

Shroff S.R. Rotary Institute of Chemical Technology

Ref: UPL University /SRICT/BOS/CH/2022-23/02

Date: 28-01-2023

Proposed Teaching Scheme for Third Year Diploma Chemical Engineering

Semester-V (Diploma Chemical Engineering) Proposed Structure

| Sl. No | Category of Course | Code No. | Course Title | Hours per week | | | Total contact hrs/ week | Total Credits | E | M | I | V | Total Marks |
|--------------|---|----------|---|----------------|---|---|-------------------------|---------------|----|----|----|----|-------------|
| | | | | L | T | P | | | | | | | |
| 1. | Humanities and Social Sciences including Management courses | CH1301 | Plant Economics & Management | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 00 | 00 | 100 |
| 2. | Program Core Course -X | CH1302 | Process Heat Transfer - II | 2 | 0 | 4 | 6 | 4 | 70 | 30 | 20 | 30 | 150 |
| 3. | Program Core Course - XI | CH1303 | Instrumentation and Process Control | 2 | 0 | 4 | 6 | 4 | 70 | 30 | 20 | 30 | 150 |
| 4. | Program Core Course -XII | CH1304 | Safety and Hazard Management In Chemical Industry | 2 | 0 | 0 | 2 | 2 | 70 | 30 | 00 | 00 | 100 |
| 5. | Program Elective -II | CH1305/6 | Program Elective -II | 4 | 0 | 0 | 4 | 4 | 70 | 30 | 00 | 00 | 100 |
| 6. | Open Elective-II | CH1307/8 | Open Elective-II | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 00 | 00 | 100 |
| 7. | Audit Course | MH1301 | Indian Constitution | 1 | 0 | 0 | 1 | 0 | 50 | 00 | 00 | 00 | 50 |
| 8. | Project work, seminar and internship in industry or elsewhere Mandatory Courses | MH1302 | In Plant Training | 0 | 0 | 0 | 0 | 3 | 00 | 00 | 50 | 50 | 100 |
| Total | | | | | | | 25 | 23 | | | | | 850 |

Semester-VI (Chemical Engineering) Proposed Structure:

| Sl. No | Category of Course | CodeNo. | Course Title | Hours per week | | | Total contact hrs/ week | Total Credits | E | M | I | V | Total Marks |
|--------------|--------------------------|-----------|--|----------------|---|----|-------------------------|---------------|----|----|-----|-----|-------------|
| | | | | L | T | P | | | | | | | |
| 1. | Program Core Course-XIII | CH1309 | Chemical Reaction Engineering | 2 | 0 | 2 | 4 | 3 | 70 | 30 | 20 | 30 | 150 |
| 2. | Program Core Course-XIV | CH1310 | Industrial organization & Supervisory management | 2 | 0 | 0 | 2 | 2 | 70 | 30 | 00 | 00 | 100 |
| 3. | Program Elective - III | CH1311/12 | Program Elective -III | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 00 | 00 | 100 |
| 4. | Program Elective-IV | CH1313/14 | Program Elective-IV | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 00 | 00 | 100 |
| 5. | Open Elective-III | CH1315/16 | Open Elective-III | 3 | 0 | 0 | 3 | 3 | 70 | 30 | 00 | 00 | 100 |
| 6. | Major Project | MH1303 | Major Project | 0 | 0 | 18 | 18 | 9 | 00 | 00 | 100 | 100 | 200 |
| Total | | | | | | | 33 | 23 | | | | | 750 |

(Established under Gujarat Private Universities Act, 2009)

Shroff S.R. Rotary Institute of Chemical Technology

A. Course Code and Definition:

| Abbreviations | Definitions |
|---------------|--------------------------------------|
| L | Lecture |
| T | Tutorial |
| P | Practical |
| E | Theory External Examination Marks |
| M | Theory Internal Examination Marks |
| I | Practical Internal Examination Marks |
| V | Practical External Examination Marks |

B. List of Professional and Open Electives Courses Sem-V and VI

| DE Sem -V | | | |
|-----------|----------------------|----------|---------------------------------|
| Sr. No. | Category of Course | Code No. | Course Title |
| 1. | Program Elective -II | CH1305 | Petroleum Refining |
| 2. | | CH1306 | Pharmaceutical Technology |
| 3. | Open Elective-II | CH1307 | Process Auxiliaries |
| 4. | | CH1308 | Environmental Impact Assessment |

| DE Sem -VI | | | |
|------------|-----------------------|----------|---|
| Sr. No. | Category of Course | Code No. | Course Title |
| 1. | Program Elective -III | CH1311 | Solid Fluid Operations |
| 2. | | CH1312 | Separation Processes |
| 3. | Program Elective -IV | CH1313 | Rubber Technology |
| 4. | | CH1314 | Polymer Technology |
| 5. | Open Elective-III | CH1315 | Process Equipments Design |
| 6. | | CH1316 | Process Equipment Auxiliaries and Plant Maintenance |

Diploma Engineering

Subject Code: CH1301

Subject Name: Plant Economics & Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Humanities and Social Sciences including Management Courses.

Prerequisite: Basic Concepts of Chemical Engineering.

Rationale: This course brings together the concepts of engineering and economics with special reference to chemical process and plant design along with the hierarchy of decisions in synthesis and analysis of a chemical process and its alternatives. This course is intended to challenge chemical engineer to combine basic technical principles learned in other courses in the general curriculum with practical elements of economics, business practices and organization along with principles of safety, environmental and sociological issues to design an integrated chemical process plant.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits C | Examination Marks | | | | Total Marks |
|-----------------|---|---|--------------|-------------------|--------|-----------------|--------|----------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|--|------------|
| SECTION-A | | |
| 1. | Introduction and Process design aspects: Basic design, factors affecting process selection, types of project design, importance of pilot plant, safety factors, types of flow diagrams. | 6 |
| 2. | Selection of process equipment: Standard versus special equipment-material of construction for process equipment, selection criteria, and specification sheets. | 6 |
| 3. | Plant location and layout: Factors affecting plant location, factors in planning layouts, principles of plant layout, use of scale models. | 6 |
| SECTION-B | | |
| 4. | Estimation of total product cost: manufacturing cost, general expenses, direct production cost, fixed charges, plant overhead cost. | 6 |
| 5. | Depreciation: Types of depreciation, service life, salvage value and present value of assets, methods of determining depreciation like straight-line method, declining-balance method, sum-of the years-digits method, sinking-fund method. | 6 |

Diploma Engineering

Subject Code: CH1301

Subject Name: Plant Economics & Management

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|-----------|--|----------|
| 6. | Project Management: Planning of project schedule by BAR CHART, inventory control scheduling a project using CPM/PERT methods. | 6 |
|-----------|--|----------|

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|-------------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 20 | 25 | 25 | 10 | 20 | 0 |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create and above Levels (Revised Bloom's Taxonomy)**

Text Book:

1. Max S. Peters, K.D. Timmerhaus and R.E. West, Plant Design and Economics for Chemical Engineers, McGraw-Hill International Edition, Chemical Engineering Series, New York, USA, 2003.

Reference Books:

1. James M. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill International Editions, Chemical Engineering Series, New York, USA, 1988.
2. V. V. Mahajani, Chemical Project Economics, Macmillan Indian Ltd., New Delhi, 2005.
3. R. Smith, Chemical Process: Design and Integration, John Wiley and Sons, West Sussex, UK, 2005.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|---|
| CO-1 | Explain the basic concepts of economics. |
| CO-2 | Select equipment, process plant design and project management. |
| CO-3 | Discuss plant location and layout. |
| CO-4 | Calculate total product costs. |
| CO-5 | Evaluate the project cost including depreciation cost for equipment. |
| CO-6 | Control and schedule of the project using CPM/PERT technique, Calculations. |

List of Open Source Software/learning website:

- <https://archive.nptel.ac.in/courses/103/105/103105166/>

Diploma Engineering
Subject Code: CH1302
Subject Name: Process Heat Transfer-II

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of Course: Program Core Course-X

Prerequisite: Basic Concepts of Process Heat Transfer-II.

Rationale: The main objective of this subject is to study the basics of heat transfer takes place in the Chemical industries. This subject provides knowledge regarding the basic modes and aspects of heat transfer process as well as it also provides an idea about various equipment used for heat transfer.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits C | Examination Marks | | | | Total Marks |
|-----------------|---|---|--------------|-------------------|--------|-----------------|--------|----------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 2 | 0 | 4 | 4 | 70 | 30 | 30 | 20 | 150 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Boiling: The boiling phenomenon, hysteresis in boiling curve, the mechanism of nucleate boiling, forced convective boiling. | 3 |
| 2. | Condensation: The condensation phenomenon, types of condensation, film condensation on vertical surface, factors affecting condensation i.e. non condensable gases. | 3 |
| 3. | Classification of Heat Exchangers: Classification according to transfer processes, number of passes, surface compactness, construction features, flow arrangements, heat transfer mechanisms. | 6 |
| SECTION-B | | |
| 4. | Construction of Heat Exchangers: construction double pipe heat exchanger, shell and tube heat exchanger, types of shell & tube heat exchangers, LMTD. | 6 |
| 5. | Classification of Evaporators: principle of evaporation, types of evaporators-their construction and operation, natural circulation evaporators, calandria type evaporators, basket type vertical evaporators, long tube vertical evaporators, forced circulation evaporators, falling film evaporators. | 3 |
| 6. | Performance of Evaporators: capacity and economy of evaporators, material and energy balances for single effect evaporators. | 3 |

Diploma Engineering
Subject Code: CH1302
Subject Name: Process Heat Transfer-II

Shroff S.R. Rotary Institute of Chemical Technology

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 20 | 25 | 25 | 10 | 20 | - |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create and above Levels (Revised Bloom's Taxonomy)**

Textbook:

1. B. K. Dutta, Heat Transfer-Principles & Applications, 1st edition, PHI Learning Pvt. Ltd., 2006.

Reference Books:

1. W. L. McCabe, J. C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 7th edition, McGraw-Hill Book Co., 2005.
2. J. P. Holman, Heat Transfer, 10th edition, McGraw-Hill, 2010.
3. D. Q. Kern, Process Heat Transfer, McGraw Hill, 1950.

List of Practical:

| Sr. No. | Practicals | Approx. Hours required |
|---------|---|------------------------|
| 1. | To determine the overall thermal conductivity of composite wall. | 4 |
| 2. | To determine the thermal conductivity of metal rod. | 4 |
| 3. | To study the heat transfer from a pin fin under forced and natural convection and calculate the heat transfer co-efficient and effectiveness of the fin. | 4 |
| 4. | To compare overall heat transfer coefficient for parallel and counter flow in a double pipe heat exchanger and also compare practical overall heat transfer coefficient value with the theoretical value. | 4 |
| 5. | To analyze the performance of an existing Shell & Tube heat exchanger and also calculate the overall heat transfer coefficient for Shell & Tube heat exchanger. | 4 |
| 6. | (i) To analyze the performance of an existing plate type heat exchanger (ii) To calculate overall heat transfer coefficient & effectiveness for plate type heat exchanger.(iii) To analyze effects of changing the flow rate for hot water & cold water fluids. | 4 |

Diploma Engineering
Subject Code: CH1302
Subject Name: Process Heat Transfer-II

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|-----|---|---|
| 7. | To determine the overall heat transfer coefficient (U) for bare pipe, longitudinal fins and transverse fins and to study the operation of heat exchanger. | 4 |
| 8. | Study of radiation heat transfer by black plate and test plate & calculate the emissivity of test plate. | 4 |
| 9. | To study the radiation heat transfer by black body and to study the effect of hemisphere temperature on it & calculate the Stefan Boltzmann constant. | 4 |
| 10. | To study the performance of heat exchangers in simulator. (CHEMCAD) | 4 |

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|---|
| CO-1 | Describe the two phase heat transfer. |
| CO-2 | Classify the heat exchangers by their mechanism. |
| CO-3 | Solve the heat transfer problems using convective equations. |
| CO-4 | Analyze the effectiveness of shell and tube heat exchanger. |
| CO-5 | Select proper evaporator for various applications. |
| CO-6 | Calculate the performance parameters associated with evaporators. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/103105140/>

Diploma Engineering

Subject Code: CH1303

Subject Name: Instrumentation and Process Control

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Program Core Course-XI

Prerequisite: Fundamentals of chemical processes and its measurements

Rationale: The course is designed to introduce fundamentals of process control along different process instrumentations required for chemical processes industries.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|--------|-----------------|--------|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | C | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 2 | 0 | 4 | 4 | 70 | 30 | 30 | 20 | 150 |

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Introduction to Process Measurement: Elements of instruments, parts of instruments, static and dynamic characteristics. Temperature Measurement: Thermometers like mercury in glass, bimetallic, filled system thermometer like pressure spring thermometer, thermo-electric temperature measurement: thermo couples, resistance temperature detector. | 4 |
| 2. | Pressure Measurement: Liquid column manometer, U tube manometer, Bourdon gauge, bellows differential pressure gauge. Vacuum Measurement: Pirani vacuum gauge, thermocouple vacuum gauge, McLeod gauge. | 4 |
| 3. | Liquid Level Measurement: Direct measurement, float and tap, float and shaft, diaphragm & air trap system, float and spring pneumatic balance, displacement float, magnetic float gauge | 4 |
| SECTION-B | | |
| 4. | Density & Viscosity Measurement: Liquid level method, displacement meters, hydrometer, viscosity meters- continuous viscosity meters, capillary type viscometers. | 3 |
| 5. | Introduction to Process Control; Need for control and automation, steady state and dynamic system, simple forcing functions- step, ramp, impulse. Servo and regulatory problem. | 5 |
| 6. | Types of control action: Proportional control (P), Proportional Integral (PI) control, Proportional Derivative (PD) control, and Proportional Integral Derivative (PID) control. | 4 |

Diploma Engineering
Subject Code: CH1303
Subject Name: Instrumentation and Process Control

Shroff S.R. Rotary Institute of Chemical Technology

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 40 | 40 | 15 | 5 | - | - |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

1. A. P. Kulkarni, Process Instrumentation and Control, 20th edition, Nirali Prakashan, 2022.

Reference Books:

1. P. E. Donald, Industrial Instrumentation, CBS Publishers, 2002.
2. C. D. William, Fundamentals of Industrial Instrumentation and Process Control, Mc-Graw Hill, 2005.
3. D. R. Coughanowr, S. LeBlanc, Process Systems Analysis and Control, 3rd edition, McGraw-Hill, 2008.

List of Practicals:

| Sr. No. | Practicals | Approx. Hours required |
|---------|---|------------------------|
| 1. | To calibrate thermocouple. | 4 |
| 2. | To calibrate resistance temperature detector. | 4 |
| 3. | To calibrate thermistor. | 4 |
| 4. | To measure pressure difference using U-tube manometer. | 4 |
| 5. | To measure viscosity of a given oil. | 4 |
| 6. | To measure density of a given solvent/solution. | 4 |
| 7. | To study on temperature, level and pressure control trainers. | 4 |
| 8. | To study flow-level cascade control. | 4 |
| 9. | To study step response of a thermometer. | 4 |
| 10. | To study step response of a liquid level tank. | 4 |

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|---|
| CO-1 | Know the static and dynamic characteristics of process instruments. |



UPL UNIVERSITY
OF
SUSTAINABLE TECHNOLOGY

(Established under Gujarat Private Universities Act, 2009)



Diploma Engineering

Subject Code: CH1303

Subject Name: Instrumentation and Process Control

Shroff S.R. Rotary Institute of Chemical Technology

| | |
|------|--|
| CO-2 | Explain the working principles of temperature and pressure measuring instruments. |
| CO-3 | Explain the working principles of liquid level measuring instruments. |
| CO-4 | Explain the working principles of density and viscosity measuring instruments. |
| CO-5 | Choose an instrument for measurement of temperature, pressure, liquid level, density, and viscosity. |
| CO-6 | Define various forcing functions and types of control action. |

List of Open Source Software/learning website:

- https://onlinecourses.nptel.ac.in/noc21_ch26/preview

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1304

Subject Name: Safety and Hazard Management in Chemical Industry

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Program core course-XII

Prerequisite: Basic understanding of chemical engineering processes and equipment, plant layout, process instrumentation control, material of construction, knowledge of piping system & basic engineering mathematics.

Rationale: Study toxicology, industrial hygiene and regulations, hazards identification for safe operation of industrial processes.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|--------|-----------------|--------|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 2 | 0 | 0 | 2 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Introduction: safety programs, engineering ethics, accident and loss statistics, acceptable risk, the nature of the accident process, inherent safety. Toxicology: entering of toxicants into biological organisms, toxicological studies, elimination of toxicants from biological organisms, effects of toxicants on biological organisms, TLVS, | 5 |
| 2. | Development of industrial hygiene and regulations: national and international regulations, OSHA: process safety management, EPA: risk management plan, material safety data sheets. | 4 |
| 3. | Fire and Explosions & their Prevention: the fire triangle, flammability characteristics of liquids and vapours, limiting oxygen concentration and inerting. | 3 |
| SECTION-B | | |
| 4. | Process Hazards Identification: Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews, | 4 |
| 5. | Process Risk Assessment: event tree analysis, fault tree analysis, layer of protection analysis. | 5 |

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1304

Subject Name: Safety and Hazard Management in Chemical Industry

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|-----------|---|----------|
| 6. | Case studies: case study on significant disaster in the world. | 3 |
|-----------|---|----------|

Suggested Specification Table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 15 | 25 | 25 | 20 | 10 | 5 |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

1. D. A. Crowl, J. F. Louvar Chemical Process Safety: Fundamentals with Applications, 4th edition, Prentice – Hall, 1990.

Reference Books:

1. L. Slote Handbook of Occupational Safety and Health, John Willey and Sons, New York, 2019.
2. F. P. Lees, Loss of Prevention in Process Industries, Vol. 1 and 2, Butterworth-Heinemann Ltd., London, 1991.
3. H. Koren, M. Bisesi, Hand book of Environmental Health and Safety, Jaico Publishing House, Delhi, 1999.

Course Outcomes:

After Learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|---|
| CO-1 | Describe engineering ethics and basic safety concept. |
| CO-2 | Explain the industrial hygiene and process safety management systems. |
| CO-3 | Apply appropriate technique for fire control. |
| CO-4 | Identify hazards in chemical and allied industries. |
| CO-5 | Examine risk in chemical and allied industries. |
| CO-6 | Understand material safety data sheet. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/103107156>

Diploma Engineering
Subject Code: CH1305
Subject Name: Petroleum Refining

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Program Elective - II

Prerequisite: Basics of unit operations, heat and mass transfer.

Rationale: Petroleum refining as well as petrochemical industries constitute a major part of chemical sector. Every chemical engineer has to invariably handle the enormous consumption of petroleum products, their diversity and increasing applications. Chemical engineer has to apply the relevant concepts for operating petroleum refinery or petrochemical plant in a safe manner. Beside this, a chemical engineer must be aware about the various properties of petroleum fractions as well as petrochemicals. Hence, this course has been designed to develop such expertise and skills.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits C | Examination Marks | | | | Total Marks |
|-----------------|---|---|--------------|-------------------|--------|-----------------|--------|----------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 4 | 0 | 0 | 4 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|--|------------|
| SECTION-A | | |
| 1. | Petroleum and Refinery: Petroleum: occurrence and history, crude oil reserves in India, basics of composition of petroleum, refinery products. | 8 |
| 2. | Petroleum Products: Gasoline, diesel, naphtha, kerosene, wax, bitumen, lubricating oil, asphalt. | 8 |
| 3. | Distillation of crude oil: Primary treatment of crude: Dehydration and desalting of crude, atmospheric distillation of crude, vacuum distillation of crude. | 8 |
| SECTION-B | | |
| 4. | Various tests of Petroleum Products: Octane number, fire and flash point, pour point, smoke point, cetane number, aniline point. | 7 |
| 5. | Thermal Cracking: Necessity of cracking, properties of cracked material, visbreaking. | 9 |
| 6. | Catalytic Cracking: Advantages of catalytic cracking, fixed bed and fluidized bed technology. | 8 |

Diploma Engineering
Subject Code: CH1305
Subject Name: Petroleum Refining

Shroff S.R. Rotary Institute of Chemical Technology

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 30 | 25 | 35 | 10 | - | - |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create and above Levels (Revised Bloom's Taxonomy)**

Textbook:

1. B. K. Bhaskar Rao, Modern Petroleum Refining Processes, Oxford and IBH, 2007.

Reference Books:

1. M. Gopal Rao, Dryden's Outlines of Chemical Technology, West press Pvt. Ltd., 2007.
2. B. K. Bhaskar Rao, A Text on Petrochemicals, Khanna Publisher, 1998.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|---|
| CO-1 | Understand the composition of the petroleum product. |
| CO-2 | Describe Petroleum Products. |
| CO-3 | Classify the distillation of crude oil. |
| CO-4 | Identify appropriate testing method for petroleum products. |
| CO-5 | Explain thermal cracking. |
| CO-6 | Discuss catalytic cracking. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/103102022>

Diploma Engineering

Subject Code: CH1306

Subject Name: Pharmaceutical Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Program Elective- II

Prerequisite: Basic knowledge of unit operations and unit processes.

Rationale: To acquire a deep-rooted knowledge of the fundamental principles in pharmaceutical formulation. This course provides knowledge about manufacturing processes used in pharmaceutical production and the tools used to prepare pharmaceutical drug. The chemical engineers will be able to handle various manufacturing processes used in pharmaceutical industries.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|---------|-----------------|----|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | ESE (E) | PA (M) | ESE (V) | PA (I) | | |
| 4 | 0 | 0 | 4 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Basics of Pharmaceutical Technology: Characteristics of pharmaceutical industries, product standards: IP, BP, USP, methods of production, fermentation, API and formulation. | 7 |
| 2. | Sterilization: Concept of sterilization, heat sterilization, steam sterilization, dry heat sterilization, filtration sterilization, sterile facilities: preparation area, compounding area, ware housing. | 8 |
| 3. | Clean Facilities: Design parameters for clean facilities: air change rate, pressurization, temperature control, humidity control, material of construction for wall, doors, ceilings, floors, HEPA filters. | 9 |
| SECTION-B | | |
| 4. | Dosage Forms: Solid dosage forms: tablets, coated tablets, gelatin capsules, chewable tablets, gum based tablets, excipients in solid dosage forms, semi-solid dosages : ointments and creams, bases for ointments and creams, packaging and storage of ointments and creams, types of gels, commercial gelling agents | 8 |
| 5. | Emulsification and Homogenization: Definition, principle and construction of colloid mills and homogenizer, industrial applications of emulsification and homogenization | 8 |

Diploma Engineering

Subject Code: CH1306

Subject Name: Pharmaceutical Technology

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|-----------|---|----------|
| 6. | Manufacturing and Packaging: Manufacturing of tablets and capsules, packaging and storage of ointments and creams, packaging materials, quality control of packaging materials | 8 |
|-----------|---|----------|

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|-------------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 30 | 35 | 25 | 10 | - | - |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

1. K. Gadamasetti, Process Chemistry in Pharmaceutical Industry, CRC Press, 2007.

Reference Books:

1. J. Hickey, Anthony and David Ganderton, Pharmaceutical Process Engineering, Marcel Dekker Inc. USA, 2001.
2. Gad and Shayne Cox, Pharmaceutical Manufacturing handbook, John Wiley and Sons, 2008.
3. W.L. Badger and J.T. Banchero, Introduction to Chemical Engineering, McGraw Hill, 2010.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|----------------|--|
| CO-1 | Review methods in medicine production. |
| CO-2 | Apply various methods of sterilization. |
| CO-3 | Use design parameters for clean facilities. |
| CO-4 | Select dosage forms. |
| CO-5 | Discuss the emulsification and homogenization process. |
| CO-6 | Identify appropriate packaging materials. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/104102113>

Diploma Engineering
Subject Code: CH1307
Subject Name: Process Auxiliaries

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Open Elective-II

Prerequisite: None.

Rationale: This subject is intended to familiarize students with the basics as well as advanced understanding of various process auxiliaries used in chemical plant and how they integrate with the process facilities and overall operation.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|--------|-----------------|--------|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Introduction: Basic considerations and flow diagrams in chemical engineering plant design. | 6 |
| 2. | Piping design: Selection of material, pipe sizes, working pressure, basic principles of piping, design, piping drawings, pipe installations, overhead installations. | 6 |
| 3. | Steam Piping: Process steam piping, selection and determination of steam – pipe size, Piping insulation, application of piping insulation, weather proof and fire resisting pipe insulation jackets, piping fittings, pipe joints. | 6 |
| SECTION-B | | |
| 4. | Valves: Types of valves, selection criteria of valves for various systems. | 6 |
| 5. | Pumps: Types of pumps, NPSH requirement, pump location, pump piping, pump piping support. | 6 |
| 6. | Compressor and Vacuum pumps: Types of compressors and vacuum pumps, lubrication and oil removal in compressors and pumps. | 6 |

Diploma Engineering
Subject Code: CH1307
Subject Name: Process Auxiliaries

Shroff S.R. Rotary Institute of Chemical Technology

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 25 | 25 | 30 | 20 | - | - |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create and above Levels (Revised Bloom's Taxonomy)**

Textbook:

1. Mukesh Doble, Principles of Downstream Techniques in Biological and Chemical Processes, 1st edition, Apple Academic Press, 2005.

Reference Books:

1. Ed Bausbacher & Roger Hunt, Process plant layout and piping design, PTR Prentice Hall, UK.
2. Oilver Lyle, Efficient Use of Steam, Prentice Hall, 1963.
3. V. M. Cherkassky, Pumps Fans Compressors, 1st edition, Mir Publishers, 1980.
4. M. S. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, 3rd edition, Mc Graw Hill.
5. G. K. Sahu, Handbook of Piping Design, New Age International Publishers, 2008.

Course Outcomes:

After Learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|---|
| CO-1 | Understand the importance of process auxiliaries in a chemical plant. |
| CO-2 | Estimate correct pipe size for required flow rate. |
| CO-3 | Compare and apply appropriate insulation on steam pipe. |
| CO-4 | Assess the different types of valves available for chemical plants |
| CO-5 | Identify proper pump for pumping of fluid. |
| CO-6 | Apply compressor and vacuum pump in chemical processing plant. |

List of Open Source Software/learning website:

- <https://archive.nptel.ac.in/courses/103/107/103107211/>

Diploma Engineering

Subject Code: CH1308

Subject Name: Environmental Impact Assessment

Shroff S.R. Rotary Institute of Chemical Technology

Semester: V

Type of course: Open Elective-II

Prerequisite: Understanding the basic concepts of ecology and environment.

Rationale: The main objective of this subject is to make students aware of industrial linkage to environmental concerns. EIA shows impact levels on the ecosystem. Hence knowledge of this subject is very important for the 21st century-diploma engineers working in chemical process industries.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits C | Examination Marks | | | | Total Marks |
|-----------------|---|---|--------------|-------------------|--------|-----------------|--------|----------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Ecology Concepts: The value of environment, industrial link to environmental concerns, aspects of industrial ecology, introduction to industrial pollution and introduction to environment audit and hazard management | 6 |
| 2. | Concepts of Environmental Impact Assessment: Environmental impacts; origin of EIA, need for EIA, Indian policies requiring EIA, EIA- as an integral part of the planning process. | 6 |
| 3. | Elements of EIA: Salient feature of EIA, components of EIA: air environment, noise environment, water environment, biological environment, land environment, socio-economic and health environment. | 6 |
| SECTION-B | | |
| 4. | EIA Methodologies: EIA planning, criteria for selection of EIA methodology, EIA stages, procedure and methods. | 6 |
| 5. | Sustainable Development: Development; sustainable development – logic of sustainable development; methods to achieve sustainable development, waste minimization, introduction to clean technology and life cycle assessment | 6 |
| 6. | Case Studies: Role of regulatory agencies and control boards, role of public, introduction to environmental management, case studies: EIA for chemical industry | 6 |

Diploma Engineering
Subject Code: CH1308
Subject Name: Environmental Impact Assessment

Shroff S.R. Rotary Institute of Chemical Technology

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 20 | 30 | 20 | 15 | 10 | 5 |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create and above Levels (Revised Bloom's Taxonomy)**

Textbook:

1. Y. Anjaneyulu, and V. Manickam, Environmental Engineering, 2nd edition, BS Publication, 2007.

Reference Books:

1. G. Kiely, Environmental Impact Assessment Methodologies, 1st edition, McGraw Hill, 1998.
2. S. C. Bhatia, Environmental Pollution and Control in Chemical Process Industries, 2nd edition, Khanna Publication, 2014.
3. Shankar, Environment, 6th edition, Shankar IAS Academy, 2018.
4. J. Glasson, R. Therivel, A. Chadwick, Introduction to Environmental Impact Assessment, UCL press – Taylor and Francis Group, 1999.

Course Outcomes:

After Learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|---|
| CO-1 | Define the Environmental Impact Assessment |
| CO-2 | Explain the need for Environmental Impact Assessment |
| CO-3 | Discuss the various components of Environmental Impact Assessment |
| CO-4 | Describe the stages and methodology of EIA |
| CO-5 | Relate various clean technology for sustainable development |
| CO-6 | Appraise the environmental impact in chemical process industries |

List of Open Source Software/learning website:

- <http://www.mygov.scot/eia>

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1309

Subject Name: Chemical Reaction Engineering

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Professional Core Course-XIII

Prerequisite: Knowledge of Mathematics, Chemistry, Fluid Mechanics, Heat and Mass Transfer, Thermodynamics etc.

Rationale: The basic concepts of chemical reaction engineering are applied to the design and operation of various industrial reactors used for non-catalytic and catalytic reactions. This course enables the diploma engineer to some extent in accomplish the task of selecting, sizing and determining the optimal operating conditions for the reactor.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|---------|-----------------|----|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | ESE (E) | PA (M) | ESE (V) | PA (I) | | |
| 2 | 0 | 2 | 3 | 70 | 30 | 30 | 20 | 150 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Basics of chemical reactions: Scope and importance of chemical reaction engineering, classification of chemical reactions, reaction rate on various basis and variables affecting the rate of reaction. | 2 |
| 2. | Kinetics of homogeneous reactions: Rate equation/ rate law, concentration dependent term of rate equation, rate constant, elementary and non-elementary reactions, molecularity and order of reaction, temperature dependent term of rate, equation, temperature dependency from Arrhenius law, activation energy. | 4 |
| 3. | Interpretation of batch reactor data: Concentration and conversion, methods for analysis of kinetic data, differential vs. integral method, half-life method, integrated rate equation for different order of irreversible reactions. | 6 |
| SECTION-B | | |
| 4. | Introduction to ideal reactors: Ideal batch reactor, steady state mixed flow reactor, steady state plug flow reactor, space time, space velocity. | 4 |
| 5. | Design of ideal reactors: Performance of ideal reactors for constant volume system, selection of material of construction for reactors. | 4 |
| 6. | Introduction to multiphase reactors: Fixed bed reactors, fluidized bed reactors, trickle bed reactor. | 4 |

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1309

Subject Name: Chemical Reaction Engineering

Shroff S.R. Rotary Institute of Chemical Technology

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 25 | 35 | 30 | 20 | - | - |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create and above Levels (Revised Bloom's Taxonomy)**

Textbooks:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd edition, John Wiley and Sons, 2006.

Reference Books:

1. J. M Smith, Chemical Engineering Kinetics, Second Edition, McGraw-Hill, 1970.
2. H. Scott Fogler, Elements of Chemical Reaction Engineering, Fourth Edition, Prentice Hall International, 2008.

List of Practicals:

| Sr. No. | Practicals | Approx. Hours required |
|---------|--|------------------------|
| 1. | Study saponification reaction at room temperature. | 2 |
| 2. | Study the effect of concentration on rate of reaction. | 2 |
| 3. | Study saponification reaction at elevated temperature. | 2 |
| 4. | Study integral method of analysis. | 2 |
| 5. | Study differential method of analysis. | 2 |
| 6. | Study half-life time method of analysis. | 2 |
| 7. | Study acid catalyzed hydrolysis of ester. | 2 |
| 8. | Study Arrhenius law and determination of activation energy. | 2 |
| 9. | Study performance of continuous stirred tank reactor (CSTR). | 2 |
| 10. | Study performance of plug flow reactor (PFR). | 2 |

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|------------------------------|
| CO-1 | Classify chemical reactions. |



UPL UNIVERSITY
OF
SUSTAINABLE TECHNOLOGY

(Established under Gujarat Private Universities Act, 2009)



Diploma Engineering

Subject Code: CH1309

Subject Name: Chemical Reaction Engineering

Shroff S.R. Rotary Institute of Chemical Technology

| | |
|------|--|
| CO-2 | Understand rate controlling factors. |
| CO-3 | Use different methods interpretation of kinetics data. |
| CO-4 | Describe ideal reactors. |
| CO-5 | Derive performance equation for different reactors. |
| CO-6 | Illustrate reactors for heterogeneous reactions. |

List of Open Source Software/learning website:

- <http://www.umich.edu/~elements/toc/frames.htm>.
- <http://nptel.ac.in/courses/103108097/>

Diploma Engineering

Subject Code: CH1310

Subject Name: Industrial organization & Supervisory Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Program Core Course-XIV

Prerequisite: None.

Rationale: An engineer has to work in industry with human, capital and machines. Therefore, managerial skills are essential for enhancing their employability and career growth. This course is therefore designed to provide the basic concepts in management principles and industrial legislation.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|--------|-----------------|--------|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 2 | 0 | 0 | 2 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|--|------------|
| SECTION-A | | |
| 1. | Introduction: definitions of management, role and importance of management, management characteristics and principles, levels of management and their functions; management, administration and organization, relation between management and administration. Functions of Management: Planning, organizing, leading/directing, staffing and controlling. | 4 |
| 2. | Organizational Process: Introduction and meaning of organization, organization as a process, span of control, authority, responsibility and accountability, delegation of authority, decentralization of authority. | 4 |
| 3. | Organizational Behavior: Enhancing managerial effectiveness through self and others, individual personality & behavior, perception, attitudes, values and aptitude, frustration, conflict, organizational structure, organizational culture, organizational transformation, organizational effectiveness and assessment. | 4 |
| SECTION-B | | |
| 4. | Principles of Management: Principles, thoughts and contributions of FW Taylor, Henry Fayol and Elton Mayo. Responsibilities of Management: society and development. | 4 |

Diploma Engineering

Subject Code: CH1310

Subject Name: Industrial organization & Supervisory Management

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|-----------|---|----------|
| 5. | Functions of Management: Planning, motivating, leading, controlling business organization structures, limitations, relative merits & demerits, types of planning and steps in planning, types of organization, steps in organizing functional areas of management. | 4 |
| 6. | Industrial Legislation: Indian Factory Act 1948, Industrial Dispute Act, Workman Compensation Act, Minimum Wages Act. | 4 |

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|-------------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 30 | 35 | 35 | - | - | - |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbook:

- O. P. Khanna, Industrial Engineering and Management, Dhanpathrai and Sons, 1980.

Reference Books:

- Veerabhadrapa, Havinal, Management and Entrepreneurship, New Age International Publishers, 2014.
- O. P. Chaudvary, Principles of Management, New Age International Publishers, 2012.
- T. R. Banga and S. C. Sharma, Industrial Engineering and Management, Khanna Publication, 2017.

Course Outcomes:

After Learning this course, students will be able to:

| Sr. No. | CO statement |
|----------------|--|
| CO-1 | Understand the significance of management in business. |
| CO-2 | Evaluate the process of management and its function |
| CO-3 | Appraise the need of effective management |
| CO-4 | Comprehend the basic principles of management |
| CO-5 | Demonstrate the roles, skills and functions of management. |
| CO-6 | Know the various provisions of industrial acts |



UPL UNIVERSITY
OF
SUSTAINABLE TECHNOLOGY

(Established under Gujarat Private Universities Act, 2009)



Diploma Engineering

Subject Code: CH1310

Subject Name: Industrial organization & Supervisory Management

Shroff S.R. Rotary Institute of Chemical Technology

List of Open Source Software/learning website:

- <https://labour.gov.in/industrial-relations>
- <https://nptel.ac.in/courses/122106031>

Diploma Engineering
Subject Code: CH1311
Subject Name: Solid Fluid Operations

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Program Elective -III

Prerequisite: Fundamental of mechanical, fluid flow, mass and heat transfer operations.

Rationale: The objective of this course is to provide detail idea about the operations that includes solid-fluid chemical operations like packed bed operation, fluidization, mixing, sedimentation, filtration, separation of solids from fluids, handling and transportation of solids etc., and develop understanding for selection of appropriate equipment for the desired duty.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits C | Examination Marks | | | | Total Marks |
|-----------------|---|---|--------------|-------------------|--------|-----------------|--------|----------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Introduction: Industrial importance of solid-fluid operation, properties of solids, no. of particles in a mixture. | 3 |
| 2. | Mixing and Agitation: Different types of agitators and their selection criteria, calculation of power required for agitation, static mixers and intensive mixers, heating and cooling mixers. | 5 |
| 3. | Fluidization: Fluid flow through granular and packed beds of particles: Ergun equation, Kozeny-Carman equation, minimum fluidization velocity, conditions for fluidization, types and applications of fluidization, fluidized bed reactor, moving bed reactor and fixed bed reactor. | 10 |
| SECTION-B | | |
| 4. | Filtration and sedimentation: Principles of flow through filter cakes and medium, Selection criteria for the filter medium, types of filtration equipment, cyclone and hydro-cyclone, Sedimentation - batch sedimentation, rate of sedimentation, thickeners and clarifier. | 10 |
| 5. | Solid- Fluid Mass Transfer: Leaching, crystallization, nucleation-growth of crystals, drying. | 4 |
| 6. | Transportation: Mechanical, hydraulic and pneumatic transport of solids. | 4 |

Diploma Engineering
Subject Code: CH1311
Subject Name: Solid Fluid Operations

Shroff S.R. Rotary Institute of Chemical Technology

Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 20 | 35 | 30 | 15 | 00 | 00 |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

- W.L. McCabe, J. C. Smith & Harriott, Unit Operations of Chemical Engineering, 6th edition, McGraw Hill international, 2000.

Reference Books:

- J. F. Richardson, J. H. Harker, J. R. Backhurst, Coulson and Richardson's Chemical Engineering, vol. 2, 5th edition, Butterworth, 2002.
- G. G. Brown, Unit Operations, CBS Publishers & Distributors, 2005.
- W. L. Badger & J.T. Banchero, Introduction to Chemical Engineering McGraw-Hill, 1955.
- R. E. Treybal, Mass transfer Operations, Treybal, Mc Graw Hill international, 1980.
- J. D. Seader, E. J. Henley, Separation Process Principles, 2nd edition, John Wiley & Sons, 2006.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|--|
| CO-1 | Understand importance of solid fluid operations in industry. |
| CO-2 | Determine power required for agitation under various conditions. |
| CO-3 | Illustrate concepts of fluidizations and its applications. |
| CO-4 | Describe sedimentation and filtration principles. |
| CO-5 | Elaborate the concept of solid- fluid mass transfer operations. |
| CO-6 | Select methods of transportation of solid. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/103105161>

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1312

Subject Name: Separation Processes

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Program Elective- III

Prerequisite: Basic knowledge of heat transfer, mass transfer and fluid flow operations.

Rationale: Separation techniques are integral unit operation in most of the modern chemical, pharmaceutical and other process plants. There are many standard and conventional separation techniques available in the market and these techniques are quite common. Newer separation techniques are gaining importance in modern day chemical plant. This course is designed to emphasize on advanced separation techniques.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits C | Examination Marks | | | | Total Marks |
|-----------------|---|---|--------------|-------------------|---------|-----------------|----|----------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | ESE (E) | PA (M) | ESE (V) | PA (I) | | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Adsorption: Definition and industrial application of adsorption, nature of adsorbents, commonly used adsorbents, effect of temperature on adsorption and heat of adsorption, basics of adsorption from dilute & concentrated solution. | 7 |
| 2. | Ion Exchange: Ion exchange principles, Applications of Ion exchange | 5 |
| 3. | Crystallization: Saturation, nucleation, principle of crystallization, nucleation, crystal growth, caking of crystals, application of crystallization, crystallization equipment. | 6 |
| SECTION-B | | |
| 4. | Leaching: Steady state leaching operations, single stage leaching, rate of leaching, recovery of solvent vapors, application of leaching, leaching equipment. | 6 |
| 5. | Membrane Separation Techniques: Principles, mechanisms, membrane materials, classification, application & advantages of membrane separation processes. | 7 |

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1312

Subject Name: Separation Processes

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|----|--|---|
| 6. | Reverse Osmosis: Concept of osmosis and reverse osmosis, membrane material for R.O., advantages and commercial applications of R.O. | 5 |
|----|--|---|

Suggested Specification Table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 35 | 35 | 30 | - | - | - |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

1. B.K. Dutta, Principles of Mass transfer and Separation processes, PHI Learning Pvt. Ltd., 2009.
2. Kaushik Nath, Membrane separation Processes, PHI Pvt. Ltd., 2008.

Reference Books:

1. Kirk & Othmer, Encyclopedia of Chemical Engineering, John Wiley & Sons, Inc., 2001.
2. S.B. Thakore & B.I Bhatt, Introduction to Process Engineering & Design, Tata McGraw-Hill Ltd., 2007.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|---|
| CO-1 | Use the concept of adsorption. |
| CO-2 | Review ion exchange unit operation. |
| CO-3 | Illustrate various crystallizers. |
| CO-4 | Relate theoretical and analytical aspects of leaching operation to deal with complex problems of separations. |
| CO-5 | Explain the applications of membrane operation as per industrial requirement. |
| CO-6 | Discuss advanced concepts of reverse osmosis used in chemical industries. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/103105060>

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1313

Subject Name: Rubber Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Program Elective- IV

Prerequisite: The basics knowledge of chemistry and materials.

Rationale: The main objective of this subject is to provide the knowledge about the different rubber processing processes.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|---------|-----------------|----|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | ESE (E) | PA (M) | ESE (V) | PA (I) | | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|--|------------|
| SECTION-A | | |
| 1. | Introduction of Polymer: Historical developments in polymeric materials, basic concepts & definitions, classification of polymers. | 6 |
| 2. | Chemistry of Natural rubber and its intermediates: Latex collection & purification, chemistry of neoprene, butyl rubber, nitrile rubber, synthetic rubbers, & elastomers. | 6 |
| 3. | Introduction to Vulcanization Techniques: Sulphur vulcanization and non-sulphur, vulcanization, reclaiming of rubber, mastication of rubber. | 6 |
| SECTION-B | | |
| 4. | Recycling of Rubber: Comparison of thermoset and thermoplastic composites, reclaiming of rubber – fuel source – pyrolysis, de-polymerization of scrap rubber, tyre retreading, uses of recycled rubber – asphalt modification, rubber tiles and other uses. | 6 |
| 5. | Finishing of Rubber components: Flash and spot removal, punching grinding, shaft blasting, painting and lacquering chemical surface treatment. | 6 |
| 6. | Manufacturing process: Properties and application of SBR, nitrile rubber, butyl, neoprene and polysulphide. | 6 |

Suggested Specification Table with Marks (Theory):

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1313

Subject Name: Rubber Technology

Shroff S.R. Rotary Institute of Chemical Technology

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 25 | 20 | 25 | 10 | 20 | - |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

1. V. R. Gowarikar and N. V. Viswanathan, Polymer Science, Willey, 1986.
2. Progress in Rubber, Plastics and Recycling Technology, Volume 17 Issue 4, SAGE Publications Ltd, 2001.
3. H. J. Manuel, W. Dierke, Recycling of Rubber, Smithers Rapra Publishing, 1997.

Reference Books:

1. V. Thakur, Recycled Polymers: Properties and Applications, Volume 2, 2015.
2. V. Goodship, Introduction to Plastics Recycling, 2nd edition, Smithers Rapra Publishing, 2007.
3. S. M. Amelia, S.F. Santos, Plastic Recycling, Nova Science Publishers, 2009.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|--|
| CO-1 | Define natural polymers and rubber materials. |
| CO-2 | Understand the Vulcanization Process. |
| CO-3 | Discuss rubber processing techniques. |
| CO-4 | Demonstrate the process of recycling of rubbers. |
| CO-5 | Explain the importance, function and different rubber compounding additives. |
| CO-6 | Distinguished the Processing of different Rubber Products. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/113105028>

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1314

Subject Name: Polymer Technology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Program Elective- IV

Prerequisite: The basics knowledge of material and its properties.

Rationale: The main objective of this subject is to provide the knowledge about the different polymer processing processes.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|---------|-----------------|----|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | ESE (E) | PA (M) | ESE (V) | PA (I) | | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Introduction: Historical developments in polymeric materials, basic concepts & definitions: monomer & functionality, oligomer, polymer, repeating units, degree of polymerization, molecular weight & molecular weight distribution. | 6 |
| 2. | Classification of Polymers: Thermoplastic/ thermoset, addition/condensation, natural /synthetic, crystalline/amorphous, step growth /chain growth, commodity, specialty, homochain/ heterochain, confirmation: homo & copolymers (detailed graft, block) configuration cis/trans; tacticity, branched/ crosslinked, classification of polymers based on end use etc. | 6 |
| 3. | Polymerization: Introduction, functionality, basic characteristics of addition & condensation polymerization, ionic polymerization, copolymerization. methods of polymerization: bulk, solution, suspension, emulsion. | 6 |
| SECTION-B | | |
| 4. | Molecular weight: Introduction- concept of average molecular weight, number and weight average molecular weight, polydispersity, degree of polymerization, significance of polymer molecular weight, size of polymer molecules. | 6 |
| 5. | Polymer Degradation: Polymer degradation (chain and random), methods of degradation of polymers such as mechanical, thermal, photo, oxidative and | 6 |

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1314

Subject Name: Polymer Technology

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|----|---|---|
| | bio degradation. | |
| 6. | Processing of Polymers: Unit operations in polymer industries, polymer processing: moulding, calendaring, extrusion etc. | 6 |

Suggested Specification Table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 20 | 30 | 20 | 10 | 20 | - |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

1. V. R. Gowarikar and N. V. Viswanathan, Polymer Science, Willey, 1986.

Reference Books:

1. P. Ghosh, Polymer Science and Technology, Tata McGraw Hill, 2011.
2. N. G McCrum, Principles of Polymer Engineering, 2nd edition, Oxford University Press, 1997.
3. G. Odian, Principles of Polymerization, Wiley Interscience, 2004.
4. G. S. Misra, Introductory Polymer Chemistry, Willey Eastern Limited, 1993.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|--|
| CO-1 | Discuss basics of polymer technology. |
| CO-2 | Understand the basic concepts of monomer, polymer, degree of polymerization, and repeating units and their properties. |
| CO-3 | Analyzed the general techniques of polymerizations, uses and applications. |
| CO-4 | Calculate number average, weight average molecular weight and polydispersity index of polymers. |
| CO-5 | Describe different degradation methods of polymer. |
| CO-6 | Discuss the molding techniques. |



UPL UNIVERSITY
OF
SUSTAINABLE TECHNOLOGY



(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1314

Subject Name: Polymer Technology

Shroff S.R. Rotary Institute of Chemical Technology

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/104105039>

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1315

Subject Name: Process Equipment Design

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Open Elective III

Prerequisite: Basic understanding of unit operations in chemical engineering.

Rationale: Chemical process plants include a number of important equipment such as distillation columns, absorbers, heat exchangers, etc. Design of such equipment should be carried out a priori to set-up a process plant and thus, it is the basic step in a chemical process. The present course enables one to learn about the process design of Heat Exchanger, Condenser, Reboiler, Packed column and Distillation column.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|--------|-----------------|--------|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | C | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Introduction to process engineering: Role of process engineers, importance of process diagrams in process engineering | 4 |
| 2. | Piping, fluid moving device: Introduction, Pressure drop in piping, $NPSH_A$ & $NPSH_R$, types of pump, power required in pump | 7 |
| 3. | Heat Exchangers: Classifications of heat exchangers, Selection criteria of heat exchangers, Shell & Tube heat exchangers, functions of various parts of shell & tube heat exchanger, criteria of selection among fixed tube sheet, u tube & floating head heat exchanger, Tinker's flow model | 7 |
| SECTION-B | | |
| 4. | Reboilers & Condensers: Criteria of selection for horizontal and vertical condenser, mechanism and selection criteria of kettle type & thermosyphon reboilers and vaporizers. | 4 |
| 5. | Distillation Column: Introduction, Criteria of selection, selection of equipment for distillation, internals of tray tower: types of tray, selection criteria of tray, types of downcomers, weirs, determination of operating pressure for distillation column, advantages & disadvantages of vacuum | 7 |

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1315

Subject Name: Process Equipment Design

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|----|---|---|
| | distillation. | |
| 6. | Absorption column: Introduction, criteria for selection among different types of absorption equipment, types of packing, selection of packing materials, types of liquid distributors. | 7 |

Suggested Specification Table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 20 | 25 | 25 | 10 | 20 | - |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

1. S. B. Thakore, B. I. Bhatt, Introduction to Process Engineering and Design, 2nd edition, McGraw Hill, 2015.

Reference Books:

1. W. L McCabe, J. C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 7th edition, McGraw-Hill Book Co., 2005.
2. R. Sinnott, G. Towler, Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design, Butterworth – Heinemann, 2008.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|--|
| CO-1 | Describe the role of process engineers. |
| CO-2 | Classify the heat exchangers by their mechanism. |
| CO-3 | Solve the designing problems of shell and tube heat exchangers. |
| CO-4 | Analyze the effectiveness of reboiler and condensers. |
| CO-5 | Design the tray tower for distillation using McCabe–Thiele method. |
| CO-6 | Calculate the design parameters of absorber. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/103107207>

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1316

Subject Name: Process Equipment Auxiliaries and Plant Maintenance

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VI

Type of course: Open Elective-III

Prerequisite: Basic knowledge of unit operations, mechanical properties of the material.

Rationale: Students should know the classification of materials and relevant fabrication techniques for construction of the process equipments. The objective is to make students aware about different components of process equipment such as heads, coils, jackets, supports and internals of column, storage vessels etc. Part of the course will provide student the knowledge of maintenance in the process plant.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|-----------------|---|---|---------|-------------------|---------|-----------------|----|-------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | ESE (E) | PA (M) | ESE (V) | PA (I) | | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

Content:

| Sr. No | Content | Total Hrs. |
|------------------|---|------------|
| SECTION-A | | |
| 1. | Introduction: Different types of equipments, static & rotary equipments, different types of static equipments, various mechanical properties of material, different methods of fabrication, different types of welding joints, joint efficiency, radiography. | 5 |
| 2. | Shell, Head, Nozzle and Reinforcement: Internal pressure, external pressure, shell thickness calculation, different types of head and their selection criteria, different types of nozzles, reinforcement pad, stiffening ring. Flanges and Gaskets: different types of flanges, different types of standard flanges, different types of flange facings, different types of gaskets. | 8 |
| 3. | Pressure Vessel and Storage Vessel Components: Different types of jackets & their selection criteria, coil, agitator, nozzle, body flange, different types of agitators, Selection between coil & jacket, classification of storage tank, types of roof. | 5 |
| SECTION-B | | |

(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1316

Subject Name: Process Equipment Auxiliaries and Plant Maintenance

Shroff S.R. Rotary Institute of Chemical Technology

| | | |
|----|---|---|
| 4. | Internals of Shell & Tube Heat Exchanger: Types of shell and tube heat exchanger Shell, tube, tube sheet, tie rod, pass partitions, baffles, head, channel. | 8 |
| 5. | Types of Supports: Different types of supports for vertical and horizontal vessels, selection criteria for supports. | 5 |
| 6. | Plant Maintenance: Functions and responsibility, types of maintenance-corrective, breakdown, scheduled, preventive, predictive, online maintenance, shutdown maintenance, procedure for shutdown and startup of a plant. | 5 |

Suggested Specification Table with Marks (Theory):

| Distribution of Theory Marks | | | | | |
|------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 20 | 30 | 25 | 15 | 10 | - |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Textbooks:

1. V. V. Mahajani, S. B. Umarji, JOSHI's Process Equipment Design, 4th Edition, Laxmi Publications, 2017.
2. D. B. Dhone, Plant Safety and Maintenance, Nirali Publication, 2018

Reference Books:

1. B. C. Bhattacharya, Process Equipment Design (Mechanical Aspects), 1st Edition, CBS Publishers & Distributors, 2012.
2. L.E. Brownell, E. H. Young, Process Equipment Design- Vessel Design, 1st Edition, Wiley, 1959.
3. Milton N. Kraus, Safe and Efficient Plant Operation and Maintenance, McGraw Hill International Publication, New York, 1980.

Course Outcomes:

After learning this course, students will be able to:

| Sr. No. | CO statement |
|---------|--|
| CO-1 | Classify of process equipments. |
| CO-2 | Understand the types fabrication techniques. |
| CO-3 | Describe the component of pressure and storage vessel. |



UPL UNIVERSITY OF
SUSTAINABLE TECHNOLOGY



(Established under Gujarat Private Universities Act, 2009)

Diploma Engineering

Subject Code: CH1316

Subject Name: Process Equipment Auxiliaries and Plant Maintenance

Shroff S.R. Rotary Institute of Chemical Technology

| | |
|------|--|
| CO-4 | Explain internals of heat exchanges. |
| CO-5 | Choose suitable support for the process equipment. |
| CO-6 | Illustrate the importance maintenance of chemical plant. |

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/103107207/>