

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM**  
**CHOICE BASED CREDIT SYSTEM (CBCS)**  
**SCHEME & SYLLABUS OF TEACHING AND EXAMINATION**  
**2015-2016**

**SEMESTER V**

<b>MANAGEMENT AND ENTREPRENEURSHIP (Common to CH &amp; PC)</b>					
<b>Subject Code</b>	:	15CH51	<b>IA Marks</b>	:	20
<b>No. of Lecture Hrs/Week</b>	:	04	<b>Exam Hours</b>	:	03
<b>Total No. of Lecture Hours</b>	:	50	<b>Exam Marks</b>	:	80
<b>Credits</b>	:	04			
<b>Course Objectives:</b> The students will be able to					
1. Understand the roles of managers and historical evolution of various approaches to the study of management.					
2. Demonstrate the process of planning which can be used as a tool for decision-making in organizations.					
3. Create logical relationships between various organizational structures and designs.					
4. Implement leadership practices towards the management and development of people within organizations.					
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating					
<b>Modules</b>			<b>Teaching Hours</b>	<b>Bloom's Taxonomy</b>	
<b>Module 1</b>	<b>Content</b>				
<b>Organization and Management:</b> Forms of Business Organization, Basic concepts of management-classification, characteristics, objectives, Functions of management-planning, organizing, staffing, directing, Organization Structure-linear, functional, line and staff, staff and functional, Management by objectives, Management information system.			10	L1, L2	
<b>Module 2</b>	<b>Content</b>				
<b>Personnel (Human Resource) Management:</b> Acquisition of manpower-functions and objectives of personnel management, manpower planning, Job analysis and evaluation, Induction, Orientation, Training and development, Maintenance of human resource. Industrial relations, Trade Unionism.			10	L1, L2	
<b>Module 3</b>	<b>Content</b>				
<b>Entrepreneurship and Project Management:</b> Entrepreneurship- Types, Growth, functions, qualities, Project Planning-project implementation, monitoring and control, evaluation strategies, Gantt charts, Critical path method, Performance evaluation and review technique, application of network techniques.			10	L2, L3, L4	
<b>Module 4</b>	<b>Content</b>				

<b>Operation Research:</b> Introduction, phases, scope, methodology, O R Models, techniques, applications of O R, Linear Programming, graphic method, simplex method, waiting line theory, game theory, Monte Carlo technique. Dynamic programming.		10	L2, L3.		
<b>Module 5</b>	<b>Content</b>				
<b>Materials Management:</b> Purchasing, make or buy decision, stores management, inventory control, spare parts management, value engineering. <b>Marketing:</b> Marketing research, marketing management, consumer behavior and market promotion.		10	L1, L2		
<b>Course outcomes: Students after completion of course are expected to</b>					
1. Understand the principles of management theory & Recognize the characteristics of an organization. 2. Demonstrate the importance of key performance areas in strategic management & decision-making process. 3. Design appropriate organizational structures and possess an ability to conceive organizational dynamics. 4. Evaluate attitudes and personality traits for inter personal effectiveness and development within organizations. 5. Implement the right leadership practices in organizations that would enable systems orientation.					
<b>Question Paper Pattern:</b> This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.					
<b>Graduate Attributes</b>					
1. Critical Thinking 2. Problem solving 3. Use of modern tools 4 Life - long Learning					
<b>TEXT BOOKS:</b>					
1. T R Banga S C Sharma Industrial Organization and Engineering Economics Khanna Publications 24 <sup>th</sup> Edition ISBN No. 81-7409-078-9 2. Dr. Vilas Kulkarni & Hardik Bavishi Engineering Economics & Management: Vikas Publishing					
<b>REFERENCE BOOKS:</b>					
1. Stephen Robbins, Mary Coulter & Neharika Vohra, Management, Pearson Education Publications, 10th Edition, ISBN: 978-81-317-2720-1. 2. James Stoner, Edward Freeman & Daniel Gilbert Jr, Management, PHI, 6th Edition, ISBN: 81-203-0981-2.					
<b>MASS TRANSFER OPERATIONS-I (Common to CH &amp; PC)</b>					
<b>Subject Code</b>	:	15CH52	<b>IA Marks</b>	:	20
<b>No. of Lecture Hrs/Week</b>	:	04	<b>Exam Hours</b>	:	03

<b>Total No. of Lecture Hours</b>	:	50	<b>Exam Marks</b>	:	80	
<b>Credits</b>	:	04				
<b>Course Objectives:</b>						
The students will						
1. Be able to formulate equations for estimation of diffusivities in fluids & solids using first principles of engineering sciences.						
2. Be able to apply mass transfer fundamentals to calculate mass transfer rates and design the mass transfer equipment.						
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating						
<b>Modules</b>			<b>Teaching Hours</b>		<b>Bloom's Taxonomy</b>	
<b>Module 1</b>	<b>Content</b>					
	Types of diffusion in fluids. Types of diffusion in solid. Measurement and calculations of diffusivities. Mass transfer coefficients and their correlations. Theories of mass Transfer. Interphase mass transfer. Material balance for co-current, cross-current and counter-current operations. Concept of stages, cascade operation, NTU and HTU concepts.				10	L1, L2, L3
<b>Module 2</b>	<b>Content</b>					
	<b>Humidification:</b> General theory, Psychrometric chart. Concepts in humidification, dehumidification. Design of cooling towers.				10	L2, L3, L4
<b>Module 3</b>	<b>Content</b>					
	<b>Drying:</b> Introduction, Equilibria, Drying rate curves. Mechanism of drying, types of dryers. Design of batch and continuous dryers.				10	L3, L4, L5
<b>Module 4</b>	<b>Content</b>					
	<b>Adsorption:</b> Theories of adsorption. Isotherms, Industrial adsorbents. Equipment, Batch & continuous multistage adsorption.				10	L4, L5, L6
<b>Module 5</b>	<b>Content</b>					
	<b>Crystallization:</b> Factors governing nucleation and crystal growth rates. Controlled growth of crystals. Incorporation of principles into design of equipment. Different types of crystallizer equipment. <b>Introduction to Novel Separations:</b> Ion exchange, Membrane processes- Reverse Osmosis, Dialysis, Ultra and Micro-filtrations, Super-critical fluid extraction. (Working principles and operations only)				10	L2, L3, L4
<b>Course outcomes:</b>						
After studying this course, students will be able to:						
1. Estimate mass transfer co-efficients and provide valid conclusions on suitability of the operation.						
2. Apply the analogies in transport processes for validating and reaching substantiated conclusions.						
<b>Question Paper Pattern:</b>						
This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full						

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

**Graduate Attributes**

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

**TEXT BOOKS:**

1. **Mass Transfer Operations**-Robert E Treybal, 3<sup>rd</sup> Edition, McGraw Hill, 1981.
2. **Unit Operations of Chemical Engineering**-McCabe & Smith, 6<sup>th</sup> Edition, McGraw Hill, 2001.

**REFERENCE BOOKS:**

1. **Chemical Engineering Vol I, II, IV and V** - Coulson and Richardson, 4<sup>th</sup> Edition, Pergamon Press, 1998.
2. **Introduction to Chemical Engineering**-Badger & Banchero, TMH 6<sup>th</sup> Reprint 1998.
3. **Principles of Unit Operations**-Foust *et. al.*, 2<sup>nd</sup> Edition, John Wiley, 1994.
4. **Transport Processes and Unit Operations**-Geankoplis CJ, Prentice Hall (I), 2000.
5. **Applied Process Design for Chemical and Petrochemical Plant** Ludwig, 2<sup>nd</sup> Edition, Gulf Publishing, 2002.

<b>Subject Code</b>	: 15CH53	<b>IA Marks</b>	: 20
<b>No. of Lecture Hrs/Week</b>	: 04	<b>Exam Hours</b>	: 03
<b>Total No. of Lecture Hours</b>	: 50	<b>Exam Marks</b>	: 80
<b>Credits</b>	: 04		
<b>Course Objectives:</b> The students will			
1. Be able to Analyze and interpret the data to determine rate equation and estimate the performance equation of ideal systems.			
2. Be able to formulate and analyze the rate equations for various reactions using suitable mechanisms.			
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating			
<b>Modules</b>		Teaching Hours	Blooms Taxonomy
<b>Module 1</b>	<b>Content</b>		
<b>Introduction:</b> Scope of Chemical Reaction Engineering. Classification of reactions. Rate equation and rate of reaction. Factors affecting rate of reaction. Chemical kinetics and Thermodynamics Equilibrium. Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reaction. <b>Non-Elementary Reactions:</b> Difference between elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions. Types of reactors.		10	L1, L2, L3
<b>Module 2</b>	<b>Content</b>		
<b>Homogeneous Reactions:</b> Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis: Differential method, Integral method, half-life method. Method of excess and method of isolation (For Reversible and Irreversible reactions up to second order). Autocatalytic reactions.		10	L2, L3, L4
<b>Module 3</b>	<b>Content</b>		
<b>Design of Ideal Reactors:</b> Concept of ideality. Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors. Numerical Problems.		10	L3, L4, L5
<b>Module 4</b>	<b>Content</b>		
<b>Comparison of Ideal Reactors:</b> General graphical comparison. <b>Multiple Reactor Systems:</b> Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series. <b>Design of Reactors for Multiple Reactions:</b> Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered).		10	L4, L5, L6
<b>Module 5</b>	<b>Content</b>		

<p><b>Non-Isothermal Reactors:</b> Introduction, effect of temperature on equilibrium constant and heat of reaction, Material and Energy balances, conversions in adiabatic and non-adiabatic reactors.</p> <p><b>Analysis of Non Isothermal Reactor:</b> Design procedure (For single/simplereaction only). Optimum temperature Progression.</p>	10	L3,L4,L5
<p><b>Course outcomes:</b>  After studying this course, students will be able to:</p> <ol style="list-style-type: none"> <li>1. Apply theoretical knowledge for interpretation of experimental data.</li> <li>2. Acquire practical knowledge of reactors.</li> <li>3. Know the use of reactors, problems associated and modifications.</li> </ol>		
<p><b>Question Paper Pattern:</b>  This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.</p>		
<p><b>Graduate Attributes</b></p> <ol style="list-style-type: none"> <li>1. Critical Thinking</li> <li>2. Problem solving</li> <li>3. Use of modern tools</li> <li>4. Life - long Learning</li> </ol>		
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Chemical Reaction Engineering</b>, Octave Levenspiel, 3<sup>rd</sup> edition, John Wiley &amp; Sons, 2001.</li> <li>2. <b>Elements of Chemical Reaction Engineering</b>, H. Scott Fogler, 3<sup>rd</sup> edition, Prentice Hall 2001.</li> </ol>		
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Chemical Engineering Kinetics</b>, J.M. Smith, 3<sup>rd</sup> Edition, McGraw Hill, 1984.</li> </ol>		

<b>CHEMICAL EQUIPMENT DESIGN (Common to CH &amp; PC)</b>				
<b>Subject Code</b>	:	15CH54	<b>IA Marks</b>	: 20
<b>No. of Lecture Hrs/Week</b>	:	04	<b>Exam Hours</b>	: 03
<b>Total No. of Lecture Hours</b>	:	50	<b>Exam Marks</b>	: 80
<b>Credits</b>	:	04		
Course Objectives: Students will				
1. Understand advances and types in the design of Chemical equipment and its accessories.				
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating				
<b>Modules</b>			<b>Teaching Hours</b>	<b>Blooms Taxonomy</b>
<b>Module 1</b>	<b>Content</b>			
<b>Introduction:</b> Basic considerations in design. General design procedure. Equipment classification. Various components of process equipment. Design parameters. Pressure vessel codes.			10	L1, L2, L3
<b>Design Considerations:</b> Material selection. Factors affecting design. Stresses due to static and dynamic loads (Internal & External). Temperature effects. Economic considerations.				
<b>Design of Pressure Vessels:</b> Design parameters, conditions & stresses. Design of shell, and other vessel components. Vessel at low & high operating temperatures. Design problems using given process parameters.				
<b>Module 2</b>	<b>Content</b>			
<b>Vessel Component Design:</b> Design of supports for vessels - Bracket, Leg, Saddle and Skirt supports. Design of flanges & nozzles, Classification of flanges. Flange thickness calculation, Gasket selection, Bolt selection, Nozzle Selection. Design of vessel closures - Flat plates, Formed heads, Elliptical & Hemispherical heads.			10	L2, L3, L5
<b>Module 3</b>	<b>Content</b>			
<b>Storage Vessels:</b> Process conditions and design parameters for storage of volatile, non-volatile fluids & gases. Design of cylindrical tanks with fixed roofs. Design of partially filled spherical tanks. Design of components, supports and selection of vessel accessories & mountings. Numerical problems.			10	L2, L3, L5
<b>Module 4</b>	<b>Content</b>			
<b>Reaction Vessels:</b> Design of reaction tanks with agitation and jacket. Types of agitators, baffles. Power requirement calculations. Design of tank dimensions and agitation system components. Drive calculations & selection of accessories. Design of jackets. Support calculations for the system. Numerical problems.			10	L1, L2, L3, L4
<b>Module 5</b>	<b>Content</b>			
<b>Tall Vertical Vessels:</b> Vessels subjected to various loads, Multi shell constructions. Determination of shell thickness. Supports for columns.			10	L3, L4, L6
<b>Pipe Line Design:</b> Pipeline sizing, Condensate and steam pipe design, optimum size of delivery line in pumping operations.				

**Course outcomes:**

After studying this course, students will be able to:

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

**Question Paper Pattern:**

This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

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

**TEXT BOOKS:**

1. **Process Equipment Design**-M.V.Joshi, 3<sup>rd</sup>Edn., Macmillan & Co. India, Delhi, 1998.
2. **Process Equipment Design – Vessel Design**, Brownell & Young, John Wiley, 1959.
3. **Process Design of Equipment – Vol 1**, S. D. Dawande, 3<sup>rd</sup>Edn, Central Techno Publications. 2003.

**REFERENCE BOOKS:**

1. **Chemical Engineers Handbook**, Perry & Green, 7<sup>th</sup>Edn, McGraw Hill, 1997.
2. **Pressure Vessel Code – IS 2825**, IS Code, B.I.S., New Delhi, 1969.
3. **Flow of Fluid through Valves, Fittings & Pipes**, Crane Amazon, 2006.



<b>OILS AND FATS TECHNOLOGY</b>				
<b>Subject Code</b>	:	15CH551	<b>IA Marks</b>	: 20
<b>No. of Lecture Hrs/Week</b>	:	03	<b>Exam Hours</b>	: 03
<b>Total No. of Lecture Hours</b>	:	40	<b>Exam Marks</b>	: 80
<b>Credits</b>	:	03		
<b>Course Objectives:</b>				
The students will				
1. Able to understand Structure of fats and oils, Sources and classification of fats and oils, Chemical and physical characteristics.				
2. Able to know its importance in industry and nutrition.				
3. Able to Process of fats and oils, Pre-extraction operations, extraction/processing, filtering and refining. Quality and nutritive values of processed products.				
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating				
<b>Modules</b>			Teaching Hours	Blooms Taxonomy
<b>Module 1</b>	<b>Content</b>			
	<b>Introduction:</b> Classification of fats and oil. Characteristic of oils. Utilization of fat and oils. Composition of oils (general). <b>Obtaining Oils and Fats from Source Materials:</b> Mechanical pretreatment. Mechanical expression. Solvent extraction (two types of extractors).		8	L1, L2, L3
<b>Module 2</b>	<b>Content</b>			
	<b>Process Techniques:</b> Refining and hydrogenation (H <sub>2</sub> production and catalyst). <b>Process Techniques (contd.):</b> Degumming. Alkali refining and bleaching.		8	L2, L3, L4
<b>Module 3</b>	<b>Content</b>			
	<b>Deodorization:</b> Theoretical consideration and operation of commercial deodorizer. <b>Vegetable Oils:</b> Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil.		8	L2, L5, L6
<b>Module 4</b>	<b>Content</b>			
	<b>Vegetable Oils:</b> Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil. <b>Vegetable Oils:</b> Refining processes and uses of palm oil, Soyabean oil, peanut oil, sunflower oil.		8	L3, L4, L6
<b>Module 5</b>	<b>Content</b>			
	<b>Marine Oils:</b> Composition. Extraction. Refining processes and uses of fish oils.		8	L3, L4, L5
<b>Course outcomes:</b>				
After studying this course, students will be able to:				
1. Work on isolation and purification of fats and oils.				
2. Develop new skills in fat and oil products development.				

3. Experiment on physical and chemical changes occurring in fat and oil products.

**Question Paper Pattern:**

This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

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

**TEXT BOOKS:**

1. **BasilyIndustrialOilandFatProducts–VolItoV**, Y.H.HeryJohnWileyInternational, 2<sup>nd</sup> Edition, 1976.

**REFERENCE BOOKS:**

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

<b>PETROLEUM REFINERY ENGINEERING</b>				
<b>Subject Code</b>	:	15CH552	<b>IA Marks</b>	: 20
<b>No. of Lecture Hrs/Week</b>	:	03	<b>Exam Hours</b>	: 03
<b>Total No. of Lecture Hours</b>	:	40	<b>Exam Marks</b>	: 80
<b>Credits</b>	:	03		
<b>Course Objectives:</b> The students will				
1. Able to understand history, classification of petroleum crudes.				
2. Able to understand the extraction and production of oil and gas to meet energy needs, as well as refining of crude oil for a wide spectrum of useful products such as petrochemicals, Chemicals, Plastics.				
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating				
<b>Modules</b>			<b>Teaching Hours</b>	<b>Blooms Taxonomy</b>
<b>Module 1</b>	<b>Content</b>			
	<b>Indian Petroleum Industry:</b> Prospects & Future. Major companies. World production, Markets, Offshore and onshore, Oil well technology. <b>Composition of Crude:</b> Classification. Evaluation of petroleum. UOP-factor. TBP analysis. EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions. <b>Product Properties and Test Methods:</b> Gas. Various types of gas and LPG. Reid vapor pressure analysis. Gasoline and naphtha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities etc. Diesel, octane testing, viscosity etc. Grades of diesel e.g. HSD, LDO. Diesel additives. Lube oils: Types, tests- carbon residue and viscosity index.		8	L1, L2, L3
<b>Module 2</b>	<b>Content</b>			
	<b>Crude Pretreatment:</b> Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical desalter and comparison of each. Heating of crude- heater, different types of pipe still heaters including box type, cylindrical etc. Crude distillation, arrangement of towers for various types of reflux. Design aspects for atmospheric and vacuum column. Atmospheric distillation distillation unit: internal and operational.		8	L1, L2, L3
<b>Module 3</b>	<b>Content</b>			
	<b>Treatment Techniques:</b> Types of impurities present and various desulfurisation processes. Production and treatment of LPG. LNG technology. Sweetening operations for gases including merox, ethanolamine, copper chloride, stertford etc. Catalytic desulphonisation. Treatment of kerosene, De-aromatisation and merox. Treatment of diesel, naphtha: desulphurisation by		8	L2, L3, L4

hydrogen and catalysts. Treatment of flubes: sulphuric acid, clay treatment, solvent treatment- phenol, furfura			
<b>Module 4</b>	<b>Content</b>		
	<p><b>Thermal Processes:</b> Thermal cracking reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. Visbreaking, durbstwo coil cracking process.</p> <p><b>Catalytic Reforming:</b> Theory of reforming. Factors influencing reforming, reforming catalysts, feedstock requirements. Plat-forming, isoplushondri forming, refining forming, power forming and flexi forming etc.</p>	8	L2, L3, L4
<b>Module 5</b>	<b>Content</b>		
	<p><b>Catalytic Cracking:</b> Comparison of thermal and catalytic cracking. Carbonium ion chemistry. Feedback requirements. Cracking conditions. Commercial cracking analysis. V arious catalytic cracking processes. Fixed bed crackers. Moving bed crackers. Fluid catalytic cracking- flexi cracking-ortho-flow reactor. Theory of coking: varioustypes of coking processes. Delayed coking, fluid coking, contact coking, flexi coking. Napthac cracking, naptha cracking for ethylene as feed selection and gas yield. Hydrocracking. Theory of hydrocracking. Catalysts for hydro cracking.</p>	8	L2, L4, L5
<p><b>Course outcomes:</b> After studying this course, students will be able to:</p> <ol style="list-style-type: none"> <li>1. Introduce the petroleum refinery sector worldwide.</li> <li>2. Develop knowledge of different refining processes</li> <li>3. Develop knowledge of safety and pollution control in the refining industries.</li> <li>4. To find the suitable refining technology for maximizing the yield.</li> </ol>			
<p><b>Question Paper Pattern:</b> This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.</p>			
<p><b>Graduate Attributes</b></p> <ol style="list-style-type: none"> <li>1. Critical Thinking</li> <li>2. Problem solving</li> <li>3. Use of modern tools</li> <li>4. Life - long Learning</li> </ol>			
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Petroleum Refinery Engineering</b>, Nelson, 4<sup>th</sup> Edition, McGraw Hill, 14<sup>th</sup> Reprint, 1982.</li> <li>2. <b>Modern Petroleum Refining Processes</b>, Bhaskara Rao, 3<sup>rd</sup> Edition, Oxford &amp; IBH Publication, Reprint, 1999.</li> </ol>			
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Petroleum Refining Technology</b>, Ram Prasad, I Edition, Khanna Publishers, 2000.</li> <li>2. <b>Challenges in Crude Oil Evaluation</b>, Nagnal J.M., Gate, McGraw Hill, 1996.</li> <li>3. <b>Petroleum Processing</b>, Bland W.F. and Davidson R.L. McGraw Hill, 1967.</li> </ol>			

PHARMACEUTICAL TECHNOLOGY				
<b>Subject Code</b>	:	15CH553	<b>IA Marks</b>	: 20
<b>No. of Lecture Hrs/Week</b>	:	03	<b>Exam Hours</b>	: 03
<b>Total No. of Lecture Hours</b>	:	40	<b>Exam Marks</b>	: 80
<b>Credits</b>	:	03		
<b>Course Objectives:</b> Students will				
<ol style="list-style-type: none"> <li>1. Learn formulations, tablet and capsule making.</li> <li>2. Learn development, testing of cosmetics.</li> <li>3. Learn manufacturing technology.</li> <li>4. Learn patent intellectual property rights and regulatory affairs.</li> </ol>				
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating				
<b>Modules</b>			<b>Teaching Hours</b>	<b>Blooms Taxonomy</b>
<b>Module 1</b>	<b>Content</b>			
<b>Electrophilic Substitution Reaction:</b> Preparation of cycloalkane. Bayer's strain theory and orbital picture of angle strain. <b>Electrophilic Substitution Reaction Mechanism &amp; Application:</b> Dehydrogenation of alkyl halides. 1-2 elimination kinetics: E2 and E1 mechanisms. Isotope effect. Dehydration of alcohols. Ease of dehydration.			8	L1, L2, L3
<b>Module 2</b>	<b>Content</b>			
<b>Nucleophilic Addition Reaction:</b> Mechanism. Important chemicals. Oxidation-Reduction reactions. Rheology of Fluids in Mixing and Blending.			8	L2, L3, L4
<b>Module 3</b>	<b>Content</b>			
<b>Preparation:</b> Test for purity and medical uses of Chlorobutal, Dimercopral, Glycerol trinitrate.			8	L3, L4, L5
<b>Module 4</b>	<b>Content</b>			
<b>Preparation:</b> Test for purity and medical uses of Urea, ethylenediamine dihydrate, vanillin, paraldehyde. <b>Preparation:</b> Test for purity and medical uses of lactic acid, citric acid, salicylic acid, saccharin sodium			8	L3, L4, L6
<b>Module 5</b>	<b>Content</b>			
<b>Preparation:</b> Test for purity and medical uses of Ethylborate, dimethylphthalate, aspirin.			8	L4, L5, L6
<b>Course outcomes:</b> After studying this course, students will be able to:				
<ol style="list-style-type: none"> <li>1. Explain various formulations and formulate tablet and capsule.</li> <li>2. Develop manufacturing technologies and apply for various cases.</li> <li>3. Practice industrial safety and involve in patent intellectual property rights and regulatory affairs.</li> </ol>				
<b>Question Paper Pattern:</b>				

This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

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

**TEXT BOOKS:**

1. **Organic Chemistry**, T.R. Morisson and R. Boyd, 6<sup>th</sup> Edition, Prentice Hall of India Pvt Ltd., New Delhi, 1992.
2. **The Theory and Practice of Industrial Pharmacy**, Liberman, and Lachman, 3<sup>rd</sup> Edition, Lea & Febiger, Philadelphia, 1986.
3. **Pharmaceutical Product Development**, Jain N.K, CBS Publications and Distributions, New Delhi, 2006.

**REFERENCE BOOKS:**

1. **Organic Chemistry Fundamentals**, I.L. Finar, 2<sup>nd</sup> Edition, ELBS, Pergemon Press, 1965.
2. **Good Manufacturing of Pharmaceuticals**, Sidnay H. Willing, Murray M. Tuckerman, and Williams Hitchings, 3<sup>rd</sup> Edition, Marcell Dekker Inc., NY, 1982.

POLYMER TECHNOLOGY					
<b>Subject Code</b>	:	15CH554	<b>IA Marks</b>	:	20
<b>No. of Lecture Hrs/Week</b>	:	03	<b>Exam Hours</b>	:	03
<b>Total No. of Lecture Hours</b>	:	40	<b>Exam Marks</b>	:	80
<b>Credits</b>	:	03			
<b>Course Objectives:</b>					
The students will					
1. Able to understand broad and fundamental knowledge of the polymers and their chemical, physical and mechanical behavior.					
2. Able to emphasize the processing techniques, along with the production of polymers and correlate structure processing properties relationships for polymers and blends.					
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating					
<b>Modules</b>			<b>Teaching Hours</b>	<b>Bloom's Taxonomy</b>	
<b>Module 1</b>	<b>Content</b>				
<b>Principles of Processing of Polymers:</b> Melt processing of thermoplastics. Classification of processes. Thermoset plastics processing, crystallization, orientation & shrinkage, copolymers blendings, compounding for engineering application, stress-strain behavior, WLF equation, practical assessment for long term behavior.			8	L1, L2, L3	
<b>Module 2</b>	<b>Content</b>				
<b>Polymer Extrusion:</b> Requirements of Polymer for extrusion. Single screw and double screw plasticating extruder zones in extrusion, breaker plates, extruder screw, power calculation. PVC extruder. Die and calibration equipment primemover for extrusion, coextrusion, extrusion coating, extrusion film blowing reactive extrusion. Extrusion blow moulding for PET bottles, wire drawing-PVC, spinning-varioustypes and applications. Application of various extruded products. Rheological aspects of extrusion and extrusion defects. Operational and maintenance of extrusion equipment, pultrusion.			8	L2, L3, L5	
<b>Module 3</b>	<b>Content</b>				
<b>Injection Moulding:</b> Polymer characteristics for injection moulding. Reciprocating screw injection moulding. Single impression mould. Multi impression moulds. Cooling requirements in moulds. Hot runner moulds, gate, mould clamping force calculations. Control of pressure, temperature and time of injection thermostat and fiber reinforced polymer injection moulding, sandwich moulding and injection blow moulding. Rheological aspects and defects of injection. Comparison of injection moulding and extrusion of injection. Operational and maintenance of injection moulding equipment. Reaction injection moulding. Applications.			8	L2, L3, L4	
<b>Module 4</b>	<b>Content</b>				
<b>Compression Moulding:</b> Applications. Principles. Comparison with other processing methods. Derivation of compression mould thickness or compaction force. Transfer moulding.			8	L3, L4, L5	

<p><b>Calendering:</b> Characteristics of polymer for calendering. Principles and operation of calendaring. Derivation of film thickness and pressure required for rollers. Gauge control during calendaring. Application of PVC calendered products.</p>		
<b>Module 5</b>	<b>Content</b>	
<p><b>Thermoforming:</b> Basic principles. Vacuum forming. Pressure forming. Description of operations. Product design. Application. Derivation of thermoformed product thickness.  <b>Rotational Moulding:</b> Principles. Operation &amp; applications. Thickness. Cooling calculations.  <b>Testing of Plastics:</b> Thermal, electrical, optical, mechanical property testing.</p>	8	L2, L4, L5, L6
<p><b>Course outcomes:</b>  After studying this course, students will be able to:  1. Explain the techniques and their characteristics /limitations of synthesis of polymers.  2. Explain the structure property relationship of polymers and apply the various processing and manufacturing techniques.</p>		
<p><b>Question Paper Pattern:</b>  This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.</p>		
<p><b>Graduate Attributes</b></p> <ol style="list-style-type: none"> <li>1. Critical Thinking</li> <li>2. Problem solving</li> <li>3. Use of modern tools</li> <li>4. Research Skill</li> <li>5. Life-long learning</li> </ol>		
<p><b>TEXT BOOKS:</b>  1. <b>Principles of Polymer Processing</b>, Morton Johnes Chapman, Hall 1989.  2. <b>Plastic Engineering</b>, R.J. Crawford, 3<sup>rd</sup> Edition Research Studies, 1996.</p>		
<p><b>REFERENCE BOOKS:</b>  1. <b>Principles of Polymer Engineering</b>, N.G. McCrum, Vol. 1, C.P. Buckley Oxford University Press, 1988.  2. <b>Polymer Materials</b> – Vols. 1, 2 &amp; 3, Manas Chanda, Springer, Univ Press, 1997.</p>		



<b>INDUSTRIAL WASTE WATER MANAGEMENT</b>					
<b>Subject Code</b>	:	15CH561	<b>IA Marks</b>	:	20
<b>No. of Lecture Hrs/Week</b>	:	03	<b>Exam Hours</b>	:	03
<b>Total No. of Lecture Hours</b>	:	40	<b>Exam Marks</b>	:	80
<b>Credits</b>	:	03			
<b>Course Objectives:</b>					
The students will					
1. Understand the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic, industrial or commercial activities prior to its release into the environment or its re-use.					
2. Understand various terms used in industrial wastewater treatment and to acquaint with different steps involved in treatment of industrial wastewater.					
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating					
<b>Modules</b>			<b>Teaching Hours</b>	<b>Blooms Taxonomy</b>	
<b>Module 1</b>	<b>Content</b>				
	Effects of Industrial Wastes on sewerage system and sewage treatment plants and receiving water bodies. Effects of waste additions on physical and chemical properties of soil. Effluent standards and receiving water quality standards. Different aspects and choices of various disposal alternatives.		8	L1, L2, L3	
<b>Module 2</b>	<b>Content</b>				
	Industrial Wastes survey-Process flow charts, condition of waste stream. Material balance, Sampling – Grab, Composite and integrated samples. Continuous monitoring – pH, Conductivity, Bio monitoring.		8	L2, L3, L4	
<b>Module 3</b>	<b>Content</b>				
	Pretreatment of Industrial Wastewater – Volume reduction, Strength reduction, Neutralization, Equalization and Proportion, Removal of Organic and inorganic dissolved solids. Wastewater Treatment in specific industries: Distillery, Sugar, Pulp and paper, Cement, Textile, Dairy, Fertilizer, Pesticides, Pharmaceutical.		8	L2, L3, L4	
<b>Module 4</b>	<b>Content</b>				
	Design of complete treatment systems & disposal for industries: Distillery, dairy, textile, paper and pulp mill to meet P.C.B. norms. Radioactive wastes treatment- Low activity and high activity radiation, application of radioactive techniques for wastewater treatment. Bio-Remediation of contaminated soils.		8	L4, L5, L6	
<b>Module 5</b>	<b>Content</b>				
	Environmental Auditing: Cost of Pollution, Environmental audit solutions, Financial and Managerial opportunities. Criminal and Regulatory liabilities.		8	L4, L5, L6	
<b>Course outcomes:</b>					
After studying this course, students will be able to:					
1. Develop physical/chemical/biological characteristics of and the evaluation technique for various industrial wastewater					

2. Express concepts in the theory, engineering application, and design technique for the industrial wastewater treatment unit processes.

**Question Paper Pattern:**

This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

**Graduate Attributes**

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

**TEXT BOOKS:**

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

**REFERENCE BOOKS:**

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

<b>AIR POLLUTION &amp; CONTROL</b>					
<b>Subject Code</b>	:	15CH562	<b>IA Marks</b>	:	20
<b>No. of Lecture Hrs/Week</b>	:	03	<b>Exam Hours</b>	:	03
<b>Total No. of Lecture Hours</b>	:	40	<b>Exam Marks</b>	:	80
<b>Credits</b>	:	03			
<b>Course Objectives:</b>					
The students will					
1. Understand knowledge on the principles and design of control of indoor/ particulate / gaseousair pollutant and its emerging trends.					
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating					
<b>Modules</b>			<b>Teaching Hours</b>	<b>Blooms Taxonomy</b>	
<b>Module 1</b>	<b>Content</b>				
<b>INTRODUCTION:</b> Structure and composition of Atmosphere – History of Air pollution and episodes, Causes of air pollution and types, Introduction to meteorology toxicology and transport of air pollution, Sources and classification of air pollutants - Effects of air pollutants on human health, vegetation & animals, Materials & Structures – Effects of air Pollutants on the atmosphere, Soil & Water bodies – Long- term effects on the planet – Global Climate Change, Ozone Holes – Ambient Air Quality and Emission Standards – Air Pollution Indices – Emission Inventories.			8	L1, L2, L3	
<b>Module 2</b>	<b>Content</b>				
<b>AIR POLLUTION MONITORING AND MODELLING:</b> Physicochemical processes governing the spread of pollutants from point, non-point, line, and area sources; Generation, transport and decay of air pollutants; Mathematical Modeling of dynamics of pollutants, Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants-Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns-Transport & Dispersion of Air Pollutants - Modeling Techniques – Air Sampling and monitoring methods.			8	L1, L2, L4	
<b>Module 3</b>	<b>Content</b>				
<b>CONTROL OF PARTICULATE CONTAMINANTS:</b> Factors affecting Selection of Control Equipment - Gas Particle Interaction, Working principle, Design and performance equations of Gravity Separators, cyclones, Fabric filters, Particulate Scrubbers, Electrostatic Precipitators - Operational Considerations - Process Control and Monitoring - Costing of APC equipment - Case studies for stationary and mobile sources.			8	L1, L2, L5	
<b>Module 4</b>	<b>Content</b>				
<b>CONTROL OF GASEOUS CONTAMINANTS:</b> Control Equipments, Factors affecting Selection of Control Equipment -			8	L1, L2, L5, L6	

Working principle, Design operation and performance of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters - Process control and Monitoring - Operational Considerations - Costing of APC Equipment - Case studies for stationary and mobile sources.		
<b>Module 5</b>	<b>Content</b>	
<b>AUTOMOBILE AND NOISE POLLUTION:</b> Vehicular Pollution: Automobile emission - Types of emissions - Exhaust emissions, evaporative emissions, crank-case emissions-Prevention and control of vehicular pollution. Noise Pollution: Sources and Effects of Noise Pollution - Measurement - Standards - Control and Preventive measures. Sources types and control of indoor air pollutants, sick building syndrome types - Radon Pollution and its control. Air pollution legislation and regulations. Case studies of a few industrial pollution control systems.	8	L1, L2, L5
<p><b>Course outcomes:</b> After studying this course, students will be able to:</p> <ol style="list-style-type: none"> <li>1. Apply sampling techniques</li> <li>2. Suggest suitable air pollution prevention Equipments and techniques for various gaseous and particulate pollutants.</li> </ol>		
<p><b>Question Paper Pattern:</b> This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.</p>		
<p><b>Graduate Attributes</b></p> <ol style="list-style-type: none"> <li>1. Critical Thinking</li> <li>2. Problem solving</li> <li>3. Use of modern tools</li> <li>4. Life - long Learning</li> </ol>		
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Air Pollution Control Engineering</b>, Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, Tokyo, 2004.</li> <li>2. <b>Air Pollution Control Engg</b>, Noel de Nevers, Mc.Graw Hill, New York, 1995.</li> <li>3. <b>Air Pollution</b>, David H.F. Liu, Bela G. Liptak, Lewis Publishers, 2000.</li> </ol>		
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Air Pollution &amp; Control Technologies</b>, Anjaneyulu. Y, Allied Publishers (P) Ltd. India, 2002.</li> <li>2. <b>Air Pollution</b> (Vol.I – Vol.VIII), Arthur C.Stern, Academic Press, 2006.</li> <li>3. <b>Air Pollution Engineering Manual</b>, Wayne T.Davis, John Wiley &amp; Sons, Inc., 2000.</li> <li>4. <b>Fundamentals of Air Pollution</b>, Daniel Vallero, Fourth Edition, 2008.</li> </ol>		

<b>SOLID WASTE MANAGEMENT</b>			
<b>Subject Code</b>	:	15CH563	<b>IA Marks</b> : 20
<b>No. of Lecture Hrs/Week</b>	:	03	<b>Exam Hours</b> : 03
<b>Total No. of Lecture Hours</b>	:	40	<b>Exam Marks</b> : 80
<b>Credits</b>	:	03	
<b>Course Objectives:</b> The students will			
<ol style="list-style-type: none"> <li>1. Understand solid waste management from an environmental public health perspective.</li> <li>2. Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system.</li> </ol>			
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating			
<b>Modules</b>			Teaching Hours Blooms Taxonomy
<b>Module 1</b>	<b>Content</b>		
	<b>Introduction:</b> Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes. <b>General Aspects:</b> Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.		8 L1, L2, L3
<b>Module 2</b>	<b>Content</b>		
	<b>Engineered Systems:</b> Typical generation rates. Estimation and factors effecting generation rates. Onsite handling, Storage and processing. Collections systems and devices. Transfer and transport.		8 L2, L3, L4
<b>Module 3</b>	<b>Content</b>		
	<b>Processing Techniques:</b> Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.		8 L2, L3, L4
<b>Module 4</b>	<b>Content</b>		
	<b>Material Recovery:</b> Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products. <b>Energy Recovery:</b> Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion in incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).		8 L2, L3, L4
<b>Module 5</b>	<b>Content</b>		
	<b>Hazardous Wastes:</b> Classification. Origin and reduction at source. Collection and handling. Management issues and planning methods. Environmental Acts. <b>Case Studies:</b> Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive		8 L2, L3, L4,

waste generation units.		L6
<p><b>Course outcomes:</b>  After studying this course, students will be able to:</p> <ol style="list-style-type: none"> <li>1. Have the working knowledge of all unit operations involved in solid waste management.</li> <li>2. Will be familiar with design and policy considerations regarding alternatives for solid waste management.</li> </ol>		
<p><b>Question Paper Pattern:</b>  This question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.</p>		
<p><b>Graduate Attributes</b></p> <ol style="list-style-type: none"> <li>1. Critical Thinking</li> <li>2. Problem solving</li> <li>3. Use of modern tools</li> <li>4. Life - long Learning</li> </ol>		
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Integrated Solid Waste Management</b>, George Tchobanoglous et al, 2<sup>nd</sup> Edition, McGraw Hill &amp; Co, 1993.</li> <li>2. <b>Industrial Solid Waste Management and Land Filling Practice</b>, Dutta et al, Narosa Publishing House, 1999.</li> </ol>		
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. <b>Waste Treatment Plants</b>, Sastry C.A. et al, Narosa Publishing House, 1995.</li> <li>2. <b>Hazardous Waste Management</b>, Lagrega, McGraw Hill, 1994</li> </ol>		

INDUSTRIAL SAFETY AND ENVIRONMENTAL MANAGEMENT				
<b>Subject Code</b>	:	15CH564	<b>IA Marks</b>	: 20
<b>No. of Lecture Hrs/Week</b>	:	03	<b>Exam Hours</b>	: 03

<b>Total No. of Lecture Hours</b>	:	40	<b>Exam Marks</b>	:	80
<b>Credits</b>	:	03			
<b>Course Objectives:</b>					
The students will					
<ol style="list-style-type: none"> <li>1. Understand and recognize hazardous conditions and practices affecting people, property and the environment.</li> <li>2. Understand the importance of plant safety and safety regulations, different types of plant hazards and their control, personal protective equipment, principles and procedures of safety audit.</li> </ol>					
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating					
<b>Modules</b>			<b>Teaching Hours</b>	<b>Bloom's Taxonomy</b>	
<b>Module 1</b>	<b>Content</b>				
	Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, ETA, FTA. Consequence analysis, Probit Analysis. Hazards in work places. Workers' exposures to hazardous chemicals. Hazards in industries.		8	L1, L2, L3	
<b>Module 2</b>	<b>Content</b>				
	Guidelines for safeguarding personnel. Safety education and training- Safety managements, fundamentals of safety nets. Measuring safety performance, motivating safety performance, legal aspects of industrial safety, safety audits.		8	L2, L3, L4	
<b>Module 3</b>	<b>Content</b>				
	Introduction and need for impact assessment. Legislation and pollution control acts and Regulations. Methodologies- collection of data and analysis, cost benefit analysis.		8	L2, L3, L4	
<b>Module 4</b>	<b>Content</b>				
	Applications of Impact assessment methods in specific developed projects, advantages and disadvantages of different methods. Applicability of specific methods with examples.		8	L2, L3, L4	
<b>Module 5</b>	<b>Content</b>				
	Clean technology Option: Clean technology and clean up technology, material reuse, waste reduction at source and clean synthesis.		8	L2, L3, L4, L6	
<b>Course outcomes:</b>					
After studying this course, students will be able to:					
<ol style="list-style-type: none"> <li>1. Carry out Hazard analysis, Risk assessment techniques (HAZOP, HAZON, Fault Tree Analysis, Consequence Analysis), Onsite and offsite emergency management, Human error Analysis and Accident Analysis.</li> <li>2. Recognize that the practice of safety requires ongoing learning, and undertake appropriate activities to address this need.</li> </ol>					
<b>Question Paper Pattern:</b>					
This question paper will have ten questions. Each full question consists of 16 marks. There will					

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

**Graduate Attributes**

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

**TEXT BOOKS:**

1. **Loss prevention in process industries**, F.P. Lees, 2<sup>nd</sup> Edition, Butterworth-Heinemann, 1996.
2. **EIA, Theory and Practice**, Peter Wathern, Unwin Hyman Ltd., 1988.

**REFERENCE BOOKS:**

1. **Environmental Health and Safety Auditing Handbook**, Lee Harrison, 2<sup>nd</sup> Edition, McGraw Hill, Inc., New York, 1994.

**HEAT TRANSFER LABORATORY**

<b>Subject Code</b>	:	15CHL57	<b>IA Marks</b>	:	20
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<b>No. of Lecture Hrs/Week</b>	:	1I + 2P	<b>Exam Hours</b>	:	03
<b>Total No. of Lecture Hours</b>	:	42	<b>Exam Marks</b>	:	80
<b>Credits</b>	:	02			
<b>Course Objectives:</b>					
The Students will					
1. Experimentally verify the Heat Exchanger concepts studied in theory.					
2. Carry out experiment and make observations for various heat transfer equipment.					
3. Study the effect of U, hi and ho in design of equipment.					
4. Evaluate the performance characteristic for different heat transfer cases.					
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating					
The following experiments are to be carried out; the data are to be analyzed based on the theoretical aspects, and recorded with comments.					Blooms Level
1. Natural Convection in Bare and Finned tube					L3,L4,L5
2. Vertical Shell and tube Heat exchanger (Condenser)					L3,L4,L5
3. Horizontal Shell and tube Heat exchanger (Condenser)					L3,L4,L5
4. Helical Coil Heat exchanger					L3,L4,L5
5. Emissivity Determination					L3,L4,L5
6. Effect of Geometry on Natural convection					L3,L4,L5
7. Heat Transfer in Packed Beds					L3,L4,L5
8. Double Pipe Heat Exchanger					L3,L4,L5
9. Heat Transfer in Jacketed Vessel					L3,L4,L5
10. Determination of Insulation Thickness					L3,L4,L5
11. Transient Heat Conduction					L3,L4,L5
12. Heat Transfer in Fluidized Beds					L3,L4,L5
13. Evaporator					L3,L4,L5
14. Solar Heater					L3,L4,L5
15. Spiral Plate Heat Exchanger					L3,L4,L5
16. Cross Flow Heat Exchanger					L3,L4,L5
<b>Course outcomes:</b>					
After studying this course, students will be able to:					
1. Apply theoretical knowledge of various Heat exchanger, evaporators and fins.					
2. Acquire practical knowledge of Heat Transfer Equipment.					
3. Know the use of Heat Exchanging equipment.					
<b>Conduct of Practical Examination:</b>					
1. Minimum of 10 experiments are to be conducted and all 10 experiments are to be included for practical examination.					
2. Students are allowed to pick one experiment from the lot.					
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.					
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.					
<b>Graduate Attributes</b>					
1. Critical Thinking					

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

**TEXT BOOKS:**

1. **Process Heat Transfer**, Kern D.Q. McGraw Hill., New York, 1965
2. **Unit Operations of Chemical Engineering**, McCabe W.L., et.al., 5<sup>th</sup> edn., McGraw Hill, New York, 2000
1. **Unit Operations of Chemical Engineering**, Coulson J.M. and Richardson J.F., Vol-I, 5<sup>th</sup> edn. Chemical Engg, Pergamon & ELBS, McGraw Hill, New York, 2000

**REFERENCE BOOKS:**

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

<b>POLLUTION CONTROL &amp; INSTRUMENTAL ANALYSIS LABORATORY</b>				
<b>Subject Code</b>	:	15CHL58	<b>IA Marks</b>	: 20

<b>No. of Lecture Hrs/Week</b>	:	11 + 2P	<b>Exam Hours</b>	:	03
<b>Total No. of Lecture Hours</b>	:	42	<b>Exam Marks</b>	:	80
<b>Credits</b>	:	02			
<b>Course Objectives:</b>					
The Students will					
1. Experimentally verify the principles and working of instruments studied in theory.					
2. Carry out experiment and make observations for various parameters.					
3. Study and use various analytical instruments for analysis of various parameters.					
4. Evaluate the data and compare with reported literature.					
<b>Revised Bloom's Taxonomy Levels:</b> L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating					
The following experiments are to be carried out; the data are to be analyzed based on the theoretical aspects, and recorded with comments.					Blooms Level
1. Analysis of effluents for pH, alkalinity and turbidity					L4,L5
2. Determination of COD and BOD					L4,L5
3. Volatile, Fixed, Filterable and Dissolved solid analysis					L4,L5
4. Analysis by ion selective electrode (any two anions)					L4,L5
5. Measurement of particulate matter in Air					L4,L5
6. Measurement of SO <sub>2</sub> in air					L4,L5
7. Analysis of exhaust by Orsat apparatus					L4,L5
8. Analysis of flue gases by Gas chromatograph					L3,L4,L5
9. UV Spectrophotometer					L3,L4,L5
10. KF Auto titrator					L4,L5
11. Flame photometer					L4,L5
12. Turbidometer					L4,L5
13. Dissolved Oxygen measurement					L4,L5
14. Bomb calorimeter					L4,L5
15. Viscometer					L4,L5
16. Polarograph					L4,L5
17. Potentiometer titration					L4,L5
<b>Course outcomes:</b>					
After studying this course, students will be able to:					
1. Apply theoretical knowledge of various Analytical Instruments.					
2. Acquire practical knowledge of preparation of solutions, standardization and calibration of instruments.					
3. Know the use of skills in handling various analytical instruments.					
<b>Conduct of Practical Examination:</b>					
1. Minimum of 10 experiments are to be conducted and all 10 experiments are to be included for practical examination.					
2. Students are allowed to pick one experiment from the lot.					
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.					
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.					
<b>Graduate Attributes</b>					

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

**TEXT BOOKS:**

1. **Air Pollution Engineering Manual**, Wayne T. Davis, John Wiley & Sons, Inc., 2000.

**REFERENCE BOOKS:**

2. **Practical Waste Treatment and Disposal**, Dickinson, Applied Science publication, London.
3. **Pollution control in Process industries**, Mahajan, TMH, New Delhi.