraw Hill, 1990.
2. **Chemical Engineering Vol. III, III Edition,** Coulson & Richardson, Pergamon Press,1998.
3. **Chemical Process Control-**An Introduction to Theory & Practical, George Stephanopoules,Vol.3, Prentice Hall, New Delhi, 1998.

**15 CH74X : Professional Elective [P.E]-III**

| **APPLIED MATHEMATICS IN CHEMICAL ENGINEERING** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH741** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

To impart the knowledge of mathematics for solving various mathematical equations that need tobe solved in several chemical engineering courses such as heat and mass transfer, momentum transfer, reaction engineering, separation processes, thermodynamics, etc.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Mathematical Formulation of the Physical Problems:** Applications of laws of conservation of mass, energy. Statement of the problem. Modeling. Examples and problems. | | 8 | L1,L2,L3,L4, L5 |
| **Module 2** | **Content** | | |
| **Ordinary Differential Equations:** Formulations of ordinary differential equations involving chemical engineering problems. Solutions- Equations of first order and first degree. Equations of first order and second degree. Bernoulli equation. Euler equation. | | 8 | L1,L2,L3,L4, L5 |

| | | | |
|---|---|---|---|
| Simultaneous linear differential equations. | | | |
| **Module 3** | **Content** | | |
| **Partial Differential Equations:** Formulations of partial differential equations involving chemical engineering problems. Solutions. Fourier series. | | 8 | L1,L2,L3,L4, L5 |
| **Module 4** | **Content** | | |
| **Numerical Methods:** Solutions of ordinary differential equations for chemical engineering problems. Solutions of partial differential equations for chemical engineering problems. | | 8 | L1,L2,L3,L4, L5 |
| **Module 5** | **Content** | | |
| Difference operator, linear difference equations, analysis of stage-wise processes. Laplace transforms and their applications to chemical engineering. | | 8 | L1,L2,L3,L4, L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Understand the basic algorithms for solution of and be able to solve linear and non-linear equations.
2. Be proficient in manipulation of logarithmic, exponential, and other non-linear functions in order to linearizeand to regress non-linear expressions.
3. Understand the basic algorithms for solution of and be able to solve numerical integration and ordinary differential equations.
4. Be familiar with a variety of numerical methods for solving partial differential equations.
5. Be able to apply the techniques learnt in this subjectto the solution of a comprehensive design problems in chemical engineering.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**


1. **Applied Mathematics in Chemical Engineering,** H.S. Mickley, T.K. Sherwood and C.E.Reed, 3rd edn, Tata McGraw Hill, 1999.
2. **Mathematical Methods in Chemical Engineering,** V.G. Jenson & G.V. Jeffreys, Academic Press, London, 1977.
3. **Mathematical Methods in Chemical Engineering,** S. Pushpavanam, Eastern Economy Edition, 2004.


**REFERENCE BOOKS:**


1. **Applications of Mathematical Modeling to Process Development and Design,** L.M. Rose

Applied Science Publishers Ltd., London, 1998.

| CHEMICAL PROCESS INTEGRATION | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH742** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

Process integration involves considering holistic view of chemical process. To understand process synthesis and analysis. Heat and mass integration techniques are studied to minimize the losses and to make the process more economical.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| Introduction to Process Integration: Graphical Techniques. Overall mass targeting, Synthesis of Mass Exchange Network: Graphical approach. Direct recycle strategies. | 8 | L1,L2,L3, |
| **Module 2** **Content** | | |
| Visualization Strategies: for development of mass integrated system. Algebraic approach totargeting direct recycles. | 8 | L1,L2,L3,L4 |
| **Module 3** **Content** | | |
| Algebraic Approach: to targeting mass exchange, network. Recycle strategies using propertyintegration. | 8 | L1,L2,L3,L4, |
| **Module 4** **Content** | | |
| Heat Integration: Combined heat and power integration. Optimization: Mathematical approach to direct recycle, Graphical method, simplex method,single variable optimization, multivariable optimization. | 8 | L3,L4,L5 |
| **Module 5** **Content** | | |
| **Mathematical Techniques:** for synthesis of mass & heat exchange excluding Lingo optimization techniques, for mass integration. Initiatives and applications. Case studies. | 8 | L3,L4,L5 |

**Course outcomes:** Students are able to synthesis and analyze the chemical process. Wherever possible students are able to solve mass integration and energy integration using algebraic, graphical and mathematical equations or models.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from

each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**

1. **Process Integration -** Mahmoud. M., El – Hawalgi, Vol. 7, Academic Press, 2006.

**REFERENCE BOOKS:**

1. **Chemical Process Design & Integration,** Robin Smith, 2nd edn, Wiley, 2005.
2. **Pinch Analysis and Process Integration -** A user guide on process integration for efficientuse of energy, Kemp I.C, 2nd edn, Butterworth, Heinneman, 2006.

| **TRANSPORT PROCESS AND MODELING OF AQUATIC SYSTEMS** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH743** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

1. To make students learn evaluation and control techniques of water quality management in streams, lakes, and estuaries.
2. Mathematical analyses of patterns of water movement and their relation to water quality.
3. Fate and transport of contaminants in natural aquatic systems, design and management of environmental and water resource systems

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Level |
|---|---|---|---|
| **Module 1** | **Contents** | | L3,L4,L5 |
| **Modeling:** Introduction, applications in environmental management. Physical phenomena advection, diffusion, dispersion, Fick's laws of diffusion and convective – diffusion equations for turbulent & shear flow regimes | | 8 | |
| **Module 2** | **Contents** | | |
| **Steady-state water quality modeling:** Models for conservative and non-conservative substances. Data collection and analysis - specialized water quality surveys, estimation of decay and recreation rates | | 8 | L3,L4,L5 |
| **Module 3** | **Contents** | | |
| **1-D Oxygen balance models:** Streeter-Phelps equation, critical point method. Calibration and verification of 1-D oxygen model. Error measures. | | 8 | L3,L4,L5 |
| **Module 4** | Contents | | |
| **Mixing zones in rivers:** Types of outfalls and mixing regimes. Steady-state 2-D analysis. Field study | | 8 | L3,L4,L5 |

| | | | |
|---|---|---|---|
| methodology.<br>Parameter estimation – lateral mixing co-efficient – critical point method – simple numerical problems. Dissolved oxygen models for lakes under completely mixed and stratified conditions | | | |
| **Module 5** | **Contents** | | |
| **Eutrophication models:**<br>Simplified nutrient loading models for rivers and lakes. Ocean disposalof wastewater: Siting and design of outfalls. Ground water quality modeling concepts: Formulation 1-D & 2-D models with decay and retardation for instantaneous sources, plume delineation studies | | 8 | L3,L4,L5 |

**Course outcomes:**

1. After studying this course, students will be able to understand:
2. Contaminant transport and fate
3. Ecological and human effects assessment
4. Environmental decision criteria
5. Monitoring strategies
6. Environmental exposure assessment
7. Development of pollutant transport, fate and persistence models; model parameter Estimation.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Life long learning
5. Independent and reflective learning

**TEXT BOOKS:**


1. Rich L.G., “Environmental Systems Engineering“, McGraw Hill.
2. Thomann R.V., and Mueller J.A., “Principles of Water Quality Management and Control”, Harper & Row Publications.


**REFERENCE BOOKS:**


1. Schnoor J.L., “Environmental Modeling – Fate and Transport of Pollutants in Water, Air and Soil”, John Wiley and Sons.
2. Thomann R.V., “Systems Approach to Water Quality Management”, McGraw Hill.
3. Lee C.C., and Lin S.D., “Handbook of Environmental Engineering Calculations”, McGraw Hill, New York.

| PILOT PLANT AND SCALE UP STUDIES | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH744** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**
To understand different scale up methods in chemical engineering and applying the knowledge to scale up the reactors for industrial scale operations.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Pilot Plants:** Evolution of process system. Need of pilot plants. Concept of prototypes, models, scale ratios, element. Principles of similarity: Geometric similarity, Distorted similarity, Static, dynamic, kinematic, thermal and chemical similarity with examples. | | 8 | L1,L2,L3,L4,L5 |
| **Module 2** | **Content** | | |
| **Dimensional Analysis:** (Review of Rayleigh's, Buckingham-∏methods), Differential equation for static systems, flow systems, thermal systems, mass transfer processes, chemical processes-homogeneous and heterogeneous. | | 8 | L2,L3,L4,L5 |
| **Module 3** | **Content** | | |
| **Regime Concept:** Static regime. Dynamic regime. Mixed regime concepts. Criteria to decide the regimes. Equations for scale criteria of static, dynamic processes, Extrapolation. Boundary effects. | | 8 | L2,L3,L4,L5 |
| **Module 4** | **Content** | | |
| Scale up of mixing process, agitated vessel, Scale up of chemical reactor systems-Homogeneous reaction systems. Reactor for fluid phase processes catalyzed by solids. Fluid-fluid reactors. | | 8 | L2,L3,L4,L5,L6 |
| **Module 5** | **Content** | | |
| Stagewise mass transfer processes. Continuous mass transfer processes. Scale up of momentum and heat transfer systems. Environmental challenges of scale up. | | 8 | L2,L3,L4,L5,L6 |

**Course outcomes:**

1. Differentiate between pilot plant and model.
2. Able to develop a prototype (Large scale plant) based on pilot plant studies.
3. Correlate the performance of geometrically similar paddle, propeller and turbine mixers.
4. Advantages and disadvantages of dimensional analysis technique over differential equation technique.
5. Designing a piece of equipment by successive approximation method(Extrapolation).
6. Able to eliminate boundary effects in various chemical systems.
7. Scaling up of equipment like heat exchangers, evaporator, and packed towers, agitated vessel and chemical reactors.
8. Analyze the problems involved in chemical engineering equipment.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes:**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**

1. **Scale up of Chemical Processes**, Attilio Bisio, Robert L. Kabel, John Wiley & Sons, 1985
2. **Pilot Plants Models and scale up method in Chemical Engineering,** John stone and Thring, McGraw Hill, 1957.

**REFERENCE BOOKS:**

**1. Pilot Plants and Scale up Studies,** Ibrahim and Kuloor.

## 15CH75X : Professional Elective-IV

| **COMPOSITE MATERIALS** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH751** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**
This subject introduces to the students the different types of composite materials, their properties and applications.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Synthesis and Fabrication:** of advanced and future materials with emphasis on ceramic, Semi-conducting and Super-conducting materials with superior structural, optical and electrical properties. **Preparation Techniques:** Techniques for preparation of ultra-pure, ultra-fine powders: of oxides, nitrides, carbides etc., with very well defined characteristics and superior properties. | 8 | L1,L2,L3,L4 |
| **Module 2** **Content** | | |
| **Processing Techniques:** Techniques such as sintering, hot pressing, hot iso static pressing, tape-casting, sol-gel processing for the formation of monolithic ceramics. Composites (ceramic, ceramic metal, as well as metal matrix). $SiO_2$. Glasses from above powders**.** | 8 | L1,L2,L3,L4 |
| **Module 3** **Content** | | |
| **Processing Techniques Based on Reaction Methods:** such as Chemical vapour deposition(CVD), vapour phase epitaxy, plasma- | 8 | L1,L2,L3,L4 |

| | | |
|---|---|---|
| enhanced chemical vapour deposition (PECVD), chemical vapour infiltration (CVI). Self-propagating high temperature synthesis (SHS) for the preparation of monolithic ceramics, composites, coating, thin films, whiskers and fibres and semi conducting materials such as Si and Gallium Arsenide. | | |
| **Module 4** | **Content** | |
| Synthesis and processing of mixed ceramic oxides with high temperature super conducting properties. Reinforcement, additives, fillers for polymer composite, master batch& compounding. | 8 | L1,L2,L3,L4 |
| **Module 5** | **Content** | |
| Polymer composite. Fibre reinforced composites. Stress – Strain modulus relationship Nano composites. Characteristics & applications in marine, aerospace, building & computer industry. Manufacturing methods, hand layouts, filament winding, pultrusion, SMC, DMC. | 8 | L1,L2,L3,L4 |

**Course outcomes:**

1. Understand the significance of advanced materials.
2. Compare the set of technological properties of the advanced materials with the conventional materials.
3. Understand the characteristic properties and usability of composite materials.
4. Calculate the strength of the composite under transverse & longitudinal loading applications.
5. Identify the strengthening mechanics and fabrication techniques adopted in different types of composite material.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes:**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**


1. **Introduction to Ceramics**, W.D. Kingrey, 2nd edn., John Wiley, 1976.
2. **Advanced Composites,** Chawla, Kluner, Academic Publisher, 2003.


**REFERENCE BOOKS:**


1. **Introduction to Material Science for Engg.,** James T. Schockel Ford, 2nd edn, McMillan Publications.
2. **Elements of Material Science and Engineering,** L.H. Van Vlack, 4th edn, 1980.
3. **Fibre Reinforced Plastic Deskbook,** Nicholas P, Paul N, Chermisin off, Ann Arbor science publishing Inc, 1978.

| CEMENT & CERAMIC TECHNOLOGY | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH752** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**
To impart a fundamental knowledge about types, properties, manufacturing process and applications of ceramics and cement.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| Modules | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | 8 | L1,L2,L3,L4 |

**INTRODUCTION OF NATURAL CERAMICS:**

The range and scope of various natural minerals and inorganic nonmetallicmaterials to be used as raw materials for ceramic products. General ideas aboutthe characterization of natural and synthetic materials.

Fundamental principles of silicate structures, structure of clay minerals,(Chinaclay, montmorillonite, pyrophyllite). Structure of mica, talc, silimanite minerals.

**Non plastic materials :**

Polymorphic forms of $SiO_2$ and their transformations. Different natural forms of $SiO_2$ ofindustrial importance – their properties and uses. Properties, composition, effect of heat,uses and availability of pyrophillite, talc, sillimanite minerals, zircon sand etc.

**Plastic Raw Materials :**

**Clays:** Classification of clay, Composition and properties viz: particle shape and size,Deflocculation and flocculation, plasticity, CEC, General ideas, occurrences, importantproperties and uses of : China Clay, Ball clay, Fire Clay, Bentonites etc.

**Fluxing agents:**

NephelineSyenite, Bone ash, Lepilolite, Wollastonite – their compositions, properties,availability and uses in ceramic industries.

**Refractory Raw materials :**

General idea, Composition, Properties effect of heat, availability and uses of Bauxitefamily, magnesite, dolomite, chromite, graphite, Limestone

| | | | |
|---|---|---|---|
| **Module 2** | **Content** | 8 | L1,L2,L3,L4 |

**SYNTHETICALLY PREPARED MATERIALS**

Importance of synthetic ceramic raw materials.

**Methods of powder preparation**: General idea of technique of powder preparation:- Sol gel, Co-precipitation, solvent vaporization.

**Preparation, composition, characterization and uses** of Sinter $Al_2O_3$ powders (prepared from different routes), Fused $Al_2O_3$, Mullite, Mag-AlSpinel, $ZrO_2$, $TiO_2$, Ba-titanate, ferrite, fumed silica, silicic acid sol, silica gel.

**Other synthetic materials:** Sea water magnesia, B/F slag, fly ash, red mud, Rice husk ash,electrolytes etc.

**Synthetic abrasives :** General ideas about their properties and uses

| Module 3 | Content | | |
|---|---|---|---|
| **MATERIAL CHARACTERIZATION & FORMING PROCESSES**<br>Characterization and specification of ceramic materials, Chemical and Phase compositions, Particle size and shapes, Density, pore structure and specific surface area.<br>**Particle mechanics and rheology:**Particle packing characteristics – Models of one, two of spherical balls Gap grading, continuous grading.<br>Rheological behavior of slurries and pastes: -Newtonian fluid, plastic flow, dilatant liquid, thixotropy, Deflocculation, Zeta potential, effect of electrolytes on Zeta potentials, applications in ceramic processing.<br>**Forming processes:**Dry pressing – powder flow and die filling, compaction behaviour, ejection and transfer, die wall effects, control of compaction defects, Cold isostatic Pressing, Plastic forming – Extrusion, Jiggering, Jolleying,<br>**Casting process**- Slip Casting,<br>**Drying:** drying processes, Mechanisms in drying, defects Shaping,surface finishing, glazing.<br>**Firing**: Firing system, Pre sintering processes, sintering, and vitrification and cooling.<br>**Glass processing**: selection of raw materials, effects of different oxides on glass properties, batch preparation, melting in glass tank furnace, refining of glass. | | 8 | L1,L2,L3,L4 |
| **Module 4** | **Content** | | |
| **CEMENT & CONCRETE – I**<br><br>**Pozzolana Cement:**Definition, classifications, Pozzolanic activity and its influencing factors, Lime –Pozzolana reaction and products formation, Applications.<br>**Portland Cement:**Definition, Raw materials and their physico- chemical characteristics, manufacturingprocess, cement making kilns viz, Rotary and shaft kiln. Refractory used in Rotary kiln,reactions occurred in different zones of rotary kiln, Hydration of cement, Setting andhardening of Portland cement, Heat of Hydration, Action of acid &sulphate water oncement, Flash set and False set of cement, Alkali – Aggregate reaction in Portlandcement., Applications.<br>**Special Cements:**Rapid hardening Portland cement, Quick setting cement, White Portland Cement,coloured cement, Sulphate resisting cement, Low heat Portland cement, Oil-wellcement, Waterproofed Portland cement, Hydrophobic cement, sorel cement, BlendedCement, Macro defect Free (MDF) Cement, Sur-Sulphated Cement, RefractoryCement, Cement paints. | | 8 | L1,L2,L3,L4 |
| **Module 5** | **Content** | | |
| **CEMENT & CONCRETE – II**<br>**Testing of Cements** : Insoluble residue in cement, estimation of free lime in cement,fineness of cement, standard consistency of cement, Initial and Final setting of cement,soundness of cement, slump test of concrete, Flow table test of mortar , Heat of hydrationof cement .Vee Bee consistometer test.<br>**High Alumina Cement:**Introduction to Refractory cement, Raw Materials used, classification and composition ofHAC, manufacturing | | 8 | L1,L2,L3,L4 |

| | | |
|---|---|---|
| process, Mineralogical phases of HAC, Hydration of HAC on thebasis of $CaO-Al_2O_3-H_2O$ Phase diagram, **Concrete:**Introduction, Admixture, Gap Grade concrete, continuous grade concrete, light, normal and heavy concrete,properties of concrete, installation technique of concrete, uses of various concretes | | |

**Course outcomes:**

After studying this course, students will be able to:

1. Understand the properties and usability of different types of natural and synthetic ceramic materials.
2. Understand the forming and processing of ceramic materials
3. Understand the different types, properties and applications of cement and concrete.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Lifelong learning
5. Independent and reflective learning

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**

1. W.E. Worral : Clays and ceramic raw materials
2. S. Kumar: Hand book of ceramics ; Vol – I & II
3. Concrete Technology by Neville
4. Cement Chemistry by F.W. H. Taylor.

**REFERENCE BOOKS:**

1. J. S. Reed: - Introduction to the principles of ceramic processing
2. Singer and Singer: Industrial Ceramics
3. F. Moore : Rheology of Ceramic systems
4. Onoda and Hench : Ceramic Processing before firing
5. Rex W. Grimshaw: The Chemistry and Physics of clays and other ceramic materials
6. High Alumina Cement by T. D. Robson
7. Chemistry of cement by F.M. Lea

| **NOVEL SEPARATION TECHNIQUES** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH753** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

1. To identify the multiple factors influencing the choice of separation techniques.
2. To be able to qualitatively and quantitatively address the fundamental aspects of specialty separation processes

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| Modules | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | 8 | L1,L2,L3,L4 |
| **Adsorptive Separations:** Review of fundamentals. Mathematical modeling of column factors. Pressure swing & thermal swing adsorption. Counter current separations. **Chromatography:** Chromatography fundamentals. Different types, Gradient & affinity chromatography, Design Calculations for chromatographic columns. | | | |
| **Module 2** | **Content** | 8 | L1,L2,L3,L4 |
| **Membrane Separation Processes:** Types, Thermodynamic considerations. Mass transfer considerations. Design of RO &UF. Ion selective membranes. Micro filtration. Electro dialysis. Pervaporation. Gaseous separations. **External Field Induced Separations:** Electric & magnetic field separations. Centrifugal separations and calculations. | | | |
| **Module 3** | **Content** | 8 | L1,L2,L3,L4 |
| **Surfactant Based Separations**: Fundamentals. Surfactants at inter phases and in bulk. Liquid membrane permeation. Foam separations. Micellar separations. | | | |
| **Module 4** | **Content** | 8 | L1,L2,L3,L4 |
| **Super Critical Fluid Extraction:** Thermodynamics and physico chemical principles. Process description. Application. Case Study. | | | |
| **Module 5** | **Content** | 8 | L1,L2,L3,L4 |
| **Mechanical–Physical Separation Process:** Introduction, Classification, Filtration in solid liquid separation. Settling & sedimentation in particle fluid separation.<br>**Other Separations:** Separation by thermal diffusion, Electrophoresis, crystallization. | | | |

**Course outcomes:**

1. Understand the fundamentals of various types of advanced separation techniques
2. Analyze a given industrial separation/problem and apply concepts of advanced separation techniques
3. Explore use of alternative separation techniques to the existing ones
4. Analyze and compare membrane reactors with conventional reactors

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes:**

1. Critical Thinking
2. Problem solving
3. Use of modern tools

4. Life - long Learning

**TEXT BOOKS:**

1. Marcel Mulder, "Basic Principles of Membrane Technology",2nd edn.,Springer Publications,2007
2. Handbook of Separation Process Technology,R.W.Rousseu, John Wiley & Sons,1987

**REFERENCE BOOKS:**

1. Encyclopedia of Chemical Technology, Kirk-Othmer, John Wiley & Sons,2001.
2. Rate Controlled Separations, Phillip C Wankat, Kluwer Academic Pub, 1990.
3. Transportation and Separation Process, Gaenkopolis, Printice Hall, 2003.
4. Large Scale Adsorption Chromatography, P C Wankat, CRC Press, 1986.
5. Reverse Osmosis and Ultra Filtration Process Principle, S. Sourirajan& T. Matsura,NRC Publication, Ottawa, 1985.
6. Surfactant Based Separation, T.O. Hatton, Vol 23.
7. Supercritical Fluid Extraction, M A McHugh & V. J. Krukonis, Butterworth, 1987.

| **DOWNSTREAM PROCESSING** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH754** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**
To develop skills of the students in the area of Downstream processing with emphasis on purification of products.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms level |
|---|---|---|
| **Module 1** **Contents**<br>**INTRODUCTION**<br>Role and importance of downstream processing in biotechnological processes. Problems and requirements of byproduct purification. Economics of downstream processing in Biotechnology. Cost cutting strategies, Characteristics of biological mixtures, Process design criteria for various classes of byproducts, high volume, low value products and low volume, high value products, Physico-chemical basis of different bio-separation processes.<br>**Primary Separation Techniques**<br>Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques; flocculation andsedimentation, Centrifugation (ultra and differential) and filtration methods. | 8 | L2,L3,L4,L5 |
| **Module 2** **Contents**<br>**PRODUCT IDENTIFICATION & SEPARATION TECHNIQUES**<br>Principle and Applications of Electrophoresis - their types, Types of staining, Iso-electric focusing, ELISA (Enzyme Linked Immuno Sorbant Assay).<br>**Product Separation Techniques**– ClassicalDistillation, Liquid - liquid extraction, Absorption and Adsorption, Evaporation. | 8 | L2,L3,L4,L5 |

| | | | |
|---|---|---|---|
| **Module 3** | **Contents** | | |
| **MEMBRANE SEPARATION & ENRICHMENT OPERATIONS**<br>Membrane – based separations theory; Design and configuration of membrane separationequipment; Solute polarization and cake formation in membrane ultra-filtration – causes, consequences and control techniques; Applications: Use of membrane diffusion as a tool forseparating and characterizing naturally occurring polymers; enzyme processing using ultrafiltration membranes; separation by solvent membranes; reverse osmosis.<br>**Enrichment Operations:** Precipitation methods with salts, organic solvents, and polymers, extractive separations. Aqueoustwo-phase extraction, supercritical extraction; In situ product removal / integrated bioprocessing | | 8 | L2,L3,L4,L5 |
| **Module 4** | **Contents** | | |
| **PRODUT RECOVERY – Traditional and Adsorptive separation**<br>Chromatographic separation processes, Electrophoretic separations, hybrid separationtechnologies, Dialysis; Crystallization. Partition chromatography - Single dimensional (Both Ascending and Descending) and twodimensional chromatography - Thin layer chromatography, Gas liquid Chromatography,Adsorption column chromatography. Ion Exchange Chromatography: Cation Exchange andAnion Exchange chromatography. Gel Filtration Chromatography, Hydrophobic interaction chromatography, Affinity Chromatography, High Performance liquid chromatography (HPLC) –analytical and preparative. | | 8 | L2,L3,L4,L5 |
| **Module 5** | **Contents** | | |
| **LAB TO INDUSTRIAL SCALE**<br>Considerations for scale up – All related unit operations. Concepts of Linear flow rate,volumetric flow rate, residence time in chromatographic column during scale up. Quality andregulatory aspects - (QC/QA and GLP and GMP requirements). | | 8 | L2,L3,L4,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Understand the fundamentals of downstream processing for biochemical product recovery.
2. Examining traditional unit operations, as well as new concepts and emerging technologies that are likely to benefit biochemical product recovery in the future.
3. Learn about various methods of separation and purification of bioproducts.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Life long learning
5. Independent and reflective learning

**TEXT BOOKS:**

1. Bioseparations: Principles and Techniques, B. Sivasankar,Published by PHI Learning Pvt. Ltd., 2006
2. BioseparationTechnology,MishraNeeraj,CRC Press,2008

**REFERENCE BOOKS:**

1. Bioseparations Science and Engineering,Day, Trevor G, and Harrison, Roger G, and Rudge, Scott R,Publisher: Oxford University Press, USA, 2002
2. Handbook of Bioseparations, SatinderAhuja,Published by Academic Press, 2000
3. HPLC of Biological Macromolecules, M. Gooding, Fred E. Regnier, Contributor Karen M. Gooding, Fred E. Regnier,Published by CRC Press, 2002
4. Isolation and Purification of Proteins,RajniHatti-Kaul, Bo Mattiasson,Published by CRC Press, 2003
5. A Century of Separation Science, Haleem J. Issaq,Published by CRC Press, 2002

| **PROCESS CONTROL LABORATORY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHL76** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **1I+2P** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **42** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **02** | | | |

**Course Objectives:**

The Students will

1. Experimentally verify the principles and working of instruments studied in theory.
2. Carry out experiment and make observations for various parameters.
3. Study and use of various first order system and controllers.
4. Evaluate the data and compare with reported literature.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| The following experiments are to be carried out; the data are to be analyzed based onthe theoretical aspects, and recorded with comments. | Blooms Level |
|---|---|
| 1. Thermometer | L4,L5 |
| 2. Single tank - Step Response | L4,L5 |
| 3. Non Interacting Tanks - Step Response | L4,L5 |
| 4. Interacting Tanks - Step Response | L4,L5 |
| 5. Pressure Tank | L4,L5 |
| 6. U – Tube Manometer | L4,L5 |
| 7. Single tank - Impulse Response | L4,L5 |
| 8. Non Interacting Tanks - Impulse Response | L3,L4,L5 |
| 9. Interacting Tanks - Impulse Response | L3,L4,L5 |
| 10. Level/Flow/Pressure/pH/Temperature control – P controller | L4,L5 |
| 11.Level/Flow/Pressure/pH/Temperature control – PI controller | L4,L5 |
| 12.Level/Flow/Pressure/pH/Temperature control – PD controller | L4,L5 |
| 13. Level/Flow/Pressure/pH/Temperature control – PID controller | L4,L5 |
| 14. Valve characteristics | L4,L5 |
| 15. Flapper Nozzle System | L4,L5 |
| 16. Valve Positioner. | L4,L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge of various process controllers.

2. Acquire practical knowledge of systems of different orders and response controllers.

**Conduct of Practical Examination:**

1. Minimum of 10 experiments are to be conducted and all 10 experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedurepart to be made zero.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Lifelong learning
5. Independent and reflective learning

**TEXT BOOKS:**

1. **Process System Analysis and Control,** Coughner & Koppel, 2nd edn, McGraw Hill, NewDelhi,1991.

**REFERENCE BOOKS:**

1. **Process Modelling, Simulation & Control for Chemical Engineers,** Luyben, 2nd edn, McGraw Hill, 1990.
2. **Chemical Engineering Vol. III, III Edition,** Coulson & Richardson, Pergamon Press, 1998.
3. **Chemical Process Control**-An Introduction to Theory and Practical, George Stephanopoulos, Vol.3, Prentice Hall, New Delhi, 1998.

| **COMPUTER APPLICATIONS & SIMULATION LABORATORY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHL77** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **1I+2P** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **42** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **02** | | | |

**Course Objectives:**

The Students will

1. Experimentally verify the Heat Exchanger concepts studied in theory.
2. Carry out experiment and make observations for various heat transfer equipment.
3. Study the effect of U, hi and ho in design of equipment.
4. Evaluate the performance characteristic for different heat transfer cases.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| The following experiments are to be carried out; the data are to be analyzed based onthe theoretical aspects, and recorded with comments. | Blooms Level |
|---|---|
| **PART – A**<br>**NUMERICAL METHODS AND COMPUTER APPLICATIONS** | |
| 1. Non-linear algebraic equation- Newton Raphson (Specific volume of binary | L3,L4,L5 |

| | |
|---|---|
| mixture) | |
| 2. Ordinary Differential Equation- R-K Method ($dCa/dt=kCa^2$) | L3,L4,L5 |
| 3. Numerical Integration- Simpson's 1/3 Rule ( Batch Reactor to find time) | L3,L4,L5 |
| 4. Curve Fitting –Least Square (Nre vs f) | L3,L4,L5 |
| 5. Calculation of Bubble Point and Dew Point for Ideal multi-component system | L3,L4,L5 |
| 6. Flash Vaporisation for multi-component system | L3,L4,L5 |
| 7. Design of Adiabatic Batch Reactor, PFR | L3,L4,L5 |
| 8. Adiabatic Flame Temperature | L3,L4,L5 |
| 9. Double pipe heat exchanger (Area, Length and Pressure drop) | L3,L4,L5 |
| 10. Distillation Column (Bubble cap) | L3,L4,L5 |
| **PART – B**<br>**SIMULATION** | |
| 1. Introduction to suggested software available (flow sheeting) | L3,L4,L5 |
| 2. Simulations Studies of flash drum, Distillation Column, CSTR, PFR, Heat Exchanger. | L3,L4,L5 |
| 3. Simulation Studies of pump, compressor, cyclone, heater. | L3,L4,L5 |
| 4. Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following:<br>a) Ethylene Glycol from Ethylene oxide<br>b) Atmospheric distillation of crude oil<br>c) Propylene Glycol from Propylene oxide<br>d) Aromatic stripper with recycle stream (Benzene, Toluene, Xylene)<br>Styrene from Ethyl Benzene | L3,L4,L5 |
| **SOFTWARES SUGGESTED**<br>1. HYSYS<br>2. CHEMCAD<br>3. DESIGN-II<br>4. PROSIM<br>5. ASPEN PLUS | |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply theoretical knowledge of numerical methods and simulation.
2. Acquire practical knowledge of simulation of various process.
3. Know the use of simulations.

**Conduct of Practical Examination:**

Minimum of 10 programs/simulations are to be conducted andall are to be included for practical examination.

Students are allowed to pick one experiment from the lot.

Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.

Change of experiment is allowed only once and 15% Marks allotted to the procedurepart to be made zero.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Life long learning
5. Independent and reflective learning

**TEXT BOOKS:**

1. **Computer based Numerical Analysis,** M. Shanthakumar, 1st edn, KPS Publisher,1987.
2. **Process Modeling Simulation and Control for Chemical Engineering,**

William. LLuyben, 2nd edn., McGraw Hill, 1990.

**REFERENCE BOOKS:**


1. **Elements of Chemical Reaction Engineering,** H. Scott Fogler, 2nd edn, Prentice Hall,2001.
2. **Introduction to Chemical Engineering Thermodynamics,** Smith J. M. and H. C. Vanness,5th edn, McGraw Hill, 1996.


| **PROJECT PHASE 1 + PROJECT WORK SEMINAR** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHP78** | **CIE Marks** | **:** | **100** |
| **Credits** | **:** | **02** | **Contact Hours/week** | **:** | **03** |

The students in a group will be assigned an experimental, design, a case study or an analytical problem, to be carried out under the supervision of a guide. The project has to be assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester. The project work should be carried out and completed at the end of eighth semester.

The students are required to give the comprehensive presentation in the form of seminar on the project work. The seminar shall be evaluated as internal assessment. While evaluating, emphasis shall be given on the presentation and communication skills.

# SCHEME & SYLLABUS OF TEACHING AND EXAMINATION
# 2017-2018
# CHOICE BASED CREDIT SYSTEM (CBCS)

**SEMESTER VIII**

| **TRANSPORT PHENOMENA [D. C.](Common to CH & PC)** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH81** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:**

1. To introduce the students about basic laws of momentum, heat and mass transfer.
2. To determine the heat transfer rate and temperature distribution for different heat transfer situations.
3. To determine the mass transfer rate and concentration distribution for different mass transfer situations.
4. To study the different analogies between mass, momentum and mass transfer

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Introduction:** Momentum Energy and Mass Transport Newton's law of viscosity (NLV). Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction (FLHC), Fick's law of diffusion (FLD), Effect of temperature and pressure on transport properties of fluids. Numerical problems on the application and use of NLV, FLHC and FLD | 10 | L-1, L-2 |
| **Module 2** **Content** | | |
| **Velocity Distribution in Laminar Flow:** Different Flow situations, Steady state Shell momentum balances, Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flow through Annulus. **Steady State Shell Energy Balances:** General Boundary conditions applicable to energy transport problems of chemical engineering. Heat conduction through compound walls. Overall heat transfer coefficient. | 10 | L-1, L-2, L-3 |
| **Module 3** **Content** | | |
| **Temperature Distribution in Solids and in Laminar Flow:** Different situations of heat transfer: Heat conduction with internal generation by electrical and nuclear energy sources, Heat conduction in a cooling fin: Forced and free convection heat transfer. **Concentration Distributions in Laminar Flow:** Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Equimolar counter diffusion. Numerical problems. | 10 | L-1, L-2, L-3 |
| **Module 4** **Content** | | |
| **Concentration Distributions in Laminar Flow:** Diffusion through stagnant gas and liquid films, Diffusion with | 10 | L-1, L-2, L-3 |

| | | |
|---|---|---|
| homogeneous reaction, Diffusion with heterogeneous reaction Diffusion into falling film – Forced convection mass transfer. | | |
| **Module 5** **Content** | | |
| **Analogies between Momentum, Heat and Mass Transport:** Analogies between Momentum, Heat and Mass Transport - Reynold's, Prandtl's and Chilton & Colburn analogies. **Equations of Change:** Equation of continuity, Equation of motion; Navier – Stokes equation. | 10 | L-1, L-2 |

**Course outcomes: Students after completion of course will be able to**

1. Explain types of fluids,comprehend effect of temperature and pressure on transport properties of fluids and apply transport laws to solve numerical problems.
2. Derive overall heat transfer coefficient, Temperature distribution with and without energy sources
3. Determine velocity profile and shear stress profiles in different flow situations
4. Derive molar flux for stagnant gas, liquid films, homogeneous and heterogeneous reactions and applications to falling film forced convection mass transfer
5. Determine HT & MT coefficient using various analogies

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**

1. **Transport Phenomena,** Bird, Stewart and Lightfoot, Academic Press, 1994.

**REFERENCE BOOKS:**

1. **Momentum Heat and Mass Transport,** Welty, Wikes and Watson, 4th edn., John Wiley, 2000.
2. **Principles of Unit Operations in Chemical engineering,** Foust *et al.*, 2nd edn, John Wiley, 1990.
3. **Transport Phenomena – A Unified Approach,** Robert S. BrodKey and Henry C. Hershley, Vol.2, Brodkey Publishing, 2003.

| **PROCESS ENGINEERING ECONOMICS AND MANAGEMENT [D.C]** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH82** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **04** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **50** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **04** | | | |

**Course Objectives:**

1. To study various phases in process design & development.
2. To determine cost involved in various processes.

3. Estimation of capital cost, alternative investments and replacement analysis.
4. To study direct, indirect expenses involved and profitability evaluation methods.
5. To study various financial statements, significance of financial ratios and cash flow diagram.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | | Teaching Hours | Blooms Taxonomy |
|---|---|---|---|
| **Module 1** | **Content** | | |
| **Process Design Development**: Overall planning of a plant, Feasibility studies and Material & energy balance, Equipment sizing and selection, Process flow sheet, P & I diagram, Plant layout and location. | | 10 | L-1, L-2, L-3 |
| **Module 2** | **Content** | | |
| **Cost Analysis**: Factors affecting investment & production cost, Estimation of capital investment, Factors in capital investment, Estimation of working capital, cost index.<br>**Time value of money**: Types of interests, Effective and nominal interest rates, present worth and discount. | | 10 | L-1, L-2, L-3 |
| **Module 3** | **Content** | | |
| **Depreciation & Taxes:** Types of Depreciation and calculation methods<br>**Profitability:** Theory of profitability and its evaluation methods. | | 10 | L-1, L-2, L-3 |
| **Module 4** | **Content** | | |
| **Replacements:** Theory of replacements, causes for replacements types of replacements **Alternatives investments:**Theory of alternative investments and causes for the same. | | 10 | L-1, L-2, L-3 |
| **Module 5** | **Content** | | |
| **Financial statements and Design report:** Introduction to financial statements, Cash flow diagrams, balance sheet and Break-even analysis.<br>**Design report:** Introduction to design of reports. Types of reports, Organization of report and purpose of report. | | 10 | L-1, L-2, L-3 |

**Course outcomes:**

The students are expected to do the following.

1. Comprehend concepts of plant location, plant layout as applicable to industrial complexes
2. Understand various components of cost and estimate requirements of Fixed and working capital
3. Evaluate value of money and its equivalence to present and future
4. Comprehend factors affecting life of equipment and Determine depreciation by various methods
5. Interpret cash flow diagrams, break even analysis and apply to evaluate profitability
6. Comprehend alternative investments, replacement alternatives and prepare financial reports.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from

each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOK:**

1. T.R. Banga & S.C. Sharma Industrial Organization & Engineering Economics 22nd edn. Khanna Publishers 1999.

**REFERENCE BOOKS:**

1. Plant design and Economics for Chemical Engineers-Peters& Timmerhaus,4th edn McGrawHill,1991

## PROFESSIONAL ELECTIVE-V

| **CHEMICAL PLANT UTILITIES AND SAFETY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH831** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Understand various utilities required for a process industry.
2. Analyze the safety factors in a typical process unit.
3. Be able to select different safety devices required.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Introduction:** Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities. **Water:** Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pretreatment. | 8 | L1, L2, L3 |
| **Module 2** **Content** | | |
| **Air:** Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system-piping and accessories. Air-water vapor system: humidification/ dehumidification and evaporative cooling-related calculations. Insulation: Insulation Materials & Selection- Economics of insulation. Insulating factors. Properties & Classification. | 8 | L2, L3 |
| **Module 3** **Content** | | |

| | | |
|---|---|---|
| **Steam and Power:** Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Calorific value. Proximate and ultimate analysis. HHV, LHV and related calculations. Cogeneration power plants. CHPs and Boiler performance. Related calculations. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories. Boiler performance. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories. | 8 | L2, L3 |
| **Module 4** **Content** | | |
| **Refrigeration:** Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect- related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants. Cold insulation and cryogenic insulation. | 8 | L2, L3 |
| **Module 5** **Content** | | |
| **Process Safety**: Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire, Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.<br>**Safety Devices:** Pressure relief valves. Rupture discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices. Process Safety Analysis: HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis. | 8 | L2, L3, L4 |

**Course outcomes:**

After studying this course, students will be able to:

1. Summarize various utilities in process industries.
2. Decide the safety aspects in a chemical industry.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Life - long learning

**TEXT BOOKS:**

1. Thermal Engineering, B.K. Sarkar, Tata Mc Graw Hill, 8thReprint, 1998.
2. Water and Waste water engineering- Vol 2, Gordon M Fair, John C. Geyer and Daniel A Okun, Jhon Hutey, 1996.

**REFERENCE BOOKS:**

1 Chemical Engineers Handbook, Perry, 8th edn, 2007.

| MULTICOMPONENT DISTILLATION | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH832** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Understand the concept of distillation applicable to multi-component systems.
2. Calculate parameters for multicomponent distillation
3. Be able to optimize process conditions.
4. Design multicomponent distillation systems.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Introduction:** Phase Equilibrium for Multi component distillation. Thermodynamic relationships for multi component mixture, prediction of phase equilibrium. **Phase Equilibria:** Use of fugacities and activities. Introduction to the method of convergence characteristics. The Theta method for converging temperature. Profile-Development & application to conventional distillation columns. The 2N Newton-Raphson method-Introduction and the Algorithm. The method of successive approximations. | 8 | L1, L2, L3 |
| **Module 2** **Content** | | |
| **Multicomponent Distillation:** Azeotropic and extractive distillation process qualitative & quantitative estimations characteristics and applications. **Phase Behavior at Constant Pressure:** Homogeneous and heterogeneous azeotropes. | 8 | L1, L2, L3 |
| **Module 3** **Content** | | |
| **Reactive Distillation**: Distillation accompanied by chemical reaction. Application of the theta method of convergence in reactive method. | 8 | L2, L4, L5 |
| **Module 4** **Content** | | |
| **Reactive Distillation**: Formulation of N[r+2] Newton Rapson method. Typical Engineering calculations, | 8 | L2, L3, L5 |
| **Module 5** **Content** | | |
| Complex Mixture: Determination of minimum number of stages required to effect a specified Separation Complex Mixture: Optimum and economic design of distillation column for the complex mixtures. | 8 | L3, L4, L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Understand the principles of Multicomponent distillation.
2. Calculate process parameters.
3. Design multicomponent distillation systems.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.

- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

**TEXT BOOKS:**

1. Fundamentals of multicomponent distillation, C.D. Holland, McGraw Hill, 1997.

2. Separation processes, C.J. King, 2nd edn, Tata McGraw Hill, 1980.

**REFERENCE BOOKS:**

1. Distillation, Van Winkel, McGraw Hill, 1967.

2. Distillation Engineering, R. Billet, Chem. Publ. Co., NY, 1979.

| **ENERGY TECHNOLOGY** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH833** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

Students will

1. Understand the various sources of alternative energies.
2. Study the design equations for energy devices.
3. Design energy systems.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Energy Sources:** Conventional energy sources; non-conventional energy sources; advantages; limitations. **Solar Energy:** Solar radiation and its measurement – solar constant, solar radiation at earth's surface, solar radiation geometry, solar radiation measurement. Introduction to solar energy. Applications – solar water heating, space heating, space cooling, solar thermal electric conversion. Agriculture and industrial process heating, solar distillation, solar pumping, solar cooking. | 8 | L1, L2, L3 |
| **Module 2** **Content** | | |

| | | |
|---|---|---|
| **Energy from Biomass (Bio Gas):** Introduction. Biomass conversion Technologies. Wet processes. Dry processes. Biogas generation. Factors affecting bio digestion or generation of gas. Classification of biogas plants. Advantages and disadvantages of floating drum plant. Advantages and disadvantages of fixed dome type plant. Types of biogas plants (KVIC model & Janata model). Selection of site for biogas plant. | 8 | L1, L2, L3 |
| **Module 3** **Content** | | |
| **Bio-Energy (Thermal Conversion):** Methods of obtaining energy from biomass. Biodiesel, Thermal gasification of biomass. Classification of biomass gasifiers. Chemistry of gasification process. Applications of the gasifiers.<br>**Wind Energy:** Introduction. Basic components of WECS (wind energy conversion system). Classification of WECS. Types of wind machines-horizontal axis machines, vertical axis machines. Applications of wind energy. | 8 | L2, L4, L5 |
| **Module 4** **Content** | | |
| **Energy from the Oceans:** Introduction. Ocean thermal electric conversion (OTEC). Methods of ocean thermal electric power generation. Open cycle OTEC system. Closed or Anderson OTEC cycle, hybrid cycle. Application of energy from oceans,Basic principles of tidal power. Components of tidal power plants. Operation methods of utilization of tidal energy. Advantages and limitations of tidal power generation. Applications of tidal energy. | 8 | L2, L3, L5 |
| **Module 5** **Content** | | |
| **Conventional Fuels:** Introduction. Classification of solid liquid gaseous fuels. Calorific value. Characteristics of good fuels. Processing of fuels Comparison between solid, liquid and gaseous fuels. Fuel Burners. | 8 | L3, L4, L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Understand the different alternative energy sources.
2. Calculate different parameters for energy calculations.
3. Design energy systems.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical thinking
2. Problem solving
3. Use of modern tools
4. Research skill
5. Life-long learning

**TEXT BOOKS:**

1. **Non-Conventional Energy Sources,** G.D. Rai, 4th edn, Khanna Publications, 2ndReprint, 1997.
2. **Engineering Chemistry,** P.C. Jain & M. Jain, 10th edn, Dhanpat Rai & Sons, 3rd Reprint, 1995.

**REFERENCE BOOKS:**

1. **Solar Energy, Second Edition,** S.P. Sukhatme, 3rd Reprint, Tata McGraw Hill, New Delhi,1998.
2. **Solar Energy Utilization,** G.D. Rai, 4th edn, Khanna Publications, 2006.

| **INTERFACIAL PHENOMENA AND SURFACE ENGINEERING** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH834** | **CIE Marks** | **:** | **40** |
| **No. of Lecture Hrs/Week** | **:** | **03** | **SEE Marks** | **:** | **60** |
| **Total No. of Lecture Hours** | **:** | **40** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **03** | | | |

**Course Objectives:**

The students will

1. Understand the concept of interfacial phenomena.
2. Understand surfactant applications.
3. Calculate thermodynamic parameters for interfaces.
4. Evaluate criteria for spreading of liquids.

**Revised Bloom's Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

| **Modules** | Teaching Hours | Blooms Taxonomy |
|---|---|---|
| **Module 1** **Content** | | |
| **Introduction:** Concept of Interface and its formation with examples. Mechanical and Thermodynamic approaches to Interface. Equivalence in the concepts of surface energy and surface tension. Applications. Excess Pressure: Generalized equation for excess pressure across a curved surface- the equation of Young and Laplace. Pressure jump across cylindrical surface, flat surface. Vapor pressure of a drop. Solubility of drops. Ostwald ripening. Capillary condensation. Super saturation. Nucleation. | 8 | L1, L2, L3 |
| **Module 2** **Content** | | |
| **Thermodynamics of Interfaces**: Thermodynamic treatment of interfaces. Free energy at interface. Temperature dependence of the surface tension. Effect of pressure on interfacial tension. Effect of curvature on surface tension. Thermodynamics of binary systems-Gibbs Equation. Surface excess concept. Verification of Gibbs equation. Gibbs monolayers.The electrical double layer. Stern treatment of electrical double layer. Free energy of a diffused double layer. Repulsion between two plane double layers. | 8 | L2, L3, L4 |
| **Module 3** **Content** | | |
| **Surface Tension:** Definition Cause for existence, Capillary rise method. Drop weight method, Wilhelm plate method, du Nuoy method. Methods based on shape of static drops or bubbles. Dynamic methods-Flow and capillary waves.Colloidal dispersions. Combined attractive and electrical interaction-DLVO theory. Kinetics of coagulation | 8 | L2, L4, L5 |
| **Module 4** **Content** | | |
| **Surface Wetting** Fundamentals and Contact Angles: Work of adhesion, cohesion. Criteria for spreading of liquids. Kinetics of spreading. Lens formation- three phase systems. Young's equation. Neumann triangle. Theories of equilibrium contact angles. Contact angle hysteresis | 8 | L2, L3, L5 |
| **Module 5** **Content** | | |

| | | |
|---|---|---|
| **Surfactants:** Anionic and nonionic. Other phases involving surfactant aggregates. Surface films of insoluble surfactants. Thermodynamics of micro emulsions. Phase behavior of oil-water surfactant. Effect of composition changes. Applications of surfactants-emulsions and detergency. Interfacial stability. Damping of capillary wave motion by insoluble surfactants. Stability and wave motion of thin liquid films foams. Interfacial stability for fluids in motion. | 8 | L3, L4, L5 |

**Course outcomes:**

After studying this course, students will be able to:

1. Understand principles of surface engineering.
2. Calculate thermodynamic parameters for surface wetting.
3. Understand principles of surfactants.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions(with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Research Skill
5. Life-long learning

**TEXT BOOKS:**

1. Interfacial Phenomena, Equilibrium and Dynamic Effects, C.A. Miller & P. Niyogi, Vol.

17, Marshal Deckder, 1985.

2. Physical Chemistry of Surfaces, A.W. Adamson, John Wiley, 5th edn, 1997.

**REFERENCE BOOKS:**

1. Surface Activity, Millet J.L., 2nd edn, Van Nostrad, 1961.

2. Surface Active Chemicals - Garrett H.E., Pergamom Press, 1974.

| **INTERNSHIP/PROFESSIONAL PRACTICE** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CH84** | **CIE Marks** | **:** | **50** |
| **Exam Hours** | **:** | **03** | **SEE Marks** | **:** | **50** |
| **No. of Lecture Hrs/Week** | **:** | **Industry Oriented** | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **02** | | | |

The students should undergo in-plant training in any chemical industry or in a reputed research laboratory with pilot plant facility. This shall be for a minimum period of two weeks during the vacation of sixth or seventh semester. If it is not possible, the students may be permitted to go on industrial visit for a period of two weeks and they should visit a minimum of five major chemical industries. Each student should submit a report separately at the beginning of the 8th semester, which is evaluated by a committee constituted by the HOD for internal assessment.an external examiner

has to be called for viva-voce and internal guide together with external examiner should evaluate the performance as examination. The student has to give a presentation on in-plant training or industrial visit to the external and internal examiners and answer for queries.

**Course outcomes:**

After studying this course, students will be able to:

1. Prepare reports and compile data.
2. Prepare presentation and communicate findings to audience.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Life long learning

| **PROJECT WORK -II** | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHP85** | **CIE Marks** | **:** | **100** |
| **No. of Lecture Hrs/Week** | **:** | **06** | **SEE Marks** | **:** | **100** |
| | | | **Exam Hours** | **:** | **03** |
| **Credits** | **:** | **06** | | | |

Course Objectives:

Students will

1. Learn to plan and perform experiments related to project work.
2. Learn to compile data and analyze.
3. Learn to publish data in reputed journals.
4. Learn to prepare report of work.

Student has to complete project work and submit thesis(Corrected from guide) at the end of VIII Semester which should be evaluated as IA Marks by the departmental committee.

Student has to submitproject thesis to the Head of the department through the guide.Evaluation of project report from the VTU by external examiner will be done. The student has to prepare for queries and give a presentation on project work to the External and internal examiners. An external examiner has to be called for viva-voce and internal guide together with external examiner should evaluate the performance as examination.

**Course outcomes:**

After studying this course, students will be able to:

1. Perform experiments, obtain results, analyze the results and publish in reputed journals.
2. Complete project thesis as per the standard format by consulting the guides.

**Graduate Attributes:**

1. Research skill.
2. Use of modern skills.
3. Project management and finance.

4. Independent and reflective thinking.

| SEMINAR | | | | | |
|---|---|---|---|---|---|
| **Subject Code** | **:** | **17CHS86** | **CIE Marks** | **:** | **100** |
| **No. of Lecture Hrs/Week** | **:** | **04** | | | |
| **Credits** | **:** | **01** | | | |

Course Objectives:
Students will

1. Develop skills in searching technical literature, analyzingand evaluating it to compare the various approaches and prepare a written report and also presenting it orally.

The student has to prepare, submit a seminar report and make a presentation on Seminar topicallotted. The seminar shall be evaluated as internal assessment by a committee constituted bythe HOD.

**Course outcomes:**
After studying this course, students will be able to:

1. Prepare reports and compile data.
2. Prepare presentation and communicate findings to audience.

**Graduate Attributes**

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Life long learning