SHIVAJI UNIVERSITY, KOLHAPUR
THIRD YEAR B.TECH
Chemical Technology
Curriculum Structure

Semester – V

Sr. No.	Subject Code	Subject Title	Contact hours			Credits
			L	T	P	
1	CH311	Chemical Plant Utilities	03	-	-	03
2	CH312	Inorganic Chemical Technologies	03	-	-	03
3	CH313	Industrial Economics and Management	03	-	-	03
4	CH314	Mass Transfer –I	03	01	-	04
5	CH315	Process Instrumentation, Dynamics and Control	03	-	-	03
6	CH316	Industrial Electronics and Measurements	01	-	-	01
7	CH314L	Mass Transfer –I Laboratory	-	-	02	01
8	CH315L	Process Instrumentation, Dynamics and Control Laboratory	-	-	02	01
9	CH316L	Industrial Electronics and Measurements Laboratory	-	-	02	01
10	CH317	Seminar	-	01	-	01
11	LS311	Audit Course III Presentation and Communication Techniques	02	-	-	-
		Total	**18**	**02**	**06**	**21**
Total Contact hours per week = 26						

Note : Tutorials and Practical shall be conducted in batches with batch strength not exceeding 18 students.

SHIVAJI UNIVERSITY, KOLHAPUR
THIRD YEAR B.TECH
Chemical Technology
Curriculum Structure

Semester – VI

Sr. No.	Subject Code	Subject Title	Contact hours			Credits
			L	P	T	
1	CH321	Reaction Engineering-I	03	-	-	03
2	CH322	Organic Chemical Technologies	03	-	-	03
3	CH323	Industrial Pollution Control	03	-	-	03
4	CH324	Mass Transfer-II	03	-	-	03
5	CH325	Process Equipment Design and Drawing	03	-	-	03
6	CH321L	Reaction Engineering-I Laboratory	-	-	02	01
7	CH322L	Organic Chemical Technologies Laboratory	-	-	02	01
8	CH324L	Mass Transfer-II Laboratory	-	-	02	01
9	CH325L	Process Equipment Design and Drawing Laboratory	-	-	02	01
10	CH326L	Mini Project	-	01	-	01
11	CH327	Report of Industrial Tour	-	-	-	01
12	RM321	Audit Course IV Research Methodology	02	-	-	
		Total	**17**	**01**	**08**	**21**
Total Contact hours per week = 26						

Note: Tutorials and Practical shall be conducted in batches with batch strength not exceeding 18 students.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH311 CHEMICAL PLANT UTILITIES

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **07Hours**

Introduction to the subject and Water resources: List of various process utilities, their role and importance in chemical plants. Sources of water, characteristics, storage and distribution of water, water for boiler, cooling, drinking purposes and process water treatment reuse and conservation of water, water resources management.

Unit II **08Hours**

Steam and Boilers : Steam generation and its application in chemical process plants, distribution and utilization, design of efficient steam heating systems, steam economy, condensate utilization, steam traps, their characteristics, selection and application, waste heat utilization. Classification of Boilers: Fire tube and water tube boilers Tube shape and position, firing, Head Sources, Fuel, Fluid, circulation, furnace position, furnace type, General Shape, Boiler mountings and accessories, Boiler draught.

Unit III **07Hours**

Compressors and Pumps: Basic types of compressors and pumps and their performance characteristics. Study of vacuum pumps , Methods of vacuum development and their limitations, materials handling under vacuum, piping systems, lubrication and oil removal in compressors and in pumps.

Unit IV **07Hours**

Refrigeration Systems: Refrigeration systems and their characteristics, load calculation in humidification and dehumidification equipments, drying and cooling tower, air blending, exhaust, ventilation, cryogenics, their characteristics and production of liquid N_2 and O_2

Unit V **07Hours**

Insulation: Importance of insulation for the process equipments, insulation materials and their effect on various materials of equipment, piping, fitting and valves, insulation for high, intermediate, low and sub zero temperatures including cryogenic insulation, determination of optimum insulation thickness.

Unit VI **06Hours**

Inert gases: Introduction**,** properties of inert gases and their use, sources and methods of generation, comparison of nitro generation routes, general arrangement for inert

system, operational, maintenance and safety aspects.

REFERENCES:

1. Jack Broughton, Process utility systems, Institution of Chemical Engineers U.K.
2. Reid, Prausnitz poling, The properties of gases and liquids, IV edition, McGraw-Hill International edition.
3. S.C.Arora & S.Domkumdwar, A course in refrigeration and air conditioning, Dhanpat Rai and Co.(P) Ltd.
4. R.L.Ballaney, Thermal Engineering, Khanna Publication
5. Gupta and Prakash, Engineering Thermodynamics, Nemchand and Brothers, Roorkee

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH312 INORGANIC CHEMICAL TECHNOLOGIES

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **10Hours**

Fuels, fuel gases and Industrial gases : Introduction to Chemical Manufacturing and Processing sector. Study of the role of Chemical Engineers and Technologists in the development of the nation. Study of the manufacture: water gas, producer gas, natural gas, LPG, hydrogen, oxygen, nitrogen, carbon dioxide and acetylene. Concept, types and applications of fuel cells

Unit II **06Hours**

Ceramic industries: Basic raw materials, Chemical Conversions, White wares, Structural clay products, Manufacture of refractory, Glass raw materials, Manufacture, types and applications of glass.

Unit III **07Hours**

Salt and sodium compounds, Chlor-alkali and electrolytic industries: Manufacture of sodium chloride, sodium sulphate and byproducts. Manufacture of Soda ash, caustic soda, chlorine, bleaching powder, sodium bicarbonate, aluminum, Sodium, chlorates and per chlorates.

Unit IV **06Hours**

Hydrochloric acid and Sulfur industries: Manufacture of hydrochloric acid, aluminum sulphate and alums. Manufacture of sulfur and sulfuric acid.

Unit V **06Hours**

Phosphate industries and Potassium industries: Study of elemental phosphorous, raw materials and processes for phosphoric acid manufacture, Manufacture of ammonium phosphate, baking powder. Manufacture of potassium, potassium chloride, potassium sulphate and potassium nitrate.

Unit VI **06Hours**

Nitrogen industries: Manufacture of synthetic ammonia, nitric acid, ammonium nitrate, urea.

(Note: Subject to be taught with reference to Chemical Engineering principles involved in each of the topic.)

TEXT BOOKS:

1. George T. Austin, “Shreve’s Chemical Process Industries”, 5th edition. , McGraw Hill Book Company, 1985.

REFERENCES:

1. S.D. Shukla, G.N. Pandey, “A Text book of Chemical Technology”, 3rd Edition
2. C.E. Dryden, “Outlines of Chemical Technology”, Affiliated East-West Press, 1973.
3. D.Venkteshwaralu, “Chemical Technology”, I & III manuals of Chemical Technology, Chemical Engineering. Ed. Dev. III Madras, 1977.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH313 INDUSTRIAL ECONOMICS AND MANAGEMENT

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **11Hours**

Economic problem and National income: Law of demand, equilibrium between demand and supply, concepts of costs, cost curves and revenue curves of a firm, equilibrium of a firm under perfect competition, break-even analysis, and break-even point.
Concept of national income, estimation of national income, difficulties in measurement of national income, uses of national income figures.

Unit II **04Hours**

Inflation: Meaning, types of inflation, causes, effects, control of inflation, value of money, index numbers, construction, utility, limitations, business cycles, phases of business cycles.

Unit III **05Hours**

Industrialization: Need, capital requirement block and working, raising finance, cottage and small scale industries, role in the Indian economy, problems of small scale industries, remedies.

Unit IV **07Hours**

Principles of management: Definition, nature, levels of management, functions of management.
i. Planning: Nature, importance, types of plans, planning process, decision making.
ii. Organization: Principles of organization, organizational structure.
iii. Directing: Theories of motivation, communication, process and barriers, leadership styles.
iv. Controlling: Control techniques.

Unit V **05Hours**

Production management: Selection of site, plant layout, its type, functions of P.P.C. Materials management, purchase, inventory control, production and quality control.

Unit VI **08Hours**

Finance management and Marketing management: Scope and importance, capital structure planning, working capital management, sources of funds, financial industries of India. Marketing concepts, physical distribution, advertising and sales promotion, marketing research, sales management.

REFERENCES:

1. Stonier, A. W. and Hague, D. C., "A Text Book of Economic Theory", Longman.
2. Bach, George Leland, "Economics -Analysis, Decision Making and policy", Prentice-Hall Inc. Englewood Cliffs N. J.
3. Bonham F., "Economics", Sir Isaac Pitman and Sons Ltd., London.
4. Seth, M. L., "Principles of Economics", Lakshmi Narayan Agarwal, Agra.
5. Agarwal, A. N., "Indian Economy", Vikas Publishing House Pvt. Ltd., New Delhi.
6. Datta R. and Sundharam, K. P. M., "Indian Economy" S. Chand & Co. Ltd., New Delhi
7. Peter F. Drucker, "The Practice of Management", Allied publishers pvt. ltd., Bombay.
8. Barat, Nikhil, "Production management & Control", Academic Publishers, Calcutta.
9. Garrett, Leonard J. & Silver, Milton, "Production Management Analysis", Harcourt Brace Jovanovich, Inc. New York.
10. Kuchhal, S. C., "Financial Management: An- Analytical & Conceptual Approach", Chaitanya Publishing House, Allahabad.
11. Pandey, L. M., "Financial Management", Vikash Publishing House Pvt. Ltd., New Delhi.
12. Kotlel, Philip, "Marketing Management: Analysis, Planning & Control", Prentice –Hall of India Pvt. Ltd: New Delhi
13. Sinha, J. C., "Marketing and Salesmanship", S. Chand & Co., Delhi.
14. H.L. Ahuja, "Modern economics", S. Chand and co. ltd., New Delhi.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH314 MASS TRANSFER-I

Teaching Scheme: L: 3 hours/week **Credits: 4**
T: 1 hour/week

Unit I Importance of mass transfer operation **08Hours**

Classification of mass transfer operations based on gas-liquid-solid contacts. Concepts of flux, resistance, driving force, equilibrium, direction of mass transfer, Dimensionless numbers in mass transfer. Diffusion, Fick's I^{st} and II^{nd} law, Dependence of diffusivity on physical properties, Schmidt's number calculation, Determination of diffusivity in liquid-liquid, gas-gas, gas-liquid diffusion.

Unit II Interphase mass transfer **08Hours**

Various coefficient of mass transfer and their determination, resistance concept, controlling phase concept, Mass transfer in turbulent flow, Analogies of mass transfer, Empirical equations. Multicomponent mixture diffusion, Maxwell's law of diffusion. Diffusion in solids, Un steady state diffusion, Theories of mass transfer, two film theory, Higbies penetration theory, Derivation of flux equation, surface renewal theory, Applications and problems. Application of mass transfer processes

Unit III Distillation Operation **08Hours**

Introduction to distillation operation, Vapor liquid equilibrium, The methods of distillation (Binary mixture), The fractionating column, Condition for varying overflow in non- ideal system(Binary), Batch distillation, Multi component mixture, Azeotropic, extractive and steam distillation, Introduction to distillation equipments.

Unit IV Extraction and Leaching Operations **08Hours**

Introduction to extraction operation, principles of extraction, Material balances for stage wise contact methods, Extraction with reflux, Fractional extraction, Stage contact and continuous contact type extractors. Introduction to leaching operation, Mass Transfer in leaching operation, Calculation of stages for different Processes, Graphical method for calculation of number of stages counter current washing process, Equipments for leaching operation.

Unit V and VI Absorption and Stripping Operations **10Hours**

Introduction to absorption operation, stage wise absorption, overall material balance, Absorption and stripping factor calculation of number of stages, McCabe-Thiele graphical method, Kremsor-Brown-Sounder's equation. Equipments of absorption, tray towers, packed towers. Continuous absorption, concepts of H.T.U, N.T.U and H.E.T.P, comparison

with stepwise columns, design concepts, determination of height and diameter of packed absorption column. Study of cooling towers.

REFERENCE BOOKS:

1) R.E.Treybal , Mass transfer operation ,McGraw Hill Publication
2) Coulson & Richardson, Chemical Engineering (Vol. I and II), Pergamon Press
3) W.L.McCabe & J.C.Smith, .Unit Operation in Chemical Engineering. McGraw Hill Publication
4) Christie J.Geankoplis ,Transport Processes & Unit Operations ,Prentice Hall inc
5) P. Chattopadhayay, Unit operation in Chemical Engineering. (Vol. I and II), Khanna Publications Delhi

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH315 PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **07Hours**

Measuring Instruments: Theories, practice and applications of measurements of temperature, mass and levels. Measurement of pressure, vacuum, humidity and pH in process industry.

Unit II **05Hours**

Flow measuring instruments: Flow measuring devices for incompressible and compressible fluids. Electro-hydraulic valves, hydraulic servomotors, electro-pneumatic valves. Pneumatic actuators.

Unit III **09hours**

Introduction to Simple system analysis and Dynamic behavior of first order system: Characteristics of Chemical Process Control, Mathematical Modeling of Chemical Processes, State Variables and State Equation for Chemical Processes. Input –Output Model, Linearization of non linear systems, Solution of Linear differential equation using Laplace Transform. Block diagrams, linearization. First and higher order systems. Pure capacity process, First order system with variable time constant and gain, Response of first order system in series: Interacting and Non-interacting systems.

Unit IV **06Hours**

Dynamic behavior of second order system: Under damped and over damped and critically damped systems, Transportation lag, and higher order systems. Introduction to feedback control, Controllers and final control elements. Control action block diagram of chemical reactant control systems.

Unit V **07Hours**

Dynamic behavior of feedback control processes: P, PD, PI, and PID. Design of feedback controller, Performance criteria, selection of type of controller, Tuning of feedback controller. Stability analysis by Routh criteria, Root Locus Diagram.

UnitVI **07Hours**

Frequency response analysis of linear processes: Bode's diagram, Nyquist plots. Design of feedback control system using frequency response technique: Bode's stability criteria, gain and phase margin. Ziegler- Nichols tuning technique. Nyquist stability criteria,

Control Systems with Multiple Loops, Feed forward control, Cascade control, Ratio control, selective control, split range control, Adaptive and Inferential control. Multi Variable Control

REFERENCES:

1) Eckman, Industrial Instrumentation; Wiley Eastern
2) Erwing, Instrumental Methods of Chemical Analysis; McGraw Hill.
3) W.Bottom, Instrumentation & Process Measurements; Orient Longman.
4) George Stephanopoulos, Chemical Process Control, Prentice Hall of India.
5) D.R. Coughnour, Process System Analysis and Control, McGraw-Hill.
6) R.P.Vyas, Process Control & Instrumentation, 2nd edition, Central Techno publication, Nagpur
7) K. Krishnaswamy, Process Control, New age International.
8) Peter Harriott, "Process Control", Tata McGraw Hill, New Delhi, 1977.
9) Coulson and Richardson, "Chemical Engineering" Volume – III, Second Edition, Pergmon Press, (UK), 1985.
10) Stephanopoulos G., "Chemical process control and introduction to theory and practice"

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH316 INDUSTRIAL ELECTRONICS AND MEASUREMENTS

Teaching Scheme: L: 1 hours/week **Credits: 1**

Unit I **03Hours**

Measurement systems and measuring instruments: Measurements, Types and sources of errors, voltmeter, Ammeter, Wattmeter, Multimeter, CRO basic principle, CRT, Horizontal and vertical deflection systems. Signal generators, Function generators

Unit II **03Hours**

Study of power supply and voltage regulators: Half and Full wave rectifiers, Bridge Rectifier, Fixed voltage regulators 78XX, 79XX series, Variable regulator LM317, SMPS Basics.

Unit III **03Hours**

Analog and digital electronics: Analog signals, Digital signals, Analog to Digital conversion techniques, Digital to analog conversion techniques, ADC and DAC chips, Pulse counters.

Unit IV **02Hours**

Transducers and measurements: Transducers and their selection, Different types of transducers, strain gauges,RTD,Thermister,Thermocouple,PT100 ,Bellows, bourdon tubes, LVDT, humidity transducers, flow rate, liquid level measurements, pH value measurement.

Unit V **02Hours**

Indicating and recording devices: LED**,** LCD, Nixie, Plasma display, recorders i.e. strips charts and X-Y recorder, seven segments displays with drivers.

Unit VI **02Hours**

Microcontrollers: Basics of microcontrollers, Microcontroller based pH measurement system, Data acquisition system, Temperature indicator, Process controllers.

TEXT BOOKS:

1. Allen Mottershed, Electronic devices and circuits, PHI
2. H .S. Kalsi , Electronic Instrumentation', 2nd edition, Tata McGraw Hill Publication
3. A. D. Helfrick, W. D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, Pearson Education

REFERENCE BOOK:

1. A.K.Sawhney 'A Course in Electrical & Electronics Measurement & Instrumentation.' – 11th Edition, 1996 --Dhanpat Rai & son

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH314L MASS TRANSFER-I Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

1) Diffusion in Still Air: To estimate mass transfer coefficient for given system at room temperature.
2) Liquid-Liquid Diffusion: To determine diffusion coefficient for given system as function of concentration.
3) Solid-Liquid Diffusion: To determine mass transfer coefficient for dissolution of benzoic acid without chemical reaction.
4) Simple Distillation: To verify Rayleigh's equation for simple distillation
5) Ternary Diagram: To construct ternary diagram for acetic acid –water – benzene
6) Liquid-Liquid Extraction: To study and determine the efficiency of cross current liquid-liquid extraction.
7) Wetted Wall Column: To determine mass transfer coefficient for air – water system.
8) Absorption in Packed Column: To find mass transfer coefficient of given system.
9) Cooling Tower: To determine volumetric mass transfer coefficient for air – water system.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH315L PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

Practical Work will consist of minimum eight experiments from list given below.

Dynamic behavior of first order system
1. Mercury Thermometer 2. Single tank system.
3. C.S.T.R.
Dynamic behavior of first order system in series
4. Two tank non-interacting system. 5. Two tank interacting system.
Dynamic behavior of second order system
6. Mercury Manometer
Dynamic behavior of final control Element
7. Pneumatic control valve.
Study of Pneumatic controllers.
8. Proportional Controller
9. Proportional Derivative Controller
10. Proportional Integral Controller
11. Proportional Integral Derivative Controller
Control Systems
12. Study of closed loop control system.

(Note: Any of the 8 experiments to be performed from the above list)

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH316L INDUSTRIAL ELECTRONICS AND MEASUREMENTS Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

1) Study of Electronic Components and characteristics.
2) Study of CRO for waveform measurements.
3) Study of electronics measuring instruments.
4) Study of temperature transducers.
5) Study of HWR with and without filter.
6) Study of FWR with and without filter.
7) Study of bridge rectifier with and without filter.
8) Study of ADC 0809 IC.
9) Study of pressure measurement.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

CH317 SEMINAR

Teaching Scheme: T: 1hour/week **Credits: 1**

The students shall deliver minimum three seminars (each of 15 to 20 minutes) and submit the seminar reports on different technical subjects during the semester. The assessment of the term-work shall be based on the: -

1. Attendance to the seminar
2. Performance of the seminar delivery
3. Seminar reports and
4. Asking and answering questions during the seminars.

The faculty member/members shall guide the students in:

1. Selecting the seminar topic.
2. Information retrieval (literature survey)

a) Source of Information i.e. names of the journals, reports, books etc.
b) Searching for the information i.e. referring to chemical abstracts etc.

3. Preparing the seminar report
4. Delivering the seminar

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester V)

Audit Course III

LS311 PRESENTATION AND COMMUNICATION TECHNIQUES

Teaching Scheme: L: 2 hours/week **No Credits**

Evaluation Scheme: The course auditor will evaluate the students for their performance in the course and the students will be given the grade by the teacher.The grade will be based on total marks obtained out of 50.

Unit I **05Hours**

Communication in a Business Organization: Internal (Upward, Downward, Horizontal, Grapevine, Problems, Solutions) External Communication, Strategies for conducting successful business meetings, documentation (notice, agenda minutes) of meetings. Introduction to modern communication techniques (for e.g. e-mail, internet, video conferencing etc), Legal & ethical issues in communication (intellectual property rights, patents)

Unit II **05Hours**

Advanced Technical Writing: a. Report – Writing and presentation: Definition and importance of reports. Qualities of Reports, language and style in reports, type of reports, formats (letter, memo, and project- reports), and methods of compiling data using computer-aids

b. Technical Paper Writing

c. Writing Proposals

Unit III **05Hours**

Interpersonal Skills: Introduction to emotional intelligence, Motivation, Negotiation and conflict-resolution Assertiveness, Leadership, Term-building, Decision-making, And Time-management.

Unit IV **05Hours**

Interview Techniques: Preparing for job interviews, verbal and non-verbal communication during interview. Observation sessions and role-play techniques may be used to demonstrate interview strategies.

Unit V **05Hours**

Group Discussion: Dynamics of Group Behavior, Techniques for effective participation.

ASSIGNMENTS:

a) Written

Assignments on Communication topics (minimum 2)

Assignments on Report writing (minimum 3)

Assignments on Interpersonal Skills (minimum 3)

b) One class test

c) Oral: Practical sessions on Group-discussion / Interview Skills / Project Presentation /

Power point Presentation.

Break up of Marks

a) Assignments Written: 20 marks b) Test: 10 marks c) Performance in GD and PI: 20 marks

Total 50 marks

Books Recommended:

A. For classroom teaching

1. Fred Luthans, 'Organizational Behavior' McGraw Hill International Edition

2. Lesiker and Petit 'Report writing For Business' McGraw Hill International Edition

3. Huckin and Olsen 'Technical Writing and Professional Communication' McGraw Hill International Edition

4. Wallace and Masters 'Personal Development for life and Work', Thomson Learning

5. Herta Murphy 'Effective Business Communication' Hearta Murphy

B. For Additional Reading:

1. Lewicki, Saunders, Minton 'Essential of Negotiation' McGraw Hill International Edition

2. Hartman Lemay 'Presentation Success' Thomson learning

3. Kitty O Locker & Kaczmark – Business Communication Building Critical Skills McGraw Hill

4. Vikas Gupta: Comdex Computer Course Kit, IDG Books Pvt, Ltd.

5. Heller & Handle: The Essential Manager's Manual – Dorleen Kindercey

6. The Sunday Times 'Creating Success Series'

1. Develop your Assertiveness.
2. Make every Minute Count.
3. Successful Presentation Skills.
4. How to motivate people.
5. Team building.

Note: There will be an industrial tour for 3days. The students will prepare a brief report of the industry visits during the tour.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH321 REACTION ENGINEERING – I

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **05Hours**

Introduction to the Subject: Chemical Kinetics and thermodynamics of reaction; Classification of reactions - Homogeneous and Heterogeneous reactions. Rate of reaction, broad definition for homogeneous and heterogeneous reactions.

Unit II **07Hours**

Kinetics of homogeneous reactions: Irreversible and reversible reactions, Equilibrium; Order and molecularity of reaction. Elementary and non elementary reactions; Stoichiometry, fractional conversion. Rate of reaction based on all components of the reaction and their interrelation. Law of mass action, Rate Constant-Based on thermodynamic activity, partial pressure, mole fraction and concentration of the reaction components and their interrelation, Temperature dependency of rate Constant -Arrhenius law, Transition state theory and collision theory.

Unit III **07Hours**

Interpretation of batch reactor data: Batch reactor concept, Constant volume Batch reactor system; Design equation for zero, first, Second and third order irreversible and reversible reactions, graphical interpretation of these equations and their limitations, Variable volume Batch reactors. Design equation for zero, first and second order irreversible and reversible reactions, Graphical interpretation of their limitations, Introduction to catalytic and auto catalytic reactions, Rate equation concept for these reactions. Multiple reactions-stoichiometry and Rate equations for series and parallel reactions; Non elementary single reactions Development of rate expression; Chain reactions development of rate expressions.

Unit IV **08Hours**

Ideal flow reactors: Concept of ideality. Types of flow reactors and their differences, Space-time and Space velocity. Design equation for plug flow reactor and CSTR; Design equations for first and second order reversible and irreversible constant volume and variable volume reactor, Graphical interpretation of these equations; Mean holding time; Development of rate expression for mean holding time for a plug flow reactor.

Unit V **07Hours**

Single and multiple reactor system: Size comparison of single reactors; Optimum size determination; Staging of reactors, Reactors in series and parallel; Performance of infinite number of back mix reactors in series, Back mix and plug flow reactors of different sizes in series and their optimum way of staging; Recycle reactors, Optimum recycle ratio for auto-catalytic (recycle) reactors.

Unit VI **07Hours**

Design for multiple reactions: Yield and selectivity, Parallel reactions Requirements for high yield, best operating condition for mixed and plug flow reactors, Series reactions Maximization of desired product rate in a plug flow reactor and back mixed reactor.

REFERENCES:

1. Octave Levenspeil, “Chemical Reaction Engineering”, 2nd Edition, John Wiley, London.
2. S. M. Walas, “Reaction Kinetics for Chemical Engineers”, McGraw Hill, New York
3. J. M. Smith, “Chemical Engineering Kinetics”, McGraw Hill, New York.
4. J. Rajaram and J. C. Kuriacose, “Kinetics and Mechanics of Chemical Transformation”, McMillan India Ltd., 1993.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH322 ORGANIC CHEMICAL TECHNOLOGIES

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **06Hours**

Food Industries: Types of food processing, preservation method, Food Products. Sugar and Starch Industries: sugar and starches. Fermentation Industries: Absolute alcohol, Beer, Wines and liquors, vinegar, citric acid, galactic acid.

Unit II **06Hours**

Oil, Fat and Waxes: Manufacture of Vegetable oils, animal Fats and oils, Waxes, Soaps and detergents,

Unit III **08Hours**

Pharmaceutical Industries: Classification of Pharmaceutical products. Manufacture of Antibiotics, Isolates from plant and animal, vitamins.

Unit IV **06Hours**

Pulp and paper industries: Manufacturing of pulp, manufacturing of paper, and structural boards.

Unit V **07Hours**

Explosives, Plastic industries: Types of Explosives, Explosive characteristics, Industrial explosives, propellants, rockets, Missiles, pyrotechnics, matches, toxic chemical weapons. Raw Materials, general polymerization processes, manufacturing processes, Compounding and Moulding operation.

Unit VI 08**Hours**

Petroleum and Petrochemicals, Dyes and their intermediates: Petroleum production and Refining, Manufacturing of Methanol, Formaldehyde, Ethylene and Acetylene, Ethylene dioxide, Isopropanol, Acetone, Isopropyl, Benzene, Butadiene, Phenol styrene. Classification and manufacturing of dyes and their intermediates.

REFERENCES:

1) George T. Austin, “Shreve’s Chemical Process Industries”, 5th Edition, McGraw Hill Book Company.
2) C.E. Dryden, Outline of Chemical Technology, Affiliated East WestPress.1973.
3) S.D.Shukla, G.N.Pandey, A text book of Chemical technology, 3rd Edition.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH323 INDUSTRIAL POLLUTION CONTROL

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **06Hours**

Introduction: Types of Pollution. Introduction to Pollution control aspects. Environmental Legislation: Water (Prevention and Control of Pollution) Act, 197, Air (Prevention and control of Pollution) Act, 1981. Industrial Waste Water Analysis. Industrial Gaseous Effluent Analysis. General Instrument for Gaseous Pollutants.

Unit II **05Hours**

Removal of BOD: Introduction to removal of BOD Biological oxidation Units: Activated Sludge Process; Trickling /Biological Filters; Waste Stabilization Ponds. Anaerobic Treatment. Numerical Examples based on removal of BOD. Removal of Chromium.

Unit III **07Hours**

Removal of Heavy Metals: Introduction to removal of Chromium. Control Methods, Reduction precipitation, Ion Exchange, Reverse Osmosis, Lime coagulation and adsorption. Introduction of removal of mercury, Measurement of Mercury, Ventron mercury removal process. Removal of ammonia/urea: Introduction to removal of ammonia/urea, Methods for removal of nitrogen, Physico-chemical processes, Biological methods.

Unit IV **05Hours**

Treatment of Phenolic Effluents: Introduction to Treatments of Phenolic Effluents, Sources of phenols. Treatments/Removal Methods: Steam Gas Stripping. Adsorption/Ion Exchange; Extraction of phenols using Phenosolvants Biological Methods of Treatment. Removal of particulate matter: Introduction to removal of particulate matter, Gravity settling chamber, solid traps, cyclone separators, fibre filters, fabric filters, liquid scrubbers and ESP. Numerical Examples based on settling chamber, cyclone separators, fiber filter, liquids scrubber and ESP.

Unit V and VI Pollution control in Different process industries **17Hours**

Introduction to pollution control, Pollution control aspects of fertilizer industry: Introduction to pollution control in fertilizer industry. Removal of carbon in ammonia plant effluents by scrubbing with liquids using vacuum filtration, Removal of oil in ammonia plant effluents, Removal of hydrogen sulphide in ammonia plant effluents. Pollution control in petroleum and petrochemical Units: Introduction, Refinery Liquid based treatment methods: Oxidation pond treatment, disposal of sludge Treatment of liquid effluents from petrochemical industries, Removal of hydrogen sulphide gas from sour gas by stripping, Removal of ammonia from gases.

Alcohol industry: Treatment method by recovery of potash from distillery spent-wash.

REFERENCES:

1. S. P. Mahajan, “Pollution Control in Process Industries”, Tata McGraw hill, 1985.
2. Metcalf and Eddy, “Waste Water Engineering Treatment”, Tata McGraw Hill, 1979.
3. Warren Riesman and Mark J. Hammer, “Water supply and Pollution control”, Harper & Row, New York, 1985.
4. M.V. Rao and A. K. Datta : “Waste Water Treatment”.
5. U. N. Mahida, “Water Pollution and disposal of Waste Water on land”.
6. Soli Arceivala, “Waste Water Treatment for Pollution Control”.
7. Lund H. F,”Industrial Pollution Control”, Hand Book, McGraw Hill, 1971.
8. H. C. Perkins, “Air Pollution”, McGraw Hill 1974.
9. L. D. Benfield and C. W. Randall, “Biological Process Design for Waste Water Treatment”, Prentice Hall, 1980.
10. C. P. Gaudy Jr. and H. C. Lim “Bio-logical Waste Water Treatment”, 1980.
11. M. J. Hammer, “Water & waste water Technology”, Wiley, 1975.
12. Artur L. Kohi and Fred C. Reisenfled, “Gas Purification”, Gulf Publishing Co.1979.
13. Arcadio P. Sincero, Gregoria A. Sincero, “Environmental engineering” (Design approach), Prentice Hall of India Pvt. Ltd, New Delhi, 1999
14. C. S. Rao “Environmental pollution control engineering” Wiley Eastern Ltd, 1994.
15. David H. F. Liu, Bela Liptak, “Environmental engineers’ handbook”, Lewis Publishers, 2nd edition, New Jersey, 1996

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH324 MASS TRANSFER-II

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **07Hours**

Drying: Principles of drying, phase equilibrium, cross circulation drying, through circulation drying, drying of suspended particles, rate of drying curve, dryers for solids and pastes, dryers for solutions and slurries i.e. various types of dryers

Unit II **08Hours**

Humidification: Terms, definitions, wet bulb temp., dry bulb temp. And measurement of humidity, adiabatic saturation temp., study of temp humidity chart, Enthalpy-humidity charts, Determination of humidity, and concept of dehumidification. Equipments for humidification operations.

Unit III **07Hours**

Crystallization: Principles of crystallization, crystal growth, properties of crystals nucleation, Effect of impurities in crystallization, Effect of temperature on solubility, caking and yield of crystals, calculation of yield, Fractional crystallization, various types of crystallizer's and their applications.

Unit IV **07Hours**

Adsorption: Adsorption equilibria, types of adsorption, properties of adsorbents, single and multi-stage adsorption, adsorption isotherms, principles of adsorption, break through curves, Adsorption of liquids, Basic equations, and Adsorber design. Adsorption equipments. Ion Exchange: Principles of ion exchange, Techniques and applications, Ion exchange equilibria, Rate of ion exchange.

Unit V **07Hours**

Evaporation: Principles of evaporation, applications of evaporation, liquid characteristics and types of evaporator, single effect evaporator calculation, pattern of liquor flow in multiple effect evaporators.

Unit VI **07Hours**

Membrane Separation Operations: Introduction to membrane separation process, Different Types of membrane separation process, (Ultra filtration, Reverse Osmosis,

Dialysis, Electro Dialysis, Pervaporation), General membrane equation, Liquid membranes. Recent Developments in Mass Transfer Operation.

.**REFERENCES:**

1) Coulson and Richardson, Chemical Engineering (Vol. II), Pergamon Press
2) RE. Tryebal, Mass Transfer Operation, McGraw hill.
3) Christie J. Geankoplis, Transport Processes and Unit Operations, Prentice Hall Inc
4) P. Chattopadhyay, Unit operations in Chemical Engineering. Vol. I and II, Khanna Publication, New Delhi

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH325 PROCESS EQUIPMENT DESIGN AND DRAWING

Teaching Scheme: L: 3 hours/week **Credits: 3**

Unit I **08Hours**

Design Considerations and Keys: Design codes, Maximum working pressure, Design pressure, Design Temperature, Design stress, Factors of safety, Selection of factor of safety, Design wall thickness, Corrosion ratio, Poisson ratio, Criteria of failure, Elastic stability. Materials of construction: Mechanical properties, Materials, Corrosion, Protective coating, Corrosion prevention, Choice of materials, Introduction, Types of keys, Strength of sunk key, Effect of key ways, Design of keys, Design of Heads: Introduction, Analysis and design of conical head, Flat cover head, Standard dished heads. Gaskets and Flanges: Introduction, Types of Gaskets and Flanges. Pipe joints: Standard pipe flanges for steam, Hydraulic pipe joints for high pressure, Design of circular flange pipe joints. Welded Joints, Riveted joints

Unit II **04Hours**

Storage vessels: Introduction, Design fixed conical roof cylindrical tank, Storage of gases in Spherical vessels Supports for vessels: Introduction, Bracket or Lug supports, Leg Supports, Skirt Supports

Unit III **06Hours**

Design of Cylindrical Vessels under internal Pressure: Introduction, Thin wall vessels, Design Equations. Design of process vessels and pipes under external pressure: Introduction, Determination of safe pressure against elastic failure, Determination safe external pressure against plastic deformation, circumferential stiffness, Pipes and tubes under external pressure.

Unit IV **06Hours**

Process Design of Heat Exchanger: Introduction, Types of Heat Exchanger, Process Design of Shell and Tube Heat Exchanger. Process Design of Evaporator: Introduction, Types of Evaporators, Methods of Feeding of Evaporators, Design of Evaporator.

Unit V **06Hours**

Process Design of Reaction Vessels: Introduction, Materials of Construction, Agitation, Classification of Reaction Vessels, Heating Systems, Design of Reaction Vessels. Crystallizer Design: Introduction, Types of Crystallizers, Design of crystallizers. Process Design of Rotary Dryer: Introduction, Types Dryers, Design of Rotary Dryer.

Unit VI **10Hours**

Design of Tall Vessels and Design for Distillation Column and Agitator : Introduction, the Axial Stresses Due to Dead Loads, the Axial Stresses Due to Pressure, Longitudinal Bending Stresses due to Dynamic Loads, Design Of Distillation (Tall) Column (Tower). Design of Sieve Tray for Distillation Column, Design of Thick Walled High Pressure Vessel, Design of Bubble Cap Tray For Distillation Operation, Agitators : Introduction, Types Of Agitators, Baffling, Power Requirements, Design Of Turbine Agitator.

REFERENCES:

1. B.C. Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects), CBS Publisher and Distributors, New Delhi

2 M.V.Joshi, V.V. Mahajan, Process Equipment Design, 3rd Edition, Macmillan India Ltd.

3 Coulson & Richardson, Chemical Engineering (Vol. VI), Pergamon Press

4 R. S. Khurmi, J.M. Gupta, A Text Book of Machine Design, S. Chand & Company Ltd, New Delhi.

5 S.D. Dawande, Process Design of Equipments (Vol. I), Central Techno Publications, Nagpur.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH321L REACTION ENGINEERING - I Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

1. Determine activation energy of acid catalyzed hydrolysis of methyl acetate.
2. To study effect of concentration of reactant and temperature on the rate of reaction.
3. Determination of specific reaction rate of acid catalyzed hydrolysis of ethyl acetate
4. Determination of specific reaction rate of acid catalyzed hydrolysis of ethyl acetate by sodium hydroxide at 298 K
5. To study the reaction between potassium persulphate and iodide
6. Kinetics of hydrolysis of methyl acetate by strong acid.
7. To study acid- catalyzed iodination of acetone.
8. To study saponification of ethyl acetate.
9. Study of Isothermal continuous stirred tank reactor

(Note: Any of the 8 experiments to be performed from the above list)

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH322L ORGANIC CHEMICAL TECHNOLOGIES Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

1) Estimation of sugar / glucose
2) Determination of saponification value of an oil
3) Determination of acid value of an oil
4) Determination of iodine value of an oil
5) Preparation of azo dye
6) Preparation of soap and analysis of soap
7) Preparation of green pigment
8) Preparation of yellow pigment
9) Preparation of blue pigment
10) Preparation of drug aspirin
11) Preparation of adipic acid and its analysis
12) Preparation of benzaldehyde and its analysis
13) Preparation of o- and p- nitrophenol and its analysis

(Note: Any of the 8 experiments to be performed from the above list)

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH324L MASS TRANSFER-II Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

1) Natural Drying (Batch): To obtain drying curve for batch drying operation.
2)Fluidized Bed Dryer: To determine the rate of drying and to obtain mass transfer coefficient for the given material.
3) Study of industrial driers
4) Study of industrial humidification systems
4) Study of Crystallization Equipments
5) Adsorption: To study adsorption of acidic acid on activated charcoal
6) Study of Ion Exchange adsorption
7) Study of Evaporation systems.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH325L PROCESS EQUIPMENT DESIGN AND DRAWING Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

1) Standard equipment symbols , Standard instrumentation symbols
2) Pipe fittings , flanges and gaskets, Heads and closures
3) Keys and couplings , Riveted joints , Welded joints
4) Pressure relief devices
5) Supports for vessels-Bracket Support ,Leg Support, Skirt Support.
6) Design and drawing of packed absorption tower
7) Design of heat exchangers.
8) Design of tall vertical vessels, Design of reaction vessel.
9) Design of evaporator.
10) Design of agitation system.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

CH326 MINI PROJECT

Teaching Scheme: T: 1 hour/week **Credits: 1**

The purpose of this particular exercise is to promote self-study, critical thinking and independent research ability. Students have to initiate their own small conceptual or practical based projects individually or as a team of no more than 2 members. While making this exercise it is expected that the knowledge acquired by them through Research Methodology subject is applied by them

Carrying out mini project work will certainly help the students to satisfactorily complete their major project in the final year.

Project Completion and Assessment

A 15 to 20-pages report is to be written upon completion of the activity. For team projects, each member has to write his own report. The report should include academic content such as the background, objectives, product/system description, the work done, the achievements and difficulties encountered.

The students will deliver a seminar and will make the demonstration of their work.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

REPORT OF INDUSTRIAL TOUR (CH327)

(An activity performed at the beginning of Semester VI)

Credits: 1

The students will prepare a brief report of the industry visits during the tour. There will be an Internal vice voce based on their visits during the tour.

Shivaji University, Kolhapur
Department of Technology
Third Year B. Tech (Chemical Technology) (Semester VI)

Audit Course IV

RESEARCH METHODOLOGY (RM 321)

Teaching Scheme: L: 2 hours/week **No Credits**

Evaluation Scheme: The course auditor will evaluate the students for their performance in the course and the students will be given the grade by the teacher. The grade will be based on total marks obtained out of 50.

Unit I: Research: **13Hours**

a) Types, Research process and steps in it, Hypothesis, Research proposals and aspects.
b) Research Design: Need, Problem Definition, variables, research design concepts, Literature survey and review, Research design process, Errors in research.
c) Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling.
d) Report Writing: Pre writing considerations, Thesis writing, Formats of report writing, Formats of publications in Research journals.

Unit II: Design of Experiments: **13Hours**

a) Objectives, strategies, Factorial experimental design, designing engineering experiments, basic principles, replication.Guidelines of experiments.
b) Single Factor Experiment: Hypothesis testing, Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking.
c) Two factor Factorial Design, Basic definitions and principles, main effect and

interaction, response surface and contour plots, General arrangement for a two-factor

factorial design; Models-Effects, means and regression, Hypothesis testing.

REFERENCES:

1. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India)
2. Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India)
3. Kothari, C.R., Research Methodology –Methods and techniques, New Age Publications, New Delhi, 2009.
4. Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. (2006), Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
5. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.

Note: All the students will have to undergo 21 days 'in plant training' after VI semester. They will prepare a report of the same. Their performance will be assessed in the VII semester by conducting a vice voce based on their training.

Equivalence of T.Y B.Tech (Chemical) Semester V and VI

The above detailed syllabus is a revised version of the T.Y.BTech (Chemical Technology) course being conducted by the Shivaji University at the Technology Department of the University. This syllabus is to be implemented from June 2013. (Academic year 2013-14)

The Equivalence for the subjects of Chemical Technology at T.Y B Tech Semester V and VI pre-revised course under the faculty of Engineering and Technology is as follows.

T.Y.B Tech Semester V (Chemical Technology)

Sr.No	T. Y. BTech(Chemical Technology) Semester V Pre-revised syllabus	T.Y.BTech(Chemical Technology) Semester V Revised syllabus	Remark
1.	Chemical Plant Utilities	Chemical Plant Utilities	No change in the subject content. Only it is converted to credit system
2.	Chemical Technology –I	Inorganic Chemical Technologies	Syllabus is the same only title is changed and it is converted to credit system
3.	Industrial Economics and Management	Industrial Economics and Management	No change in the subject content Only it is converted to credit system
4.	Mass Transfer –I	Mass Transfer –I	No change in the subject content(only one lecture per week is added), and it is converted to credit system
5.	Process Instrumentation, Dynamics and Control	Process Instrumentation, Dynamics and Control	No change in the subject content(only one lecture per week is added), and it is converted to credit system
6.	----------	Presentation and Communication Techniques	Shifted from VI semester and treated as an audit course
7.	----------	Seminar	Shifted from VI semester

The examination pattern is changed from percent marks into credit system and the contents in all the subjects have been unitized into 6 units (chapters)

T.Y.B Tech Semester VI (Chemical Technology)

Sr.No	T. Y. BTech(Chemical Technology) Semester VI Pre-revised syllabus	T.Y.BTech(Chemical Technology) Semester VI Revised syllabus	Remark
1.	Chemical Reaction Engineering	Reaction Engineering-I	The subject was vast and needs to be split up into Part I and II. Also its title is changed and it is converted to credits
2.	Chemical Technology-II	Organic Chemical Technologies	Syllabus is the same only title is changed. It is converted to credits
3.	Industrial Pollution Control	Industrial Pollution Control	No change in the subject content (only practical work is omitted on account of repetition). It is converted to credits
4.	Mass Transfer-II	Mass Transfer-II	No change in the subject content. It is converted to credits
5.	Process Equipment Design and Drawing	Process Equipment Design and Drawing	No change in the subject content. It is converted to credits
6.	Presentation and Communication Techniques	----------	Shifted to V semester.
7.	Report of Industrial Tour	Report of Industrial Tour	No change in the concept
8.	Seminar	----------	Shifted to V semester.
9.	----------	Research Methodology (an audit course)	Competency and research attitude developing subjects have been introduced
10.	----------	Mini Project	

The examination pattern is changed from percent marks into credit system and the contents in all the subjects have been unitized into 6 units (chapters)

The students from the pre-revised syllabus need not complete the course work of newly added subjects i.e. Research Methodology, Mini Project.