Dr. Babasaheb Ambedkar Technological University, Lonere

(Established as a University of Technology in the State of Maharashtra)

(Under Maharashtra Act No. XXIX of 2014)

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Curriculum for Third Year Undergraduate Degree Programme B. Tech. in Chemical Engineering

With effect from AY 2022-23

	Semester V									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				
			L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC501	Mass Transfer Operations - I	3	1	-	20	20	60	100	4
PCC	BTCHC502	Chemical Reaction Engineering - I	3	1	-	20	20	60	100	4
PCC	BTCHC503	Chemical Technology	3	-	-	20	20	60	100	3
OEC	BTCHO504	Open Elective - II	3	-	-	20	20	60	100	3
PEC	BTCHE505	Professional Elective – III	3	-	-	20	20	60	100	3
LC	BTCHL506	Chemical Reaction Engineering Lab	-	-	3	60	-	40	100	2
Project	BTCHM507	Mini Project - 1	-	-	4	60	-	40	100	2
Internship	BTCHI508	Internship – 2 (Evaluation)	-	-	-	-	-	-	-	Audit
		Total	**15**	**2**	**7**	**220**	**100**	**380**	**700**	**21**
	Semester VI									
PCC	BTCHC601	Chemical Reaction Engineering - II	3	1	-	20	20	60	100	4
PCC	BTCHC602	Mass Transfer Operations - II	3	1	-	20	20	60	100	4
PCC	BTCHC603	Process Instrumentation and Control	4	1	-	20	20	60	100	5
HSSMC	BTHM604	Engineering Economics and Project management	4	-	-	20	20	60	100	4
OEC	BTCHO605	Open Elective - III	3	-	-	20	20	60	100	3
LC	BTCHL606	Mass Transfer Operations Lab	-	-	3	60	-	40	100	2
Project	BTCHM607	Mini Project - 2	-	-	4	60	-	40	100	2
Internship		Field Training / Internship3/Industrial Training (minimum of 4 weeks which can be completed partially in fifth semester and sixth semester or in at one time).	**-**	**-**	**-**	-	-	-	-	Credits To be evalua-ted in VII Sem.
		Total	**17**	**3**	**7**	**220**	**100**	**380**	**700**	**24**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course HSSMC = Humanities and Social Science including Management Course

List of Electives

1) Professional Elective III
   A. Industrial Safety and Hazard Mitigation
   B. Optimization Techniques
   C. Petroleum refining and Petrochemicals
   D. Food technology
   E. Disaster Management in Chemical Industries
2) Open Elective II
   A. NSS II
   B. Pollution Control in Process Industries
3) Open Elective III
   A. Pharmaceuticals and fine Chemicals
   B. Heat Transfer Equipment Design

Semester: V

BTCHC501 Mass Transfer operations – I

4 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC 501	Mass Transfer operations – I	3	1	-	20	20	60	100	4

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Diffusion in fluids and solids, mass transfer coefficients.
2. Material balances and co-current, countercurrent operation and concept of stage.
3. Gas absorption and stripping, number of transfer units in plate towers and packed bed towers.
4. Liquid liquid extraction and solid liquid extraction and calculation of amount of solvent needed and number of stages.
5. Adsorption and ion exchange, adsorption isotherms and their applications.
6. Equipments for majorly gas-liquid operations.

Course Outcomes:

On completion of course, students will be able to:

1. Understand Fick's law of diffusion
2. Determine diffusivity coefficient in gases and liquids
3. Determine mass transfer coefficients
4. Calculate rate of mass transfer in humidification
5. Select equipment for gas-liquid operations

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	-	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	-	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Unit I:
Diffusion in fluids - Fick's Law of diffusion equimolecular counter diffusion, diffusion in stationary gas. Maxwell's low of diffusion. Inter phase mass transfer - Mass transfer equilibrium, diffusion between two phases. Local mass transfer coefficient, Local and average overall mass transfer coefficients. Simultaneous heat and mass transfer.

Unit II:
Material balance – steady state co current and counter current processes stage wise and differential contacts. Number of theoretical stages. Stage efficiency Height of mass transfer units.

Unit III:
Gas Absorption - Equilibrium solubilities of gases. Material balance for transfer of one component. Counter current multistage operations for binary and multi component systems. Continuous contactors, absorption with chemical reaction.

Unit IV:
Liquid–liquid extraction - Calculations with and without reflux for immiscible and partially miscible system.
Leaching - Leaching single and multistage operations based on solvent free co ordinates.

Unit V:
Adsorption and ion-exchange**:** Types of adsorption; Nature of adsorption; Freundlich equation; Types of adsorption; Nature of adsorption; Freundlich equation; Stage wise and continuous adsorption. Stage wise and continuous adsorption.Theory of ion – exchange and its application to removal of ionic impurity.
Gas–Liquid operations - Sparged vessels (bubble columns), mechanically agitated vessels for a single phase and gas liquid contact.liquid dispersed scrubbers, venturi scrubbers, wetted towers packed towers. Mass transfer coefficients for packed towers co-current flow of gas and liquid end effect and axial mixing.

Texts / References:
1. R. E. Treybal, Mass transfer operations, 3ed ed. McGraw Hill, 1980.
2. A. S. Foust et al. Principles of Unit Operations
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1 ELBS, Pergaman press, 1970
4. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergaman press, 1970

BTCHC502 Chemical Reaction Engineering – I **4 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	**BTCHC 502**	**Chemical Reaction Engineering – I**	**3**	**1**	**-**	**20**	**20**	**60**	**100**	**4**

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Mole balances in chemical reactions, types of reactors and their performance equations along with rector sizing
2. Rate laws used in chemical kinetics and design equations
3. Reactor design in isothermal conditions and its applications to different types of reactors and problems.
4. Collection and analysis of data, integral and differential methods
5. Catalysts and catalysis , rate determining steps and applications

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand different types of chemical reactors.
CO2	Write rate law for chemical reactions of different orders.
CO3	Analyze the performance of different reactors to carry out isothermal processes
CO4	Analyze the reaction data by different analysis methods
CO5	Understand catalysis and analyze the rate determining step in catalytic reaction

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO5	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-

Unit I:

Mole Balances - Definition of the rate of reaction, General mole balance equation, Batch Reactors, Continuous-flow reactors, Industrial reactors

Conversion and Reactor Sizing - Definition of conversion, Design equations, Applications of the design equations for continuous-flow reactors, Reactors in series

Unit II:
Rate-Law and Stoichiometry - Basic definitions, Approach to reactor sizing and design, Stoichiometric table, expressing concentrations in terms other than conversion, Reactions with phase change

Unit III:
Isothermal Reactor Design - Design structure for isothermal reactors, Scale up of liquid-phase batch reactor data to the design of a CSTR, Tubular reactors, Recycle reactors

Unit IV:
Collection and Analysis of Rate Data - Batch reactor data, Method of initial rates, Method of half-life, Differential reactors, Least square analysis

Unit V:
Catalysis and Catalytic Reactors - Catalysts, Steps in a catalytic reaction, synthesizing a rate law, mechanism and rate-limiting step, Design of Reactors for gas-solid reactions, Heterogeneous data analysis for reactor design

Texts / References:

1. .H. S. Fogler, "Elements of Chemical Reaction Engineering", 3rd Ed, New Delhi-Prentice a Hall, 2001
2. O. Levenspiel," Chemical Reaction Engineering" Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, "Chemical Engineering Kinetics", 3rd Ed., McGraw- Hill, 1988

BTCHC503 Chemical Technology **3 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC 503	Chemical Technology	3	-	-	20	20	60	100	3

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Chemical industries in general, chlor-alkali industries, phosphorous industries
2. Nitrogen and sulphuric acid industries
3. Soaps and detergents , starch production
4. Fermentation industries and polymerization industries
5. Petroleum processing and allied industries

Course Outcomes:

On completion of course, students will be able to:

1. Understand inorganic and organic chemical technologies.
2. Draw process flow diagrams.
3. Identify the effect of chemical technologies on the health, safety and environment.
4. Understand engineering problems in chemical processes and equipments.
5. List chemical reactions and their mechanism involved

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO3	✓	✓	✓	-	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed Syllabus

Unit I:
Introduction: Chemical industries-facts and figures, Unit operation and unit process concepts, chemical processing and role of chemical engineers. Chloro-Alkali Industries: Soda ash, Solvay process, dual process, Natural soda ash from deposits, Electrolytic process, Caustic soda.Phosphorus Industries: Phosphoric acid, Wet process, Electric furnace process, Calcium phosphate, Ammonium phosphates, Nitrophosphates, Sodium phosphate. Potassium Industries: Potassium recovery from sea water.

Unit II:
Nitrogen Industries: Ammonia, Nitric acid, Urea from ammonium carbonate, Ammonium nitrate.Sulfur and Sulfuric Acid Industries: Elemental sulfur mining by Frasch process, Sulfur production by oxidation-reduction of H2S, Sulfur and sulfur dioxide from pyrites, Sulfuric acid. Contact process, Chamber process.

Unit III:
Soap and Detergents: Batch saponification production, Continuous hydrolysis and saponification process, Sulfated fatty alcohols, Alkyl-aryl sulfonates. Sugar and Starch Industries: Sucrose, Extraction of sugar cane to produce crystalline white sugar, Extraction of sugar cane to produce

sugar, Starch production from maize, Production of dextrin by starch hydrolysis in a fluidized bed.

Unit IV:
Fermentation Industries: Ethyl alcohol by fermentation, Fermentation products from petroleum. Pulp and Paper Industries: Sulfate pulp process, Chemical recovery from sulfate pulp digestion liquor, Types of paper products, Raw materials, Methods of production. Plastic Industries: Polymerization fundamentals, Polymer manufacturing processes, Ethenic polymer processes, Polycondensation processes, Polyurethanes.

Unit V:
Petroleum Processing: Production of crude petroleum, Petroleum refinery products, Types of refineries, Design of refinery, Choice of crude petroleum, Refinery processes, Pyrolysis and cracking, Reforming, Polymerization, Isomerization, Alkylation. Rubber: Elastomer polymerization processes, Rubber polymers, Butadiene-Styrene copolymer, Polymer oils and rubbers based on silicon.

Text / References:

1. Austin G.T., Shreve's Chemical Process Industries - International Student Edition, 5th Edition, McGraw Hill Inc., 1998.
2. Sittig M. and GopalaRao M., Dryden's Outlines of Chemical Technology for the 21st Century, 3rd Edition, WEP East West Press, 2010

BTCHO504 Open Elective -II 3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
OEC	BTCH 504	Open Elective -II	3	-	-	20	20	60	100	3

A. NSS – II

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Citizenship and understanding constitution of india
2. Needs and scope of health , hygiene and sanitation
3. Philosophy and concept of Yoga
4. Environmental issues and waste management

5. Disaster management and role of youth
6. Sociological and psychological factors regarding youth and crime

Course Outcomes:

On completion of course, students will be able to:

1. Understand constitution of India and fundamental rights
2. Understand health, hygiene , sanitation and its importance
3. Have knowledge about Yoga and its philosophy
4. Know environmental issues, enrichment and sustainability
5. Understand disaster management and classification of disaster
6. Understand Sociological and psychological factors regarding youth and crime

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												✓
CO2												✓
CO3												✓
CO4												✓
CO5							✓					✓
CO6												✓

Detailed Syllabus:

Unit I:
Citizenship: Basic Features of Constitution of India, Fundamental Rights and Duties, Human Rights, Consumer awareness and the legal rights of the consumer, RTI.

Unit II:
Health, Hygiene & Sanitation: Definition, Needs and scope of health education , Food and Nutrition , Safe drinking water, Water borne diseases and sanitation, National Health Programme, Reproductive health , Healthy Lifestyles ,HIV AIDS, Drugs and Substance abuse, Home Nursing , First Aid.

Unit III:
Youth and Yoga: History, Philosophy and concept of Yoga , Myths and misconceptions about yoga , Different Yoga traditions and their Impacts, Yoga as a preventive, promotive and curative method, Yoga as a tool for healthy lifestyle.

Unit IV:

Environment Issues: Environment conservation, Enrichment and Sustainability, Climate change, Waste management, Natural resource management, Rain water harvesting, Energy conservation, Waste land development, Soil conservations and forestation.

Unit V:

Disaster Management: Introduction to Disaster Management, Classification disaster, Role of youth in Disaster Management. Youth and crime: Sociological and psychological factors influencing youth crime, Peer mentoring in preventing crime, Awareness about anti-ragging, Cybercrime and its prevention, Juvenile justice.

B. Pollution Control in Process Industries

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Biosphere, hydrological cycle and air pollutants
2. Meteorological aspects of air pollutant dispersion
3. Air pollution control equipments
4. Control of sulphur oxides, nitrogen oxides etc.
5. Waste water sampling, analysis and treatment

Course Outcomes: At the end of the course, the student will be able to:

1. Analyze the effects of pollutants on the environment
2. Understand meteorological aspects of air pollution
3. Understand air pollution control methods
4. Select treatment technologies for water/wastewater/solid waste
5. Design unit operations for pollution control

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO2	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO3	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO4	✓	✓	-	✓	✓	-	✓	-	-	-	-	-

CO5	✓	✓	✓	✓	-	-	✓	-	-	-	-	-

Detailed Syllabus

Unit I:

Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil. Air pollution sources & effects: Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.

Unit II:

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise. Air pollution sampling and measurement: Types of pollutant sampling and measurement, Ambient air sampling, Stack sampling, Analysis of air pollutants.

Unit III:

Air pollution control methods & equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment.

Unit IV:

Control of specific gaseous pollutants: Control of sulphur dioxide emissions, Control of nitrogen oxides, Carbon monoxide control, Control of hydrocarbons and mobile sources. Water pollution: Water resources, Origin of wastewater, types of water pollutants and there effects.

Unit V:

Waste water sampling, analysis and treatment: Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, Advanced wastewater treatment, Recovery of materials from process effluents. Solid waste management: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal. Hazardous waste management: Definition and sources, Hazardous waste classification, Treatment methods, Disposal methods.

Text / References:

1. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern Limited, India, 1993.
2. Noel de Nevers, Air Pollution and Control Engineering, McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, 2nd Edition, Prentice Hall of India, 2004.

4. Rao M.N. and Rao H.V.N - Air Pollution, Tata – McGraw Hill Publishing Ltd., 1993.
5. De A.K - Environmental Chemistry, Tata – McGraw Hill Publishing Ltd., 1999.

BTCHE505 Professional Elective – III 3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PEC	BTCHE 505	Professional Elective – III	3	-	-	20	20	60	100	3

A. Industrial Safety and Hazard Mitigation

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Safety programs, engineering ethics and public perceptions
2. Fire and explosions with flammability characteristics
3. Prevention of fire and explosion
4. Operated reliefs in liquids, vapors, gases
5. Hazard identification, safety procedures and designs

Course Outcomes:

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

1. Know Safety programs, engineering ethics and public perceptions
2. Understand the principles of fire and explosions , flammability characteristics
3. Know about the methods for prevention of fire and explosion
4. Know about Operated reliefs in liquids, vapors , gases
5. Know about process hazard checklist, how to do hazard surveys
6. Know safety procedures and best safety practices

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-

Detailed syllabus

Unit I:
Introduction: Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, Nature of the Accident Process, Inherent Safety. Industrial Hygiene: Anticipation and Identification, Hygiene Evaluation, Hygiene Control.

Unit II:
Fires and Explosions: Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram

Unit III:
Concepts to Prevent Fires and Explosions: Inerting, Controlling Static Electricity, Explosion-Proof Equipment and Instruments, Ventilation, Sprinkler Systems. Introduction to Reliefs: Relief Concepts, Location of Reliefs, Relief Types, Relief Scenarios, Data for Sizing Reliefs, Relief Systems.

Unit IV:
Relief Sizing- Conventional Spring: Operated Reliefs in Liquid Service, Conventional Spring-Operated Reliefs in Vapor or Gas Service, Rupture Disc Reliefs in Liquid Service, Rupture Disc Reliefs in Vapor or Gas Service. Hazards Identification: Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews.

Unit V:
Safety Procedures and Designs: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures—Operating, Procedures—Permits, Procedures—Safety Reviews and Accident Investigations, Designs for Process Safety.

Text / References:

1. D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall,2011.
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Vol. 6, Elsevier India, 2006.

B. Optimization Techniques

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Single variable optimization algorithms , optimality criteria
2. Multivariable optimization algorithms and different methods
3. Constrained optimization algorithms with Kuhn-Tucker conditions
4. Sensitivity analysis in optimization
5. Integer programming, geometric programming
6. Non-traditional optimization algorithms

Course Outcomes:

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

1. Formulate single variable optimization algorithms and its solution
2. Know and formulate Multivariable optimization algorithms and its methods of solution
3. Understand Constrained optimization algorithms , Kuhn-Tucker conditions and solve using transformation methods
4. Do Sensitivity analysis in optimization
5. Solve optimization problems using Integer programming, geometric programming
6. Formulate Non-traditional optimization algorithms and their solution techniques

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	-	-	✓	✓	-	-	✓	-	-	-
CO2	-	-	-	-	✓	✓	-	-	✓	-	-	-
CO3	-	-	-	-	✓	✓	-	-	✓	-	-	-
CO4	-	-	-	-	✓	✓	-	-	✓	-	-	-
CO5					✓	✓			✓			
CO6					✓	✓			✓			

Detailed Syllabus:

UNIT I:
Single-variable optimization algorithms: Optimal problem formulation, Optimization algorithms, Optimality criteria, Bracketing methods, Region-elimination methods, Point-estimation method, Gradient based methods, Root finding using optimization techniques.

UNIT II:

Multi-variable optimization algorithms: Unidirectional search, Direct search methods, Gradient based methods.

UNIT III:
Constrained optimization algorithms: Kuhn-Tucker conditions, Transformation methods,

UNIT IV:
Sensitivity analysis, Direct search for constrained minimization, Linearized search techniques, Feasible direction method, Generalized reduced gradient method, Gradient projection method

UNIT V:
Specialized algorithms: Integer programming, Geometric programming.
Non-traditional optimization algorithms: Genetic algorithms, Simulated annealing, Global optimization.

Texts / References:

Deb K., Optimization for Engineering Design, Algorithms and Examples, Prentice Hall of India, New Delhi 1996

C. Petroleum Refining and Petrochemicals

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Petroleum basics, its origin , formation and composition
2. Fractionation of petroleum with different treatment techniques
3. Thermal and catalytic cracking and reforming
4. Different chemicals from C3, C4 and higher carbon atoms with applications

Course Outcomes:

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

1. State the composition of petroleum.
2. Understand the unit operations and processes in petroleum refining
3. Understand the technologies for conversion of petroleum refining products to chemical products
4. Select feed stock for conversion to products

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-

CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-

DETAILED SYLLABUS:

Unit I:
ORIGIN, FORMATION AND COMPOSITION OF PETROLEUM: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry, composition of petroleum. PETROLEUM PROCESSING DATA: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

Unit II:
FRACTIONATION OF PETROLEUM: Dehydration and desalting of crudes, heating of crude-pipe still heaters, distillation of petroleum, blending of gasoline. TREATMENT TECHNIQUES: Fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

Unit III:

THERMAL AND CATALYTIC PROCESSES: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Petrochemical Industry – Feed stocks

Unit IV:
CHEMICALS FROM METHANE: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines. CHEMICALS FROM ETHANE-ETHYLENE-ACETYLENE: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, Vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

Unit V:
CHEMICALS FROM C3, C4 AND HIGHER CARBON ATOMS: Chemical from Propylene, manufacture of Isopropanol, manufacture of Acrylonitrile, production of Acrylic acid, polymers and copolymers of propylene, production of Phenol from cumene, production of Bisphenol-A, manufacture of maleic Anhydride, production of Acetic acid and production of Butadiene from Butane. SYNTHESIS GAS AND CHEMICALS: Steam reforming of hydrocarbons, production of synthesis gas, SNG from Naphtha, Synthesis gas via partial Oxidation.

TEXT BOOKS:

1. B.K. BhaskaraRao - Modern Petroleum Refining Processes - 3rd edition, Oxford & IBH Publishing Co. Pvt. Ltd., Jan. 1997.
2. B.K. BhaskaraRao - A Text of Petrochemicals - 2nd edition, Khanna Publications, 1998.

REFERENCE BOOK:

W.L. Nelson - Petroleum Refinery Engineering; McGraw Hill Book Company.

D. Food Technology

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. General aspects of food industry and constituents of food
2. Basic principle of food and its properties
3. Ambient temperature processing for food
4. Heat processing of food using various techniques
5. Post processing techniques of food

Course Outcomes:

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

1. Understand general aspects of food industry
2. Know Basic principles about properties of food , effect of heat on microorganisms
3. Understand Ambient temperature processing for food with raw material preparation, separation and concentration of food components
4. Understand Heat processing of food using steam, water , air , dielectric heating
5. Know Post processing techniques of food with its applications with types of packaging materials

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO4	✓	✓	-	✓	-	✓	✓	-	-	-	-	-

Detailed Syllabus

Unit 1:

Introduction: General aspects of food industry, World food demand and Indian scenario, Constituents of food, Quality and nutritive aspects, Product and Process development, engineering challenges in the Food Processing Industry.

Unit 2:
Basic principles: Properties of foods and processing theory, Heat transfer, Effect of heat on micro-organisms, Basic Food Biochemistry and Microbiology: Food Constituents; Food fortification, Water activity, Effects of processing on sensory characteristics of foods, Effects of processing on nutritional properties, Food safety, good manufacturing practice and quality Process Control in Food Processing.

Unit 3:
Ambient Temperature Processing: Raw material preparation, Size reduction, Mixing and forming, Separation and concentration of food components, Centrifugation, Membrane concentration, Fermentation and enzyme technology, Irradiation, Effect on micro-organisms, Processing using electric fields, high hydrostatic pressure, light or ultrasound.

Unit 4:
Heat processing using steam, water and air: Blanching, Pasteurization, Heat sterilization, Evaporation and distillation, Extrusion, Dehydration, Baking and roasting.
Heat processing by direct and radiated energy: Dielectric heating, Ohmic heating, Infrared heating.

Unit 5:
Post Processing Applications Packaging: Coating or enrobing, Theory and Types of packaging materials, Printing, Interactions between packaging and foods, Environmental considerations.

Text / Reference:

1. Fellows P., Food Processing Technology: Principles and Practice, 2nd Edition, Woodhead Publishing, 2000.
2. Toledo R, Fundamentals of Food Process Engineering, 3rd Edition, Springer, 2010.
3. Singh, R.P. &Heldman, D.R., Introduction to Food Engineering, 3rd Edition, Academic Press, UK, 2001.
4. Smith J.M., Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981

E. Disaster Management in Chemical Industries

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. General aspects of industrial disaster due to fire, explosion etc.
2. Classification of chemical hazards, occupational diseases

3. Hazard analysis and health management
4. Pressure vessels ,its storage and handling
5. Safety practices, protection devices

Course Outcomes: At the end of the course, the student will be able to:

1. Analyze the effects of release of toxic substances
2. Select the methods of prevention of fires and explosions
3. Understand the methods of hazard identification and preventive measures
4. Assess the risks using fault tree diagram

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-

Unit 1:
General aspects of industrial disaster: Due to fire, explosion, toxicity and radiation; Chemical hazards.

Unit 2:
Classification of chemical hazards, Chemical as cause of occupational diseases – dust, fumes, gases and vapors.

Unit 3:
Hazard analysis and health management; Engineering control of chemical plant hazards – Plant layout, ventilation and lighting.

Unit 4:
Pressure vessels, Storage, Handling, Transportation, Electrical systems, Instrumentation.

Unit 5:
Emergency planning, Personal protective devices, Maintenance procedure; Emergency safety and laboratory safety; Legal aspects of safety. Management information system and its application in monitoring disaster, safety and health; Hazop Analysis.

Text Book:
1. H. H. Tawcatt & W S Wood, Safety and Accident Prevention in Chemical Operations.

Reference Books:

1. R. V. Betrabet and T. P. S. Rajan in CHEMTECH-I, Safety in Chemical Industry, Chemical
2. Engineering Development Centre, Madras, 1975.
3. Wells, Safety in Process Plant Design.
4. Less, P. Frank, Loss Prevention in Process Industries.
5. J. Lolb & S. Roy Sterm, Product Safety and Liability.

BTCHL506 Chemical Reaction Engineering Lab 2 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
LC	BTCHL 506	Chemical Reaction Engineering Lab	-	-	3	60	-	40	100	2

Course Objectives

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Activation energy of acid catalyzed hydrolysis of methyl acetate.
2. Specific reaction rate of acid catalyzed hydrolysis of ethyl acetate
3. The reaction between potassium persulphate and iodide
4. Saponification of ethyl acetate.
5. Different types of reactors
6. RTD studies in reactors

Course Outcomes

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

1. Find activation energy of acid catalyzed hydrolysis of methyl acetate.
2. Find Specific reaction rate of acid catalyzed hydrolysis of ethyl acetate
3. Study the reaction between potassium persulphate and iodide
4. Study saponification of ethyl acetate.
5. Study different types of reactors
6. **Study RTD studies in reactors**

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	✓							
CO6	✓	✓	✓	✓	✓							

List of Practicals

1. Determine rate constant/activation energy of acid catalyzed hydrolysis of methyl acetate.
2. To study effect of concentration of reactant / temperature on the rate of reaction.
3. To 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 saponification of ethyl acetate.
8. Study of Isothermal continuous stirred tank reactor.
9. Study of RTD in packed bed.
10. Study of RTD studies in continuous stirred tank reactor.
11. Study of non- catalytic homogenous reaction in a isothermal tubular flow reactor.
12. Study of non- catalytic homogenous reaction in a batch reactor.
13. Study of non- catalytic homogenous reaction in a continuous stirred tank reactor.
14. Study of non- catalytic homogenous reaction in plug flow reactor.
    (Minimum 12 experiments to be performed by all the students)

BTCHM507 Mini Project I

2 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Project	**BTCHM 507**	**Mini Project – I**	**-**	**-**	**4**	**60**	**-**	**40**	**100**	**2**

The purpose behind the mini project is that the student should be exposed to more hands-on rather than merely theory. It is expected that the student (or a small group say, not more than two in a group, to be confirmed) will undertake to make a working model, a program, etc. which he/she will benefit from since he /she will be doing it first-hand.

BTCHI508 Internship – 2 (Evaluation) Audit

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Internship	**BTCHI508**	**Internship - 2 (Evaluation)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**Audit**

Course Outcomes: At the end of the course, the student will be able to:

1. Acquire knowledge on topics outside the scope of curriculum on summer training.
2. Communicate with group of people on different topics of summer training.
3. Collect and consolidate required information on a topic of summer training.
4. Prepare a seminar report on summer training

Each student is expected to spend Four weeks in any one factory/project/workshop at the end of fourth semester (during summer vacation). Here he/she shall observe layout, working and use of various machinery, plants, design, instruments, process etc. under the general supervision of the foreman/artisan/engineer of the factory etc.

The student shall submit the report in a systematic technical format about the major field of the factory, particularly about the section/department where he/she has received the training giving details of equipment, machinery, materials, process etc. with their detailed specifications, use etc. The report shall be checked and evaluated by the concerned teacher and appropriate grade shall be awarded.

SEMESTER VI

BTCHC601 Chemical Reaction Engineering - II 4 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC 601	Chemical Reaction Engineering - II	3	1	-	20	20	60	100	4

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Multiple reactions , their types and use of PFR, CSTR for multiple reactions
2. Different types of non-elementary reactions, their kinetics and applications
3. External diffusion effects on heterogeneous reactions with application of mass transfer to reaction
4. General characteristics of RTD in chemical reactors
5. Models for non-ideal reactors

Course Outcomes: At the end of the course, students will be able to :

1. Compare the performance of ideal and non-ideal reactors using E- and F-curves.
2. Determine the mean residence time and standard deviation using residence time distribution (RTD)
3. Analyze the performance of non-ideal reactors using segregation model, tanks-in series model and dispersion model
4. Understand the effect of velocity, particle size and fluid properties on rate of reactions controlled by mass transfer
5. Design fixed bed reactors involving chemical reactions with mass transfer
6. Determine internal and overall effectiveness factors

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
CO6	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed Syllabus:

UNIT I:
Multiple Reactions - Maximizing desired product in parallel reactions, Maximizing desired product in series reactions, Stoichiometric table using fractional conversion
Multiple reactions in PFR and CSTR – An alternative approach to using fractional conversion

UNIT II:
Nonelementary Reaction Kinetics - Fundamentals, Searching for a mechanism, polymerization, enzyme reaction fundamentals, Bioreactors

UNIT III:
External Diffusion Effects on Heterogeneous Reactions - Mass transfer fundamentals, Binary diffusion, External resistance to mass transfer, The shrinking core model

UNIT IV:
Distribution of Residence times for Chemical Reactors - General characteristics, Measurement of RTD, Characteristics of RTD, RTD in ideal reactors, Reactor modeling with RTD, Zero-parameter models

UNIT V:
Models for non-ideal reactors - One-parameter models; tank-in-series model, dispersion model

Texts / References:

1. H. S. Fogler, "Elements of Chemical Reaction Engineering", 3rd Ed, New Delhi-Prentice Hall, 2001
2. O. Levenspiel," Chemical Reaction Engineering" Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, "Chemical Engineering Kinetics", 3rd Ed., McGraw- Hill, 1988

BTCHC602 Mass Transfer Operations – II **4 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	BTCHC 602	Mass Transfer Operations – II	3	1	-	20	20	60	100	4

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Distillation, flash and differential distillation
2. McCabe Thiele method and Ponchon Savarit method to do calculations of distillation
3. Humidification operations and cooling tower design
4. Drying and different types of dryers
5. Crystallization basics and membrane separation processes

Course Outcomes: At the end of the course, the student will be able to:

1. Select solvent for absorption and extraction operations.
2. Determine number of stages in distillation, absorption and extraction operations.
3. Determine the height of packed column in absorption, distillation and extractior
4. Calculate drying rates and moisture content for batch and continuous drying.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	-	-	-

Detailed Syllabus:

UNIT I:
Distillation - Vapour liquid equilibria, flash vapourisation, batch distillation, differential distillation.

UNIT II:
Continuous fractionation - Binary systems, Mc-Cabe.Thiele and PonchonSavarit method calculations with multiple feeds and withdrawal

UNIT III:
Humidification - Vapour liquid equilibrium, enthalpy for pure substances, vapour gas contact operation. Psychrometric charts and measurement of humidity
Dehumidification and Cooling Tower Design **-** Adiabatic and non adiabatic operations evaporative cooling, cooling tower design and dehumidification methods.

UNIT IV:
Drying - Drying equilibrium and rate of drying, drying operation batch and continuous number of transfer units.

UNIT V:
Crystallisation - Theories of crystallisation nucleation and crystal growth. principles of supe saturation. different types of crystallisers.
Special topics in separation**:** Types of membranes for osmosis and dialysis; Mechanism of solute/solvent rejection in the process; Design of R.O. and dialysis units; applications.

Texts / References:

1. R. E. Treybal, Mass transfer operations, 3ed ed. McGraw Hill, 1980.
2. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1 ELBS, Pergamon press, 1970
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergamon press, 1970.

BTCHC603 Process Instrumentation and Control **5 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
PCC	**BTCHC 603**	**Process Instrumentation and Control**	**4**	**1**	**-**	**20**	**20**	**60**	**100**	**5**

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Characteristics of measurement systems with pressure measurement
2. Temperature, flow and level measurement
3. Close loop and open loop systems, dynamics of first order systems
4. Transient response of control systems
5. Frequency response analysis and controller tuning

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the measurement techniques for Pressure and Temperature
2. Understand the measurement techniques for Flow and Level

3. Understand recording, indicating and signaling instruments
4. Analyze repeatability, precision and accuracy of instruments
5. Understand open-loop and closed loop systems
6. Understand transient response of control systems
7. Understand frequency response analysis

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	-	✓	✓	✓	-	-	-	-	-	-	-
CO2	✓	-	-	✓	✓	-	-	-	-	-	-	-
CO3	✓	-	-	✓	✓	-	-	-	-	-	-	-
CO4	✓	-	-	✓	✓	-	-	-	-	-	-	-
CO5	✓			✓	✓							
CO6	✓			✓	✓							
CO7	✓			✓	✓							

Detailed syllabus

Unit I

Characteristics of Measurement System -Elements of instruments, static and dynamic characteristics, basic concepts of response of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer, static accuracy and response of thermometers. Pressure Measurement- Pressure, vacuum and head manometers, measuring elements for gage pressure and vacuum, measuring pressure in corrosive liquids, measuring of absolute pressure, static accuracy and response of pressure gages.

Unit II

Temperature Measurement–Industrial thermocouples, thermocouple wires, thermo couple wells and response of thermocouples. Flow Measurement- head flow meters, open channel meters, area flow meters, flow of dry materials, viscosity measurement. Level Measurement- direct measurement of liquid level, level measurement in pressure vessels, measurement of interface level, level of dry materials.

Instruments for Analysis - recording instruments, indicating and signaling instruments, instrumentation diagram.

UNIT III

Introduction Block diagrams, closed loop and open loop control systems, Basic control actions. Open loop response of simple systems**:** Dynamics of first order systems using transfer functions; Various first order response such as, a thermometer bulb. General response to step, ramp, impulse, and sinusoidal inputs; Concentration and temperature responses of a stirred tank;

Linearization of liquid level systems; Response of a pressure system, second order systems, the manometer; Response of interacting and non interacting systems.

UNIT IV

Transient response of control systems: Servo and regulated operation, General equations for the transient response, proportional control of a signal capacity process; Integral control, Proportional-integral control and derivative action. Stability**:** Concept of stability, Stability criterion, Routh test for stability. Root locus analysis**:** Concept of root locus, Locus diagram.

UNIT V

Frequency response analysis: First order systems, Bode diagram, and Complex numbers to get frequency response. Controller selection and tuning, Control valve characteristics and sizing, cascade control, Feed forward control. Introduction of digital control principles.

Text / References:

1. Patranabis D, Principles of Industrial Instrumentation, 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 1999.
2. EckmanDonald P., Industrial Instrumentation, Wiley Eastern Ltd., 2004.
3. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, 1st Edition, Tata McGraw-Hill Education Private Limited, 2009.
4. D. R. Coughanowr, Process system analysis and control, 2nd ed, McGraw Hill, 1991.
5. P. Harriott, Process Control, Reprint of text, ed. Tata McGraw Hill, 1983.
6. G. Stephanopoulos, Chemical Process Control: An introduction to theory and practice, Prentice Hall, New Jersey, 1984.

BTHM604 Engineering Economics and Project management 4 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
HSSMC	BTHM 604	Engineering Economics and Project management	4	-	-	20	20	60	100	4

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Fixed and working capital investment , total product cost
2. Application of time value of money, interest and investment costs
3. Taxes and insurance , depreciation and depreciation methods
4. Profitability of projects
5. Optimum process design, CPM/PERT techniques

Course Outcomes:

On completion of course, students will be able to:

1. Analyze alternative processes and equipment for manufacturing a product
2. Design plant layout and engineering flow diagrams
3. Perform economic analysis related to process design
4. Evaluate project profitability

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	-	✓	-	✓	-	✓	-
CO3	-	-	✓	✓	✓	-	-	✓	✓	-	-	-
CO4	-	-	✓	✓	✓	-	-	✓	-	-	-	-

Detailed Sullabus

UNIT I
Capital cost estimation in chemical industries, different methods of calculation of fixed costs. Capital Investment and working Capital.

UNIT II
Time value of money, types of interest, investment costs, annuities, perpetuity and capitalized costs, discounted cash flow analysis

UNIT III
Taxes and insurance, depreciation, amortization and obsolescence in chemical industries, types of depreciation methods, breakeven point analysis

UNIT IV
Discussion on projects , causes for time and cost overruns, project evaluation and assessment of project profitability, organization of project engineering.

UNIT V
Optimum process design with examples, project development and commercialization, plant location and layout, selection of plant capacity.
Project engineering management, project scheduling and its importance, use of CPM/PERT techniques.

Texts / References:

1. M. S. Peters and K. D. Timmerhaus, "Plant Design Economics for Chemical Engineers", 5th Ed., McGraw-Hill, New York - 2003.
2. V. W. Uhl and A. W. Hawkins, "Technical Economics for Chemical Engineers", AIChE - 1971.
3. J. Moder and Philips, "Project Engineering with CPM and PERT", Rein Hold.
4. Choudhary, "Project Management"
5. Jelen, "Cost and Optimization Engineering"

BTCHO605 Open Elective III

3 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
OEC	BTCHO 605	Open Elective III	4	-	-	20	20	60	100	4

A. Pharmaceuticals and Fine Chemicals

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Different grades of chemicals
2. Different methods of preparation of reagents and laboratory chemicals
3. Uses and testing of the pharmaceuticals and fine chemicals
4. Manufacture of Pharmaceuticals and fine chemicals with flow sheets
5. Study compressed tablet making and coating techniques
6. Study Preparation of capsules and extraction of crude drugs

Course Outcomes:

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

1. Know different grades of chemicals
2. Understand different methods of preparation of reagents and laboratory chemicals
3. Know uses and testing of the pharmaceuticals , fine chemicals and their applications
4. Know the techniques for manufacture of Pharmaceuticals and fine chemicals with flow sheets and their applications
5. Tablet making and coating techniques

6. Know Industrial procedures of capsule formulation and methods of recovering the drugs formulated from the reaction mixture

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	-	-	-	-	-	-	-	-
CO2	✓	✓	-	-	-	-	-	-	-	-	-	-
CO3	✓	✓	-	-	-	-	-	-	-	-	-	-
CO4	✓	-	-	✓	-	-	-	-	-	-	-	-
CO5	✓	-	-	✓	-	✓	-	-	-	-	-	-
CO6	✓			✓		✓						

Detailed Syllabus

Unit 1:
A brief outline of different grades of chemicals – Reagent grade and Laboratory grade.
Outlines of preparation – Different methods of preparation of Reagent grade and Laboratory grade Chemicals.

Unit 2:
Uses and testing of the pharmaceuticals and fine chemicals – Applications of medicinal value Chemicals and their quality testing procedures.

Unit 3:
Properties, assays and manufacture of Pharmaceuticals and fine chemicals with flow sheets-Physical and Chemical properties, methods of assessing the quality and industrial methods of formulating the drugs and fine chemicals that have no medicinal value but are used as the intermediates.

Unit 4:
Compressed Tablet making and coating – Types of tablets and Methods of compressed tablet making and coating.

Unit 5:
Preparation of capsules and extraction of crude drugs – Industrial procedures of capsule formulation and methods of recovering the drugs formulated from the reaction mixture. Sterilization – Need for sterilization, Sterilization methods, batch and continuous sterilization.

Text / References:

1. Remington, Pharmaceutical Sciences, Mak. Publishing Co., 16th Edition, 1980.
2. William Lawrence Faith, Donald B. Keyes and Ronald L. Clark, Industrial Chemicals, 4th Edition, John Wiley & Sons, 1975.
3. Gurdeep R. Chatwal, Synthetic Drugs, Himalaya Publishing House, 2002.

B. Heat Transfer Equipment Design

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. process design of double pipe heat exchanger
2. process design of Shell and Tube heat Exchanger
3. process design of condenser and reboiler
4. process design of evaporator
5. process design of agitator

Course Outcomes: At the end of the course, the student will be able to:

1. Do process design of double pipe heat exchanger
2. Do process design of Shell and Tube heat Exchanger
3. Do process design of condenser and reboiler
4. Do process design of evaporator
5. Do process design of agitator

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	-	-	✓	-	✓	-	-	-	-	-
CO2	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO3	✓	✓	-	-	✓	-	✓	-	-	-	-	-
CO4	✓	✓	-	-	✓	-	✓	-	-	-	-	-
CO6	✓	✓			✓		✓					

Detailed Syllabus

Unit I:
Detailed Process Design of Double Pipe Heat Exchangers

Unit II:
Detailed Process Design of Shell and Tube heat exchanger

Unit III:
Detailed Process design of condenser and reboiler

Unit IV:
Detailed Process Design of Evaporator

Unit V:

Detailed process design of Agitator

Text/Reference books:

1. J. M. Coulson and J. F. Richardson, "Chemical Engineering" Vol. 2 ELBS, Pergamon press, 1970
2. D. Q. Kern, "Process Heat Transfer", McGraw Hill, 1950.

Practicals

All above designs will be manually calculated and then verified using Aspen Plus software.

BTCHL606 Mass Transfer Operations Lab 2 Credits

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
LC	BTCHL 606	Mass Transfer Operations Lab	-	-	3	60	-	40	100	2

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to :

1. Diffusivity of components in other components
2. Equilibrium solubility diagram
3. The overall plate efficiency of sieve plate distillation
4. Rayleigh's equation for batch and differential distillation
5. Liquid-liquid extraction
6. The critical moisture content in drying

Course Outcomes:

On completion of course, students will be able to:

1. Determine diffusivity of components

2. Draw equilibrium solubility diagram
3. Determine the overall plate efficiency of sieve plate distillation
4. Verify Rayleigh's equation for batch distillation
5. Study liquid-liquid extraction
6. Determine the critical moisture content in drying

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	-
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CO5	✓	✓	✓	✓	✓							
CO6	✓	✓	✓	✓	✓							

LIST OF PRACTICALS:

1. To determine the diffusivity of acetone in air
2. To study liquid-liquid diffusion.
3. To study the absorption with/without chemical reaction.
4. To study single stage/multistage leaching operation for calcium carbonate, sodium hydroxide water system.
5. To draw equilibrium solubility diagram for an acetic acid, benzene/toluene, water.
6. To study counter-current single stage extraction process for water(A), acetic acid(B) and benzene(C)/Toluene(C) system
7. To study liquid-liquid extraction in packed bed for suitable ternary system (HTU/NTU)
8. T-x-y diagram for water-acetone system
9. To prove Rayleigh equation by carrying out simple distillation of methanol-water system
10. To study crystallization of given salt
11. To determine rate of drying of given sample and to plot (kg moisture content/ kg of dry solid) V/S time and rate of drying V/S time
12. To study Batch/Continuous crystallizer
13. Study of Rotary/fluidized bed dryer.
14. Study of steam distillation/Sieve plate distillation column
15. Study of Humidification/dehumidification system
16. Study of Cooling Tower

(About 12 Experiments are to be conducted)

BTCHM607 Mini Project – 2 **2 Credits**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Project	**BTCHM 607**	**Mini Project – 2**	**-**	**-**	**4**	**60**	**-**	**40**	**100**	**2**

The purpose behind the mini project is that the student should be exposed to more hands-on rather than merely theory. It is expected that the student (or a small group say, not more than two in a group, to be confirmed) will undertake to make a working model, a program, etc. which he will benefit from since he /she will be doing it firsthand.

BTCHI708 Internship - 3 **Audit**

Category	Code	Subject Name	L	T	P	CA	MSE	ESE	Total	Credit
Internship	**BTCHI708**	**Internship - 3**							**-**	**Audit**

Field Training / Internship 3 / Industrial Training (minimum of 4 weeks, which can be completed partially in fifth semester and sixth semester or at one time). Credits To be evaluated in VII Sem.

Course Outcomes: At the end of the course, the student will be able to:

1. Acquire knowledge on topics outside the scope of curriculum on summer training.
2. Communicate with group of people on different topics of summer training.
3. Collect and consolidate required information on a topic of summer training.
4. Prepare a seminar report on summer training

Each student is expected to spend Four weeks in any one factory/project/workshop at the end of VI semester (during summer vacation). Here he/she shall observe layout, working and use of various machinery, plants, design, instruments, process etc. under the general supervision of the foreman/artisan/engineer of the factory etc. Student shall submit report in a systematic technical format about the major field of the factory, particularly about the section/department where he/she has received the training giving details of equipment, machinery, materials, process etc. with their detailed specifications, use etc. The report shall be checked and evaluated by the concerned teacher and appropriate grade shall be awarded.