


|  MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI TEACHING AND EXAMINATION SCHEME FOR POST S.S.C. DIPLOMA COURSES | | | | | | | | | | | | | | | | | | |
|--|------------------------------|--------------|----------|-----------------|-----------|-----------|--------------------|------------|-----------|---------------------------------|-----------|-----------|-----------|------------|-----------|-----------|------------|----|
| COURSE NAME : DIPLOMA IN CHEMICAL ENGINEERING | | | | | | | | | | | | | | | | | | |
| COURSE CODE : CH | | | | | | | | | | | | | | | | | | |
| DURATION OF COURSE : 6 SEMESTERS | | | | | | | | | | WITH EFFECT FROM 2012-13 | | | | | | | | |
| SEMESTER : SIXTH | | | | | | | | | | DURATION : 16 WEEKS | | | | | | | | |
| PATTERN : FULL TIME - SEMESTER | | | | | | | | | | SCHEME : G | | | | | | | | |
| SR. NO | SUBJECT TITLE | Abbreviation | SUB CODE | TEACHING SCHEME | | | EXAMINATION SCHEME | | | | | | | | | | SW (17600) | |
| | | | | TH | TU | PR | PAPER HRS. | TH (1) | | PR (4) | | OR (8) | | TW (9) | | | | |
| | | | | | | | | Max | Min | Max | Min | Max | Min | Max | Min | | | |
| 1 | Management \$ | MAN | 17601 | 03 | -- | -- | 03 | 100 | 40 | -- | -- | -- | -- | -- | -- | -- | 50 | |
| 2 | Environmental Technology | ETE | 17646 | 03 | -- | 02 | 03 | 100 | 40 | 25@ | 10 | -- | -- | -- | -- | -- | | |
| 3 | Chemical Engineering Drawing | CED | 17647 | 02 | -- | 04 | 04 | 100 | 40 | -- | -- | 25# | 10 | 25@ | 10 | -- | | |
| 4 | Mass Transfer Operation | MTO | 17648 | 03 | -- | 04 | 03 | 100 | 40 | 50# | 20 | -- | -- | 25@ | 10 | -- | | |
| 5 | ELECTIVE (Any One) | | | | | | | | | | | | | | | 50 | | |
| | Alcohol Technology | ATE | 17649 | 03 | -- | 02 | 03 | 100 | 40 | -- | -- | -- | -- | 25@ | 10 | | | -- |
| | Petro Chemical Technology | PCT | 17651 | 03 | -- | 02 | 03 | 100 | 40 | -- | -- | -- | -- | 25@ | 10 | | | -- |
| 6 | Process Simulation | PSI | 17802 | -- | -- | 02 | -- | -- | -- | -- | -- | -- | -- | 25@ | 10 | -- | | |
| 7 | Project & Seminar | PAS | 17803 | -- | -- | 04 | -- | -- | -- | -- | -- | 50# | 20 | 50@ | 20 | -- | | |
| TOTAL | | | | 14 | -- | 18 | -- | 500 | -- | 75 | -- | 75 | -- | 150 | -- | 50 | | |
| Student Contact Hours Per Week: 32 Hrs. THEORY AND PRACTICAL PERIODS OF 60 MINUTES EACH. Total Marks : 850 @ - Internal Assessment, # - External Assessment, No Theory Examination, \$ - Common to all branches, #* - Online Theory Examination. | | | | | | | | | | | | | | | | | | |
| Abbreviations: TH-Theory, TU- Tutorial, PR-Practical, OR-Oral, TW- Term Work, SW- Sessional Work | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> ➤ Conduct two class tests each of 25 marks for each theory subject. Sum of the total test marks of all subjects is to be converted out of 50 marks as sessional work (SW). ➤ Progressive evaluation is to be done by subject teacher as per the prevailing curriculum implementation and assessment norms. ➤ Code number for TH, PR, OR, TW are to be given as suffix 1, 4, 8, 9 respectively to the subject code. | | | | | | | | | | | | | | | | | | |

Course Name : All Branches of Diploma in Engineering / Technology

**Course Code : EJ/EN/ET/EX/EV/IC/IE/IS/MU/DE/ME/PG/PT/AE/CE/CS/CR/CO/CM/IF/
CW/EE/EP/EU/CH/CT/PS/CD/ED/EI/CV/FE/IU/MH/MI/TX/TC/FG**

**Semester : Sixth for EJ/EN/ET/EX/EV/IC/IE/IS/MU/DE/ME/PG/PT/AE/CE/CS/CR/
CO/CM/IF/CW/EE/EP/EU/CH/CT/PS/TX/TC/FG and Seventh for
MH/MI/CD/ED/EI/ CV/FE/IU**

Subject Title : Management

Subject Code : 17601

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|-----|----|----|----|-------|
| TH | TU | PR | PAPER HRS | TH | PR | OR | TW | TOTAL |
| 03 | -- | -- | 03 | 100 | -- | -- | -- | 100 |

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

Management concepts are universal and it is a multidisciplinary subject. They are equally applicable to different types industries like Manufacturing, Service and Trade as well as different kind of business activities like industry, army, school, hospital, retail shops etc. Also, at the end of diploma course polytechnic students are expected to enter in to the Industrial Environment. This environment is altogether different and new to the students. A proper introduction and understanding of management fundamentals is therefore essential for all these students.

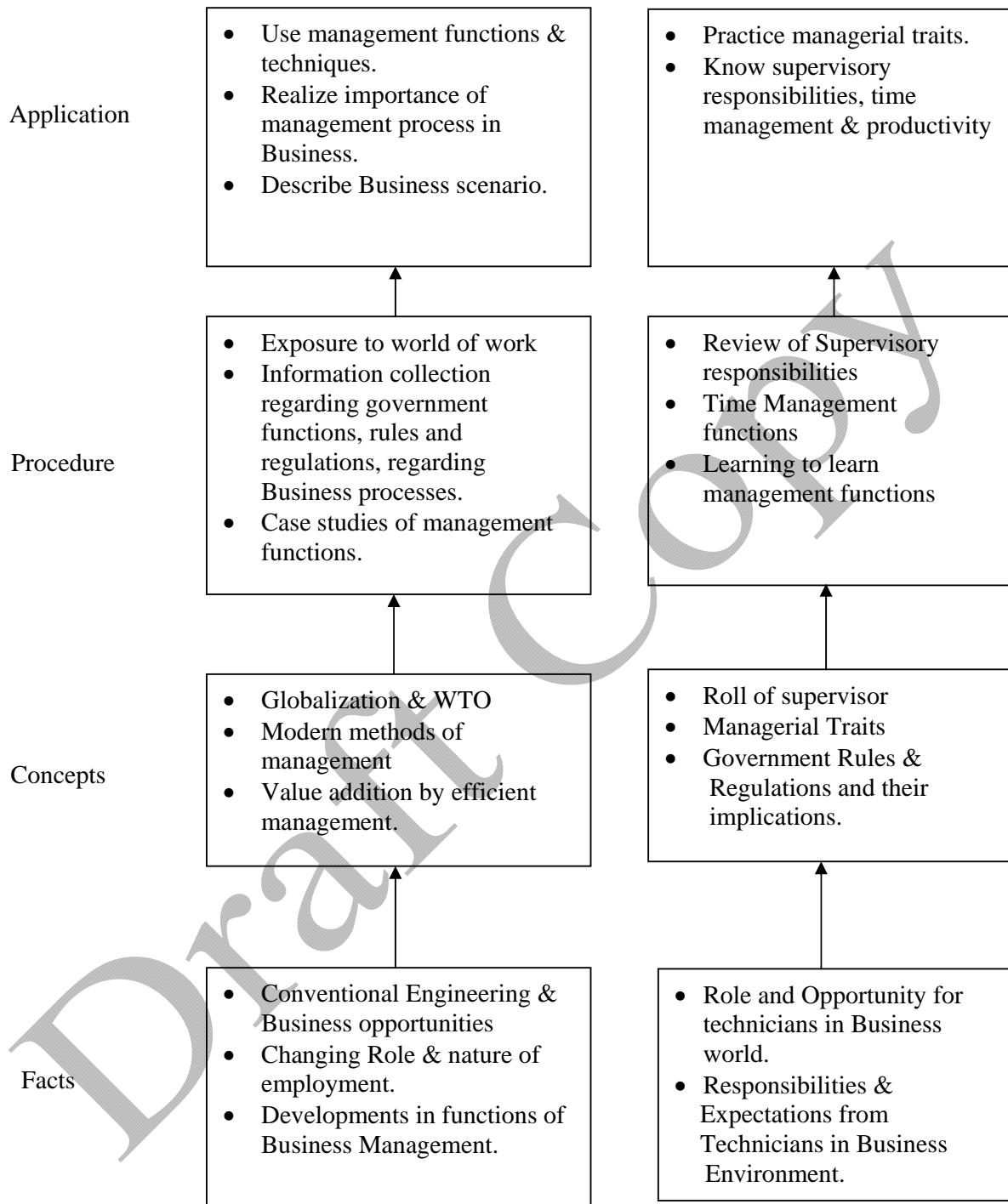
Contents of the this subject will enable the students to address various issues related to human resource, finance, materials, legislations etc. by use of basic principles of management. This will ensure that students will play their role effectively to enhance the quality of business output in total.

Objective:

The students will able to:

1. Get familiarized with environment related to business processes.
2. Know the management aspects of the organisations.
3. Understand Role & Responsibilities of a Diploma engineer.
4. Understand importance of quality improvement techniques.
5. Appreciate need and importance of safety in industries.
6. Understand process of Industrial finance and its management.
7. Know the latest trends in industrial management.

Learning Structure:



Contents: Theory

| Topic and contents | Hours | Marks |
|---|-------|-------|
| <p>Topic 1: Overview of Business</p> <p>Specific Objectives</p> <ul style="list-style-type: none"> ➤ State various business types and sectors ➤ Describe importance of globalisation <p>1.1. Types of Business</p> <ul style="list-style-type: none"> • Service • Manufacturing • Trade <p>1.2. Industrial sectors Introduction to</p> <ul style="list-style-type: none"> • Engineering industry • Process industry • Textile industry • Chemical industry • Agro industry • IT industry • Banking, Insurance, Retail, Hospitality, Health Care <p>1.3 Globalization</p> <ul style="list-style-type: none"> • Introduction • Advantages & disadvantages with respect to India | 02 | 06 |
| <p>Topic 2: Management Process</p> <p>Specific Objectives</p> <ul style="list-style-type: none"> ➤ State various management principles ➤ Describe different management functions <p>2.1 What is Management?</p> <ul style="list-style-type: none"> • Evolution • Various definitions of management • Concept of management • Levels of management • Administration & management • Scientific management by F.W.Taylor <p>2.2 Principles of Management (14 principles of Henry Fayol)</p> <p>2.3 Functions of Management</p> <ul style="list-style-type: none"> • Planning • Organizing • Directing • Controlling • Decision Making | 08 | 16 |
| <p>Topic 3: Organisational Management</p> <p>Specific Objectives</p> <ul style="list-style-type: none"> ➤ Compare different forms of organisation , ownership for a specific business ➤ Describe types of departmentation <p>3.1 Organization :</p> <ul style="list-style-type: none"> • Definition | 08 | 16 |

| | | |
|---|----|----|
| <ul style="list-style-type: none"> • Steps in organization <p>3.2 Types of organization</p> <ul style="list-style-type: none"> • Line • Line & staff • Functional • Project <p>3.3 Departmentation</p> <ul style="list-style-type: none"> • By product • By process • By function <p>3.4 Principles of Organisation</p> <ul style="list-style-type: none"> • Authority & Responsibility • Span of Control • Effective Delegation • Balance ,stability and flexibility • Communication <p>3.5 Forms of ownership</p> <ul style="list-style-type: none"> • Proprietorship • Partnership • Joint stock • Co-operative Society • Govt. Sector | | |
| Topic 4: Industrial Safety and Legislative Acts | | |
| <p>Specific Objectives</p> <ul style="list-style-type: none"> ➤ Describe types of accidents & safety measures ➤ State provisions of industrial acts. <p>4.1 Safety Management</p> <ul style="list-style-type: none"> • Causes of accidents • Types of Industrial Accidents • Preventive measures • Safety procedures <p>4.2 Industrial Legislation - Necessity of Acts</p> <p>Important Definitions & Main Provisions of following acts:</p> <ul style="list-style-type: none"> • Indian Factory Act • Workman Compensation Act • Minimum Wages Act | 08 | 14 |
| Topic 5: Financial Management (No Numerical) | | |
| <p>Specific Objectives</p> <ul style="list-style-type: none"> ➤ Explain functions of financial management ➤ State the sources of finance & types of budgets. ➤ Describe concepts of direct & indirect taxes. <p>5.1 Financial Management- Objectives & Functions</p> <p>5.2 Capital Generation & Management</p> <ul style="list-style-type: none"> • Types of Capitals - Fixed & Working • Sources of raising Capital - Features of Short term, Medium Term & Long Term Sources <p>5.3 Budgets and accounts</p> <ul style="list-style-type: none"> • Types of Budgets | 08 | 16 |

| | | |
|--|-----------|------------|
| <ul style="list-style-type: none"> • Fixed & Variable Budget - Concept • Production Budget - Sample format • Labour Budget - Sample format • Profit & Loss Account & Balance Sheet - Meaning, sample format, meaning of different terms involved. <p>5.4 Meaning & Examples of -</p> <ul style="list-style-type: none"> • Excise Tax • Service Tax • Income Tax • Value Added Tax • Custom Duty | | |
| <p>Topic 6: Materials Management (No Numerical)</p> <p>Specific Objectives</p> <ul style="list-style-type: none"> ➤ Describe concept of inventory, ABC analysis & EOQ. ➤ Describe purchase functions & procedures ➤ State features of ERP & MRP <p>6.1. Inventory Concept, its classification, functions of inventory</p> <p>6.2 ABC Analysis - Necessity & Steps</p> <p>6.3 Economic Order Quantity Concept, graphical representation, determination of EOQ</p> <p>6.4 Standard steps in Purchasing</p> <p>6.5 Modern Techniques of Material Management</p> <ul style="list-style-type: none"> • Material Resource Planning (MRP) - Functions of MRP, Input to MRP, Benefits of MRP • Enterprise Resource Planning (ERP) - Concept, list of modules, advantages & disadvantages of ERP | 08 | 16 |
| <p>Topic 7: Quality Management</p> <p>Specific Objectives</p> <ul style="list-style-type: none"> ➤ State Principles of Quality Management ➤ Describe Modern Technique & Systems of Quality Management <p>7.1 Meaning of Quality</p> <p>Quality Management System – Activities, Benefits</p> <p>Quality Control - Objectives, Functions, Advantages</p> <p>Quality Circle - Concept, Characteristics & Objectives</p> <p>Quality Assurance – Concept, Quality Assurance System</p> <p>7.2 Meaning of Total Quality and TQM</p> <p>Components of TQM – Concept, Elements of TQM, Benefits</p> <p>7.3 Modern Technique & Systems of Quality Management like Kaizen,5'S',6 Sigma</p> <p>7.4 ISO 9001:2000 - Benefits, Main clauses.</p> | 06 | 16 |
| Total | 48 | 100 |

Learning Resources:**Books:**

| Sr. No | Author | Name of Book | Publisher |
|---------------|--|--------------------------------------|------------------------------|
| 01 | Dr. O.P. Khanna | Industrial Engineering & Management | Dhanpat Rai & Sons New Delhi |
| 02 | Banga & Sharma | Industrial Engineering & Management | Khanna Publication |
| 03 | Dr. S.C. Saksena | Business Administration & Management | Sahitya Bhavan Agra |
| 04 | W.H. Newman E. Kirby Warren Andrew R. McGill | The process of Management | Prentice-Hall |

E Source:

nptel.iitm.ac.in

<http://iete-elan.ac.in/subjects/amIndustrialMgmt.htm>

Course Name : Diploma in Chemical Engineering

Course Code : CH

Semester : Sixth

Subject Title : Environmental Technology

Subject Code : 17646

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|-----|-----|----|----|-------|
| TH | TU | PR | PAPER HRS | TH | PR | OR | TW | TOTAL |
| 03 | -- | 02 | 03 | 100 | 25@ | -- | -- | 125 |

NOTE:

- Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.
- Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).

Rationale:

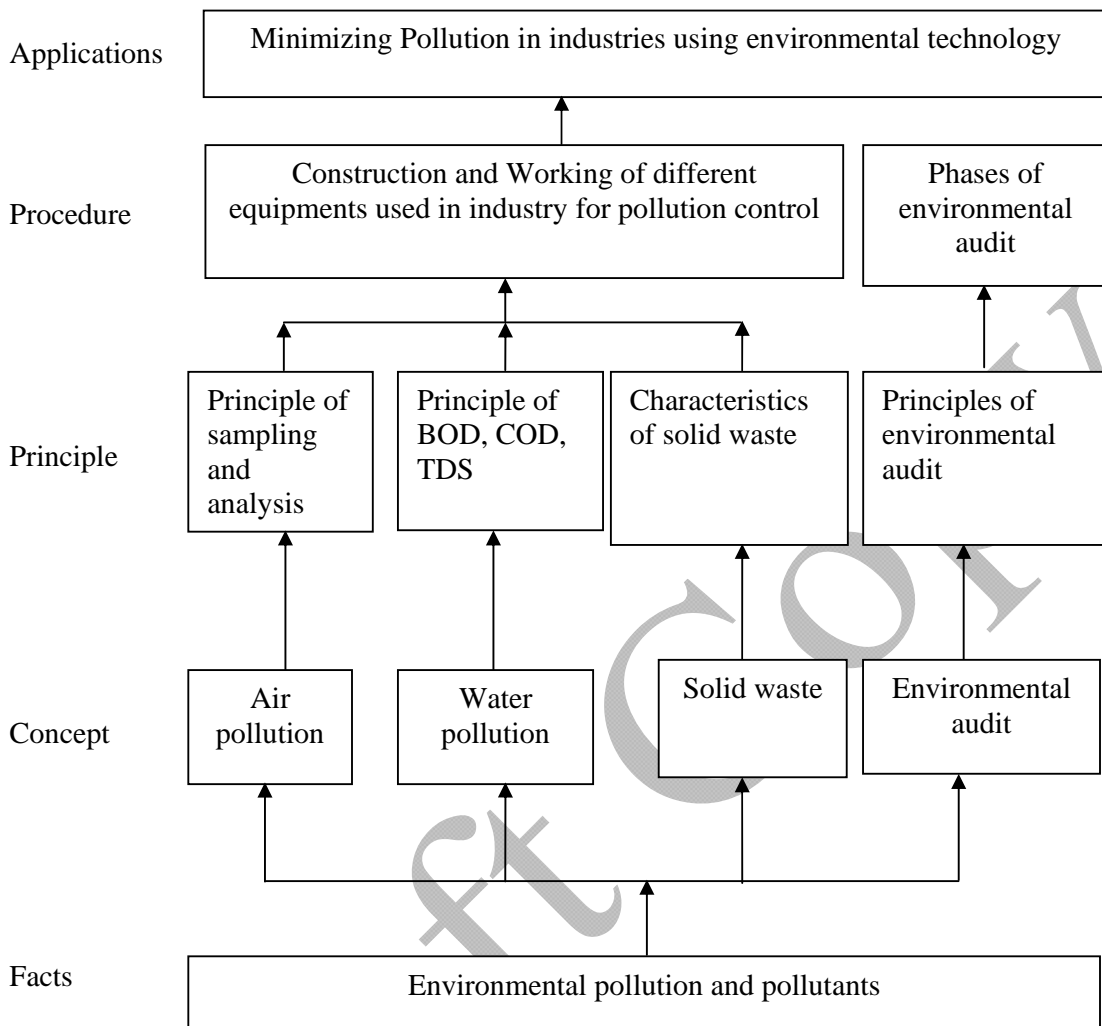
Environmental Technology is the application of environmental science, environmental monitoring and electronic devices used for monitoring and analysis of environmental pollutants. Environmental technology is used to control air pollution, water pollution. Content of this subject include working of different equipments for controlling air pollution, waste water treatment methods, solid waste management. Subject also covers industry specific waste treatment and environmental audit with ISO 14000.

Objectives:

The students will be able to

1. Understand the types of pollution and pollutants
2. Know working of different equipment used to control the air and water pollution.
3. Understand disposal methods of solid waste management.
4. Know waste treatment methods for specific industries.
5. Understand the procedure for environmental audit and norms of ISO 14000.

Learning Structure:



Content: Theory

| Topic No. | Topic | Hours | Marks |
|-----------|---|-------|-------|
| 1 | <p>Air Pollution</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ To describe sources & effects of air pollutants ➤ To draw & explain different equipment's for gaseous and particulate air pollutants control <p>Content:</p> <p>1.1 Cause and methods of sampling.... 14</p> <ul style="list-style-type: none"> • Air pollution : definition and classification of air pollutants • Natural and Manmade sources of pollution (CO, CO₂, SO_x, NO_x, Particulates, Hydrocarbons, O₃) • Effect of air pollution on health, animals, material and vegetation • Air Quality monitoring: <ul style="list-style-type: none"> - CPCB Air quality standards (SO_x, NO_x, SPM,CO) - Necessity of air sampling and Basic consideration during sampling - Sampling methods for gaseous and particulate type pollutants: • Gaseous pollutants: Grab sampling, Absorption, Adsorption, Freeze out sampling • Particulate pollutants: dust fall jar, high volume sampler, electrostatic precipitation. <p>1.2 Methods of controlling air pollution 16</p> <ul style="list-style-type: none"> • Air pollution controlling methods • Principle, construction, working and application of Equipment for gaseous pollutants control: <ul style="list-style-type: none"> - Gas absorption equipment: Packed column, Plate column and venturi scrubber. - Fixed bed adsorber - Thermal and catalytic incinerator • Principle, construction, working and application of Equipment for particulate types of pollutants control: <ul style="list-style-type: none"> - Gravity settling chamber - Cyclone separator - Fabric filter - Wet Scrubber - Electrostatic precipitator | 12 | 30 |
| 2 | <p>Water Pollution and Waste Water Treatment</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ To describe preliminary, primary and secondary treatment methods. ➤ To describe sludge treatment methods. <p>Content:</p> <p>2.1 Waste water characteristics 14</p> <ul style="list-style-type: none"> • Types of water pollutants and their sources& effects • Physical, chemical & biological characteristics of | 18 | 34 |

| | | | |
|---|---|----|----|
| | <p>Wastewater</p> <ul style="list-style-type: none"> • Water sampling methods: Grab sampling and composite sampling • Concepts & significance: DO, TSS, TDS, pH, BOD, COD etc . • Drinking water quality standard (MPCB/WHO) • Role of pollution control board <p>2.2 Effluent treatment methods..... 12</p> <ul style="list-style-type: none"> • Preliminary Treatment. • Primary Treatment • Secondary (Biological) Treatment: Principle, construction & working of; <ul style="list-style-type: none"> - Trickling Filters. - Activated Sludge Treatment plant <p>2.3 Sludge treatment..... 08</p> <ul style="list-style-type: none"> • Sludge Thickening • Sludge Digestion • Sludge Dewatering • Sludge Disposal | | |
| 3 | <p>Industry Specific Waste Treatment</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ To describe waste treatment in fertilizer industry. ➤ To describe waste treatment in petrochemical industry <p>Content:</p> <p>3.1 Fertilizer industry</p> <ul style="list-style-type: none"> • Names of pollutants produced from urea plant and their effects • Treatment of solid, liquid, gaseous effluent produced in urea plant <p>3.2 Pulp & Paper (Kraft) Industry</p> <ul style="list-style-type: none"> • Problems of black liquor • Recovery of chemicals from black liquor | 04 | 10 |
| 4 | <p>Solid Waste Management</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ To test solid waste collection methods ➤ To describe precautions to be taken while disposal of biomedical waste. <p>Content:</p> <p>4.1 Solid waste :</p> <ul style="list-style-type: none"> • Definition, classification, characteristics and origin. • Solid waste collection methods. • Solid waste processing. • Reuse, recycle and recovery. <p>4.2 Disposal of Biomedical waste.</p> | 08 | 14 |
| 5 | <p>Environmental Audit & ISO 14000</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ To describe environmental audit procedure. ➤ To state business benefits of ISO 14000 <p>Content:</p> <p>5.1 Environmental management:</p> <ul style="list-style-type: none"> • Principle, objective and components of Environment management | 06 | 12 |

| | | |
|--|-----------|------------|
| 5.2 Environment Audit :principle, Procedure and benefits 5.3 ISO 14001: <ul style="list-style-type: none"> • Need for ISO 14001 • Business Benefits of ISO 14000 | | |
| Total | 48 | 100 |

Practicals:

Skills to be developed:

Intellectual Skills:

1. To develop logical thinking ability for carrying out titrations
2. To interpret test results on the basis of standard limits for each parameter
3. To develop reasoning ability for the parameters that exceeds standard limit

Motor Skill:

1. To handle the glassware
2. To operate instruments
3. To observe the phenomenon of chemical reactions
4. To measure required quantities accurately

List of Practicals:

Note: Practicals can be conducted in group of 4 students.

- 1) To estimate the concentration of flue gas/air pollutants by Orsat Apparatus/Gas analyzer.
- 2) To estimate suspended particulate matter in air by High Volume Sampler.
- 3) To determine total suspended solids and total dissolved solids in given Effluent sample.
- 4) To determine Acidity and Alkalinity of given Effluent sample.
- 5) To measure the turbidity of given waste water sample.
- 6) To estimate chloride content of the given water sample,
- 7) To determine the hardness of the given effluent sample.
- 8) To determine BOD of the given effluent sample.
- 9) To determine COD of the given effluent sample.
- 10) To prepare a report on pollution control/Effluent treatment plant of any industry visited.

Learning Resources:

Books:

| Sr. No. | Name of Book | Name of Author | Name of Publisher |
|---------|--|------------------|---------------------------------|
| 1 | Text Book of Environmental Pollution and Control.- | Dr. H. S. Bhatia | New Delhi Galgotia Publication. |
| 2 | A Text Book of Environmental Chemistry and Pollution | Mr. S. S. Dara | S. Chand & Company Ltd. |

| | | | |
|---|---|--------------------|--|
| | Control | | New Delhi. |
| 3 | Environmental Pollution Control Engineering | C. S. Rao | New Age International(P) Limited, Publishers |
| 4 | Pollution Control in Process Industries | Mr. S. P. Mahajan. | Tata McGrawHill, New Delhi. |
| 5 | Wastewater Engineering: Treatment, Disposal & Reuse | Metcalf & Eddy | Tata McGraw Hill, New Delhi. |

Website:

1. www.mpcb.gov.in
2. www.cpcb.nic.in
3. <http://edugreen.teri.res.in>
4. www.unep.org
5. www.cceindia.org
6. www.iso.org

Draft Copy

Course Name : Diploma in Chemical Engineering

Course Code : CH

Semester : Sixth

Subject Title : Chemical Engineering Drawing

Subject Code : 17647

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|-----|----|-----|-----|-------|
| TH | TU | PR | PAPER HRS | TH | PR | OR | TW | TOTAL |
| 02 | -- | 04 | 04 | 100 | -- | 25# | 25@ | 150 |

NOTE:

- Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.
- Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).

Rationale:

There are different types of Chemical Process Industries. These industries require different unit processes, unit operations depending upon their product. While working in Chemical Plants Diploma Engineer is expected to locate the faults in various equipments.

Similarly he is required to interpret the process flow sheet and operate & control the process.

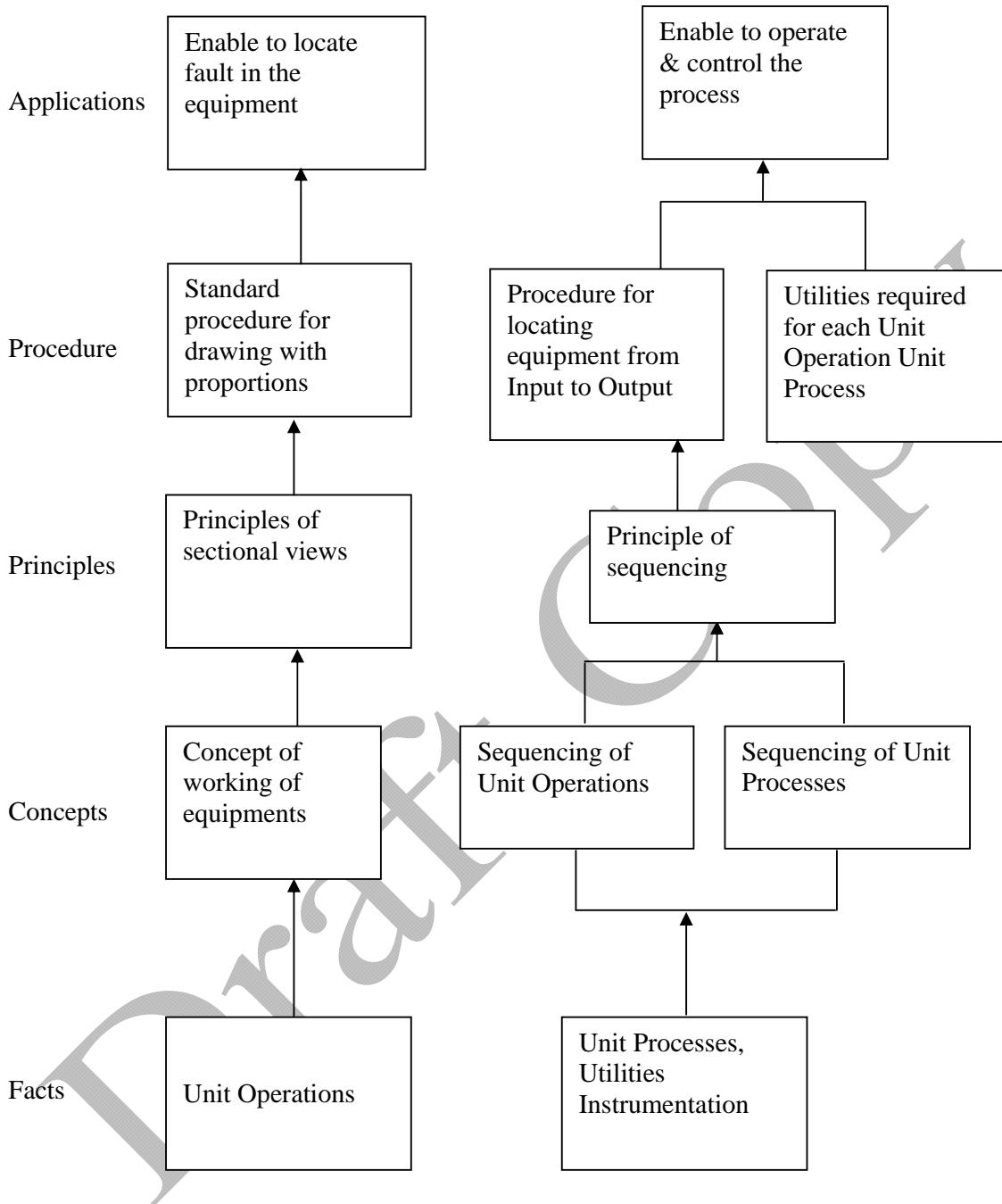
Contents of this subject provide him the opportunity to draw various equipment and flow processes. The practice of drawing will help the students to interpret the process diagram.

General Objectives:

The students will be able to

1. Know various equipments for unit operations in chemical process industries.
2. Understand the working of various processes.
3. Know different symbols used in chemical processes industries.
4. Understand the sequence of equipments from Input to Output.

Learning Structure:



Theory:

| Topic No. | Topics and Contents | Hours | Marks |
|-----------|---|-------|-------|
| 1 | <p>Process Instrumentation Symbols: Specific Objective</p> <ul style="list-style-type: none"> ➤ Draw the symbols for equipments, valves, instrumentation, pumps <p>Contents: Symbols for Unit Operation equipments, Instrumentation, Valves as per IS 3232</p> | 03 | 04 |
| 2 | <p>Valves Specific Objectives</p> <ul style="list-style-type: none"> ➤ Use working mechanism of different valves to identify the faults ➤ Select pipe joint for specific application <p>Contents: Explain working and specific applications of Gate Valve, Globe valve, Ball Valve, Swing Check & Lift Check valves, Diaphragm Valve, Safety Valve (Spring loaded, Rams Bottom)</p> | 05 | 12 |
| 3 | <p>Pipe Joints Specific Objectives</p> <ul style="list-style-type: none"> • Select proper pipe joint for specific application <p>Contents:</p> <ul style="list-style-type: none"> • Joints used for smaller pipes- Bend, Elbow, Nipple, Socket, Reducer, Expander, Union Joint, Tee, Cross, Plug, Blind • Flanged Joints- CI, Welded neck, Hub type, welded flange type, Screwed flange type • Other Joints: Socket & Spigot Joint, Hydraulic Joint, Expansion Joints (Corrugated joint, Loop) | 03 | 12 |
| 4 | <p>Support Specific Objectives</p> <ul style="list-style-type: none"> ➤ Select proper support for vertical, horizontal, tall process vessel <p>Contents:</p> <ul style="list-style-type: none"> • Hanger, roller support for steam pipes • Leg, bracket and skirt support • Saddle support | 02 | 08 |
| 5 | <p>Fabrication Drawing Specific Objectives</p> <ul style="list-style-type: none"> ➤ Draw assembly of equipments. <p>Contents:</p> <ul style="list-style-type: none"> • Shell & Tube Heat Exchanger • Batch Reactor • Distillation Column • Types of heads, jackets, coils • Types of packings • Types of trays- sieve plate, bubble cap, valve tray | 05 | 16 |
| 6 | <p>Specification Sheet Specific Objectives</p> | 04 | 08 |

| | | | |
|--------------|--|-----------|------------|
| | <ul style="list-style-type: none"> ➤ Select suitable MOC for specific application <p>Contents:</p> <ul style="list-style-type: none"> • Specification Sheet for Batch Reactor, Shell & Tube Heat Exchanger | | |
| 7 | <p>Process Flow Diagrams</p> <p>Specific Objectives</p> <ul style="list-style-type: none"> ➤ Develop skill of drying process flow diagram from process description <p>Contents:</p> <p>For any given chemical process, develop -</p> <ul style="list-style-type: none"> • Process Flow Diagram, Process Instrumentation Diagram (16 Marks) • Utility Line Diagram (08 Marks) • Equipment Layout (08 Marks) • Tank Farm (08 Marks) <p>NOTE: Question on this topic is to be set by giving a process description and related questions of each subpart without any option</p> | 10 | 40 |
| Total | | 32 | 100 |

Practicals:

Intellectual Skills:

1. Develop the ability of following the sequence of Unit Operations & Unit Processes.
2. Locate the fault in Unit Operation Equipments.

Motor Skills:

1. Draw proportionate drawings of equipments & processes
2. Develop the line work in preparing the drawing

NOTE: All drawing sheets must be drawn using drafter.

Draw following sheets

1. Symbols (IS-3232)
2. Systematic sectional views of gate, globe, ball and needle valve
3. Systematic sectional views of safety, check, foot valve.
4. Pipe joints - Bend, Elbow, Nipple, Socket, Reducer, Expander, Union Joint, Tee, Cross, Plug, Blind, Flanged Joints- CI, Welded neck, Hub type, welded flange type, Screwed flange
5. Pipe joints - Socket & Spigot Joint, Hydraulic Joint, Expansion Joints
6. Supports - Hanger, roller support for steam pipes. Leg, bracket and skirt supports, Saddle support.
7. Shell & Tube Heat Exchanger
8. Batch Reactor (Types of heads, jackets, coils)
9. Distillation Column (Types of packings, Types of trays- sieve plate, bubble cap, valve tray)

10. Process flow diagram
11. Process Instrumentation diagram
12. Utility line diagram
13. Equipment layout and tank farm
14. Specification sheet for Batch reactor/Heat exchanger.

Learning Resources:

Books:

| Sr. No. | Author | Title | Publisher |
|----------------|---------------|----------------------------|---------------------------|
| 1 | BIS | IS-3232 | BIS Publication |
| 2 | M.V.Joshi | Process Equipment & Design | Mc Millan |
| 3 | S.D.Dawande | Process Equipment & Design | Central Techno Publishers |

Course Name : Diploma in Chemical Engineering

Course code : CH

Semester : Sixth

Subject Title : Mass Transfer Operation

Subject Code : 17648

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|-----|-----|----|-----|-------|
| TH | TU | PR | PAPER HRS. | TH | PR | OR | TW | TOTAL |
| 03 | -- | 04 | 03 | 100 | 50# | -- | 25@ | 175 |

NOTE:

- Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.
- Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).

Rationale:

Mass transfer operation is a core subject of chemical engineering.

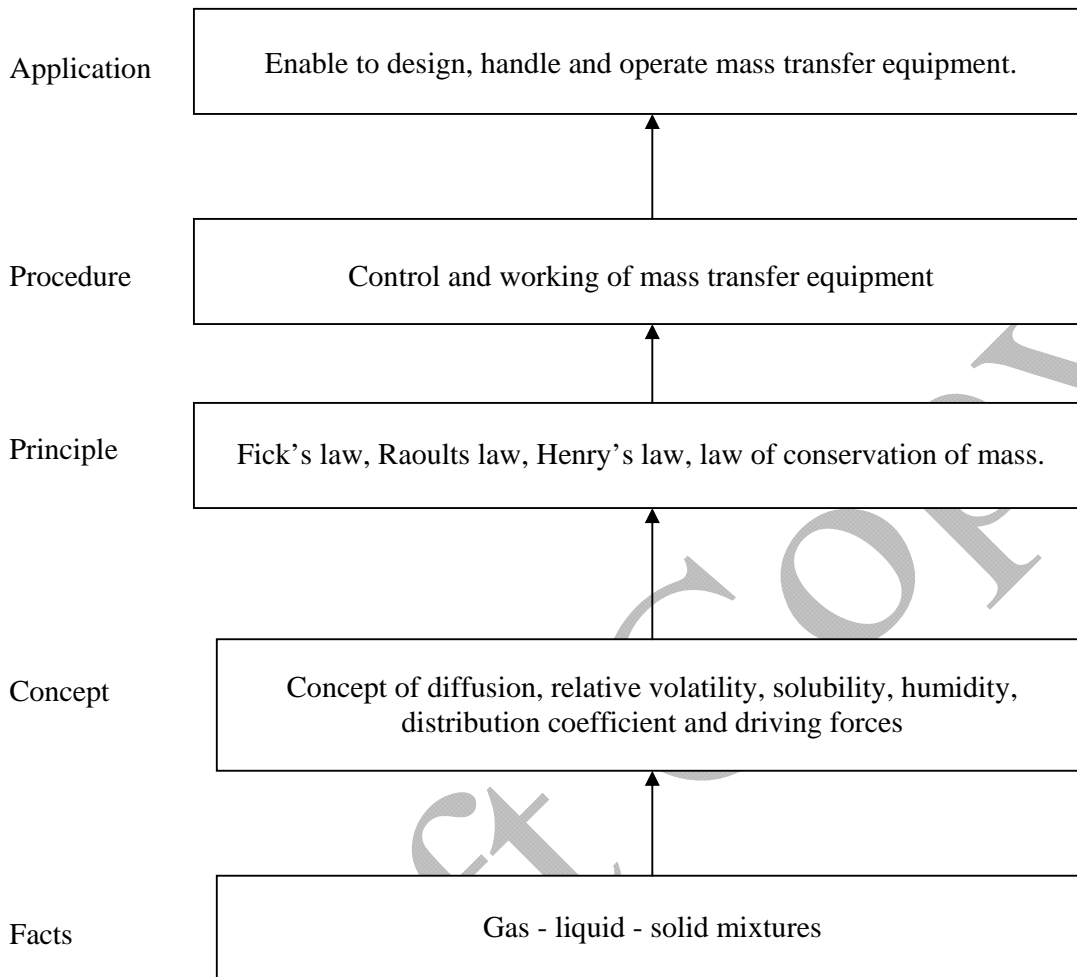
After studying this subject the student would be able to design, operate and control various parameters related to mass transfer equipment.

General Objectives:

This subject will enable students to

1. Understand working & construction of mass transfer equipments
2. Select proper mass transfer operation.
3. Separation techniques studied in this subject are applicable in all chemical industries.

Learning Structure:



Theory:

| Topic and Content | Hours | Marks |
|--|-------|-------|
| <p>Topic 1: Diffusion. Specific Objectives: ➤ Calculate the rate of diffusion in gas-gas and liquid-liquid system ➤ State different mass transfer theories. Contents: • Definition, Ficks Law, Flux equation, Molecular diffusion in gases, Steady state diffusion of A through non diffusing B, Steady state equimolar counter diffusion. Numericals. • Analogy between mass transfer and heat transfer, film theory, surface renewal theory, penetration theory, Equilibrium</p> | 05 | 08 |
| <p>Topic 2: Distillation. Specific Objectives: ➤ Describe various distillation methods. ➤ Calculate no. of equilibrium stages in distillation column ➤ Decide a reflux ratio for obtaining certain purity of product. Contents: 2.1 Principles of Distillation : (08 Marks) • Concept of distillation, • Boiling point diagram, change of pressure on boiling point diagram. • Vapour liquid equilibrium diagram. • Henry’s Law, Raoults Law. • Determination of vapor composition by above laws. • Computing x – y data • Volatility, relative volatility • Methods of distillation • Differential distillation, Rayleigh’s equation • Flash distillation • Rectification • Azeotropic distillation, batch distillation & Steam distillation 2.2 Design (12 Marks) • Material balance on distillation column • Derivation of equation for feed line, top and bottom operating line • McCabe – Thiele method • Lewis – Sorel method • q line, derivation, effect of feed conditions on slope of q line • Reflux ratio – minimum, total & optimum reflux ratio • Equipments for distillation • Rectification column • Bubble cap plate • Sieve plate • Valve plate • Down comers & weirs • Introduction to packed distillation column 2.3 Numericals based on Simple Distillation, Flash Distillation & calculating number of theoretical plates using McCabe Thieles and Lewis Sorel Method (14 Marks)</p> | 16 | 34 |

| | | |
|--|----|----|
| <p>Topic 3: Absorption Specific Objectives :</p> <ul style="list-style-type: none"> ➤ Calculate minimum liquid gas flow rate ratio to obtain a certain composition of outlet gas. ➤ State selection criteria for packing material in packed column and its effect on absorption <p>Contents:</p> <ul style="list-style-type: none"> • Concept of Gas Absorption, comparison with distillation, selection criteria for solvent. • Concept of equilibrium, minimum liquid-gas ratio, material balance, Concept of HETP. • Hydrodynamics of packed column. Loading and flooding of packed columns. • Gas absorption equipments- mechanically agitated vessel, packed columns, types of packings, channeling in packed columns. | 06 | 14 |
| <p>Topic 4: Extraction Specific Objectives :</p> <ul style="list-style-type: none"> ➤ Distinguish between distillation and extraction. ➤ State the application of various extraction equipment <p>Contents:</p> <ul style="list-style-type: none"> • Concept of Extraction, liquid-liquid extraction, comparison between distillation and extraction, distribution coefficient, selection criterion of solvent • Extraction equipments- mixer settler, spray column, rotating disc contactor | 06 | 12 |
| <p>Topic 5: Drying Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Calculate the time required for drying solids from initial to final moisture content. ➤ Selection of dryer to be used for drying different materials. <p>Contents:</p> <p>5.1 General Principles (14 Marks)</p> <ul style="list-style-type: none"> • Moisture content on dry and wet basis • Total, free, critical and equilibrium moisture content • Rate of drying-Constant and falling rate period • Time required for drying • Numericals <p>5.2 (06 Marks)</p> <ul style="list-style-type: none"> • Drying equipments & their Application • Tray dryer • Rotary dryer • Drum dryer • Spray dryer • Fluidized bed dryer • Pneumatic dryer | 08 | 20 |
| <p>Topics 6: Crystallization Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Explain solubility and super solubility curve. ➤ Calculate the yield of crystal that can be obtained for different feed composition. | 07 | 12 |

| | | |
|---|-----------|------------|
| Contents: <ul style="list-style-type: none"> • Concept of crystallization, saturation, super saturation, solubility curves • Method of super saturation, Mier's super saturation theory. • Crystallization equipments- Agitated tank crystalliser, vacuum crystalliser, Oslo (cooler and evaporative) crystallizer, Swenson-Walker crystallizer. • Simple material balance, numericals on crystallization. | | |
| Total | 48 | 100 |

Practical:

Skills to be developed:

Intellectual Skills:

1. Control operating parameters in different unit operation equipments.
2. Select suitable solvents for extraction / absorption.

Motor Skills:

1. To measure and control various parameters to control the quality of output product.
2. To operate different types of dryers.
3. To operate different types of distillation columns.

List of Practicals:

1. To verify Rayleigh's equation by simple distillation.
2. To compare the purity of distillate in a packed column at total reflux and any other reflux ratio.
3. To calculate the pressure drops of a given packed column for wet and dry packing.
4. To find out distribution coefficient for liquid - liquid mixture.
5. To find the percent yield of crystallization using a batch crystallizer.
6. To plot drying rate curves.
7. To plot the solubility curve while heating and cooling.
8. Control of distillation column on simulator.
9. To construct an equilibrium diagram [X-Y plot].
10. To perform a fractional distillation experiment to measure purity and verify material balance.
11. To determine the diffusivity of volatile liquids & compare diffusivities of any three volatile liquids (Reference: Richardson & Coulson, 6th Edition, Vol. 2, page 582)

Learning Resources:**Books:**

| Sr. No. | Author | Title | Publisher |
|----------------|---|--|---|
| 1. | Mr. Walter L. Badger & Mr. Julius T. Banchero | Introduction to Chemical Engineering | Tata Mc Graw Hill, New Delhi |
| 2. | Mc Cabe, W. L. Smith & Harriot. | Unit Operations of Chemical Engineering. | Tata Mc Graw Hill International, New York |
| 3. | Treybal, Robert E | Mass Transfer Operations | Tata Mc Graw Hill International, New York |
| 4. | Richardson & Coulson | Chemical Engineering Vol. 2 | Asian Books Pvt. Ltd., New Delhi |

Websites:

www.vlab.co.in

Course Name : Diploma in Chemical Engineering

Course Code : CH

Semester : Sixth

Subject Title : Alcohol Technology

Subject Code : 17649

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|-----|----|----|-----|-------|
| TH | TU | PR | PAPER HRS | TH | PR | OR | TW | TOTAL |
| 03 | -- | 02 | 03 | 100 | -- | -- | 25@ | 125 |

NOTE:

- Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.
- Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).

Rationale:

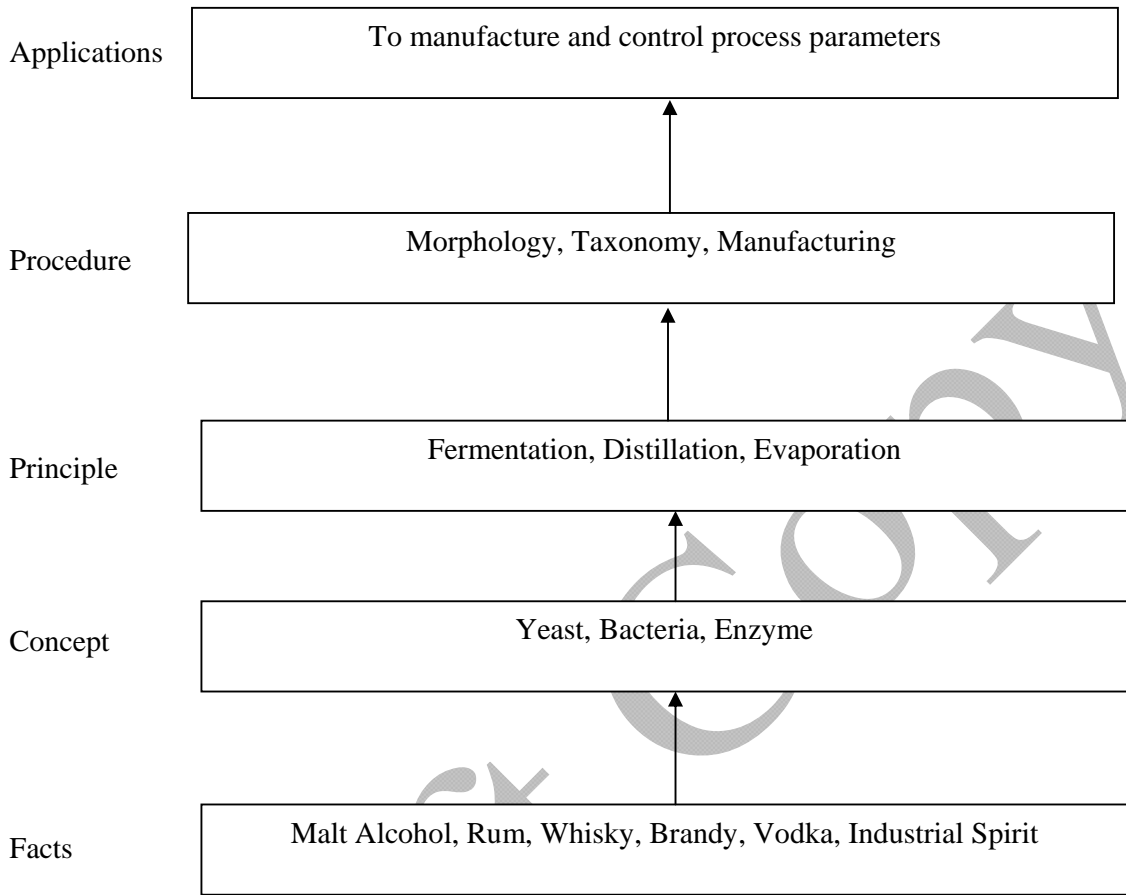
During last century, alcohol technology has greater importance in chemical industry because of its use in medicine; paint, as a solvent etc. There has been tremendous growth in various fields of chemical industry. The knowledge of this development is useful in understanding the future needs of chemical industry. All the chemical industry basically requires unit operations & unit processes. The basic content like fermentation, distillation and microbiology are covered in the contents, which will help in understanding the higher levels of subjects.

Objectives:

The students will be able to

1. Understand the unit operation in chemical industries.
2. Understand the role of enzyme, bacteria, yeast in fermentation.
3. Know uses of various alcohol based product.
4. Prevent pollution in alcohol industries.

Learning Structure:



Theory Content:

| Topic and Contents | Hours | Marks |
|--|-------|-------|
| <p>Topic 1: Unit Processes and operations related to alcohol Technology Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Describe process of fermentation ➤ Define Distillation, Evaporation <p>Contents:</p> <ul style="list-style-type: none"> • Batch fermentation • Continuous Distillation • Azeotropic Distillation • Evaporation | 06 | 18 |
| <p>Topic 2: Applied Microbiology Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Explain yeast morphology and Taxonomy ➤ Explain Concept of Nutrition <p>Contents:</p> <p>2.1 Yeast , Enzyme and Bacteria</p> <ul style="list-style-type: none"> • Definition, comparison with other microorganisms • Yeast morphology and Taxonomy • Nutritional requirement of yeast • Pre treatment (Liquefaction) of Enzyme • Enzyme dosing • Bacteria used for fermentation | 12 | 20 |
| <p>Topic 3 : Stimulation and Acclimatization of yeast Specific Objectives:</p> <ul style="list-style-type: none"> ➤ State acidification of yeast ➤ Describe propagation of yeast <p>Contents:</p> <ul style="list-style-type: none"> • Material of construction and maintenance of yeast vessel • Pre fermentation practices adopted for yeast propagation • Propagation practices of yeast • Yeast Acidification • Use of sterile air system in pre-fermenter | 10 | 22 |
| <p>Topic 4: Alcohol Technology Specific Objectives:</p> <ul style="list-style-type: none"> ➤ State use of yeast, Enzyme and Bacteria in manufacturing <p>Contents:</p> <p>4.1 Raw Material, Reaction, Flow Diagram and Process Description of the following</p> <ul style="list-style-type: none"> • Manufacturing of Malt alcohol • Manufacturing of Rum • Manufacturing of Whisky • Manufacturing of Brandy • Manufacturing of Vodka • Manufacturing of Industrial Spirit | 12 | 22 |
| <p>Topic 5: Effluent Treatment Specific Objectives:</p> <ul style="list-style-type: none"> ➤ State the methods of pollution control <p>Contents:</p> | 08 | 18 |

| | | |
|---|-----------|------------|
| <ul style="list-style-type: none"> • Content of waste • Toxicological effect • Government stipulated condition for Alcohol Industry waste water • Primary treatment • Biological treatment | | |
| Total | 48 | 100 |

Practical:

Skills to be developed:

Intellectual Skills:

1. Apply principles to select proper material for given products.
2. Interpret the test results.
3. Judge the density of given polymer.

Motor Skills:

1. Handle the instruments properly.
2. Handle chemicals carefully & safely.
3. Prepare various tests as per standard.

List of Practicals:

1. Determination of total solids and suspended solids of molasses
2. Determination of brix, specific gravity, pH of molasses.
3. Propagation of yeast in laboratory
4. Study of alcohol from sweet potato
5. Determination of starch in grain sample
6. Study of different types of microorganisms used in fermentation process
7. To determine the reducing sugar in the given sample of molasses.
8. To conduct potassium permanganate test for finding the quality of spirit
9. Determination of methyl alcohol content of spirit
10. Determination of sludge contents of molasses.

Learning Resources:

Books:

| Sr. No. | Author | Title |
|---------|--------------------------------|---|
| 1 | Jacques, T.P.Lyon, Dr. Kelsall | The Alcohol Textbook |
| 2 | Satyanarayana Rao | Alcoholometry |
| 3 | A.C.Chatterjee | Handbook of fermentation & Distillation |
| 4 | H.C.Baron | Distillation |
| 5 | Paturao | Byproducts of Sugar Industry |

Course Name : Diploma in Chemical Engineering

Course Code : CH

Semester : Sixth

Subject Title : Petro Chemical Technology (Elective)

Subject Code : 17651

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|-----|----|----|------|-------|
| TH | TU | PR | PAPER HRS | TH | PR | OR | TW | TOTAL |
| 03 | -- | 02 | 03 | 100 | -- | -- | 25 @ | 125 |

NOTE:

- Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.
- Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).

Rationale:

There are various types of chemical industries. Among them petroleum and petrochemical industries are expanding very fastly in India and world wide due to increasing demand.

Chemical engineers have better job opportunities in such industries. In view of increasing job requirements, this subject has been introduced as an elective subject. This subject covers aspects related to petroleum refining process and petrochemical processes.

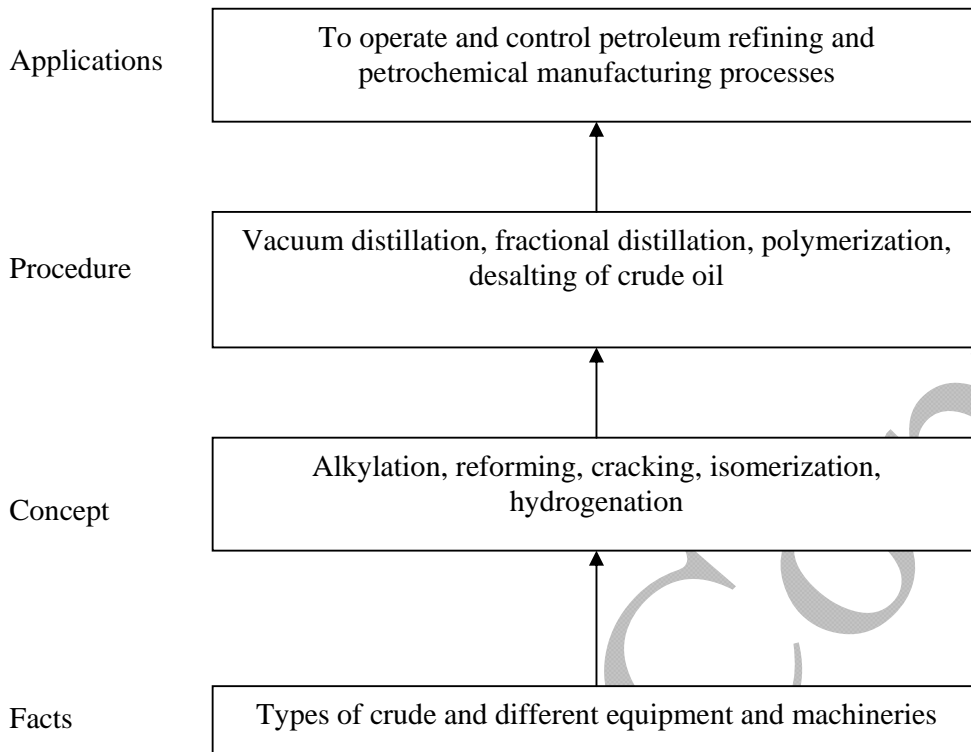
These contents will develop in sight among the chemical engineers.

General Objectives:

Student will be able to:

- 1) Understand the global crude oil scenario.
- 2) Manufacturing of different petroleum and petrochemical products from crude oil.
- 3) Working of unit operations & unit processes in refineries to improve quality of fuel.

Learning Structure:



Theory:

| Topic and Contents | Hours | Marks |
|---|-------|-------|
| <p>Topic 1: Introduction to Petroleum Refining</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ State names and location of given refineries ➤ Give composition of crude oil <p>Contents:</p> <ul style="list-style-type: none"> • Indian Refineries, their location and capacity • Global crude oil producers, OPEC • Characteristics, Composition, constituents of crude oil | 06 | 14 |
| <p>Topic 2: Refining</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Describe the distillation of crude oil to obtain various fractions ➤ Give names of different fractions, their boiling ranges and uses <p>Contents:</p> <ul style="list-style-type: none"> • Preliminary processing of petroleum refining • Distillation of crude oil • Hydrocarbons/ fractions obtained from crude oil, Boiling Range and their uses | 10 | 22 |
| <p>Topic 3: Unit Processes in Refineries</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Give definitions of different properties of fuel ➤ Describe different unit processes used in refineries ➤ Describe different waste treatment methods <p>Contents:</p> <p>3.1 Definitions of octane number, cetane number, flash point, fire point, aniline point, pour point, cloud point, drop point, ignition temperature, calorific value. (06 Marks)</p> <p>3.2 Flow sheet and reaction of (16 Marks)</p> <ul style="list-style-type: none"> • Hydrogenation, Cracking, Alkylation, Polymerisation, Hydrocracking, Isomerization, Reforming, Esterification & Hydration. <p>3.3 Waste Treatment - (10 Marks)</p> <ul style="list-style-type: none"> • Emission control • Oil removal • Organic content removal • Solid & hazardous waste treatment | 16 | 32 |
| <p>Topic 4 : C1 to C4 and Aromatic Hydrocarbons</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ List different petrochemicals obtained from C1 to C4 and aromatic hydrocarbons and describe specific petrochemicals <p>Contents:</p> <p>4.1 List of Hydrocarbons from C1, Manufacturing process, flow sheet and reactions of formaldehyde, methanol (06 Marks)</p> | 16 | 32 |

| | | |
|--|-----------|------------|
| 4.2 List of Hydrocarbons from C2, Manufacturing process, flow sheet and reactions of Ethanol, ethylene oxide, styrene (08 Marks) | | |
| 4.3 List of Hydrocarbons from C3, Manufacturing process, flow sheet and reactions of Acetaldehyde, propylene oxide (06 Marks) | | |
| 4.4 List of Hydrocarbons from C4, Manufacturing process, flow sheet and reactions of Butadiene, MTBE, Butyle acetate (06 Marks) | | |
| 4.5 Aromatic Fractions (06 Marks) | | |
| • Production of BTX | | |
| Total | 48 | 100 |

Practical:

Skills to be developed:

Intellectual Skills:

- 1) Interpret test results
- 2) Follow systemic procedure for handling Chemicals

Motor Skills:

- 1) To handle equipments / instruments
- 2) To observe physical phenomenon

Note: Following practicals to be conducted by a group of 2 students.

List of Practical:

- 1) Determination of Aniline Point.
- 2) Determination of Fire Point, Flash Point.
- 3) Determination of calorific value.
- 4) Measurement of viscosity by using Redwood Viscometer
- 5) Preparation of Ethyl Acetate by Esterification.
- 6) Preparation of Biodiesel from used cooking oil by Transesterification process and observe two layers of biodiesel and glycerin respectively.
- 7) Preparation of Phenol Formaldehyde resins.
- 8) Determination of Drop Point.
- 9) Determination of Pour Point.
- 10) To determine the carbon residue of oil by using Caonradson Apparatus/Ramsbottom Apparatus.

Learning Resources:

Books:

| Sr. No. | Author | Title | Publisher |
|---------|---------------------------|--------------------------------------|--------------------------|
| 01 | M. Gopala Rao, M. Sittig, | Dryden's Outlines of Chemical Tech | East West Press |
| 02 | George Austin | Shreve's Chemical Process Industries | Mc Graw Hill Publication |
| 03 | B. K. Sharma | Fuels and Petroleum processing | Goel publishing |
| 04 | B.K. Bhasker Rao | Petrochemicals | Khanna Publishers |
| 05 | B.K. Bhasker Rao | Modern Petrochemical Refining | Oxford –IBH Publications |

Course Name : Diploma in Chemical Engineering

Course Code : CH

Semester : Sixth

Subject Title : Process Simulation

Subject Code : 17802

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|----|----|----|-----|-------|
| TH | TU | PR | PAPER HRS | TH | PR | OR | TW | TOTAL |
| -- | -- | 02 | -- | -- | -- | -- | 25@ | 25 |

Rationale:

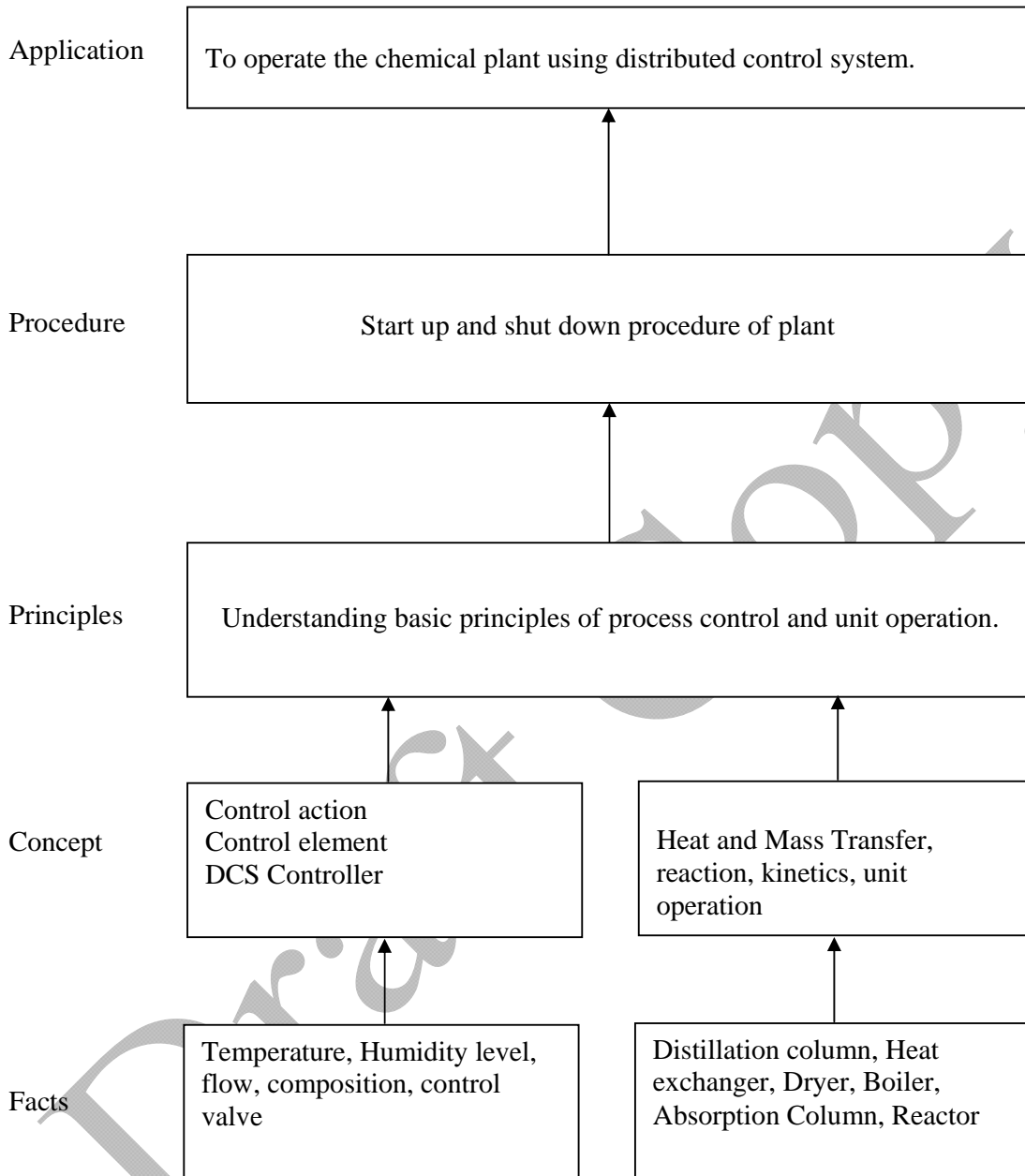
Most of the Chemical process plant are operated and controlled through Distributed Control System (DCS). It is necessary to train student on DCS process simulator where he will get first hand experience of process plant Operation and control.

Objectives:

Student will be able to:

1. Understand process instrument controls.
2. Get familiarized with the various chemical process.
3. Get experience and exposure to set of typical upset and equipment malfunction.

Learning Structure:



Content: Theory

Note: Content of theory are to be taught in practical period.

| Topic No. | Name of Topic | Hours |
|------------------|---|--------------|
| 1 | Process Simulators Need of simulators, Application simulators distributed controlled system- Dynamic Graphic (mimic), Bar graph, Trend and Alarm, | 01 |
| 2 | Process Simulator Software Installation of software. Introduction of software features using member, Toolbar, dialogue bar, Toolbar, Status bar Scroll bar Title bar. Screens (Display), Mimics, bar graph, trend alarms, snapshots, back track, caution longing, connectivity between bar graph – mimics-trends-alarm, Exercise-loading, saving, delete, Controlling the session – run freeze, quit etc. mal function, online hold, start up and shut down procedure. | 03 |

Practical:

Note:

1. Print of logs to be attached as term work.

2. Practicals can be conducted in group of 4 students.

1. Each institute may be having simulation software of old version or new version.
2. The software help files provide guidelines and exercises for implementation.
3. Provide sufficient practice to the students preferably in group of three.
4. Following are the suggested modules. Give the practice to the students on any six modules.
 - i. Binary distillation column for Benzene and Toluene.
 - ii. Temperature and pressure control
 - iii. Stirred tank reactor.
 - iv. Filtration.
 - v. Level and Flow in different type size vessels.
 - vi. Three-element boiler control.
 - vii. Level control in coupled tanks.
 - viii. Pressure control in different sizes valve.
 - ix. Catalytic reactor.
 - x. Absorption
 - xi. Superheated steam
 - xii. Dryer
 - xiii. Heat Exchanger
 - xiv. Multi component distillation column

Course Name : Diploma in Chemical Engineering

Course Code : CH

Semester : Sixth

Subject Title : Project & Seminar

Subject Code : 17803

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|----|----|-----|-----|-------|
| TH | TU | PR | PAPER HRS | TH | PR | OR | TW | TOTAL |
| -- | -- | 04 | -- | -- | -- | 50# | 50@ | 100 |

Rationale:

In practice the diploma technicians come across problems of varied nature. He/she will have to solve the problems involving drawings, designs, manufacturing, installation, testing and maintenance of machines. In order to cultivate the systematic methodology for problem solving using acquired technical knowledge and skills, this particular subject is introduced.

This subject will also help to enhance the generic skills and professional skills.

Contents:

Skills to be Developed:

Intellectual Skills

1. Design various equipments used in a unit operation and unit process.
2. Convert innovative or creative idea into reality.
3. Understand and interpret Chemical process drawing.
4. Put into practice the theoretical knowledge gained.

Motors Skills

1. Classify and analyze the information collected.
2. Modify the existing process to maximize output.
3. Trouble shooting of defective process equipment.
4. Analyze the financial aspect of a chemical plant.

Notes : 1) Project group size : Maximum 4 student.

2) Project report will be of minimum 40 pages unless otherwise specified.

3) Project diary should be maintained by each student.

PART A) Project

Batch of maximum 4 students will select a topic and then plan, organize and execute the project work of solving the problem in a specified duration. Student is expected to apply the knowledge and skills acquired. Batch may select any one topic from the following categories.

- a) Literature survey based project: - The most economical and viable manufacturing process of any chemical is related. Students should compulsorily study the properties, thermodynamic feasibility, process selection, process description, material & energy balance, cost estimation, application, P & I diagram by industrial visit and literature survey.
- b) Lab scale manufacture of any chemical/ product: Student should do a detailed study of the manufacturing of any Chemical / product which can be prepared in lab and the same shall be prepared.
- c) Preparing the Scale model of any Chemical Process equipment: Student should analyze a problem to design equipment and a scale model should be prepared.
- d) Projects using equipment available in the laboratory: Students should use the existing equipment in the laboratory, study & analyze various processes used in the equipment and develop different applications.
- e) Project based on industry like: pollution control, effluent treatment, energy auditing, trouble shooting.
- f) Project title should not be repeated for minimum three consecutive years.

PART B: Seminar

- a) Students should prepare and deliver a seminar on the assigned project at the end of semester using power point slides / presentation. The marks of the same shall be considered in term work.