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

SEMESTER V

PROCESS INDUSTRY MANAGEMENT (Common to CH & PC)					
Subject Code	:	15CH51	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	80
Credits	:	04			

Course Objectives: 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.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
Organization and Management: 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
Module 2 **Content**		
Personnel (Human Resource) Management: 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
Module 3 **Content**		
Entrepreneurship and Project Management: 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
Module 4 **Content**		

Operation Research: 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.
Module 5 **Content**		
Materials Management: Purchasing, make or buy decision, stores management, inventory control, spare parts management, value engineering. **Marketing:** Marketing research, marketing management, consumer behavior and market promotion.	10	L1, L2

Course outcomes: Students after completion of course are expected to

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.

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. T R Banga S C Sharma Industrial Organization and Engineering Economics Khanna Publications 24th Edition ISBN No. 81-7409-078-9
2. Dr. Vilas Kulkarni &HardikBavishiEngineering Economics & Management:Vikas Publishing

REFERENCE BOOKS:

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.

MASS TRANSFER OPERATIONS-I (Common to CH & PC)

Subject Code	:	15CH52	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03

Total No. of Lecture Hours	:	50	**Exam Marks**	:	80
Credits	:	04			

Course Objectives:

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.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules		Teaching Hours	Bloom s Taxonomy
Module 1	**Content**		
Typesof diffusionin fluids.Typesofdiffusionin solid.Measurementand calculationsofdiffusivities. Masstransfercoefficientsandtheircorrelations.TheoriesofmassTransfer. Interphasemasstransfer. M**a**terialbalanceforco-current,cross-currentandcounter-current operations.Conceptofstages,cascadesoperation,NTUandHTU concepts.		10	L1,L2, L3
Module 2	**Content**		
Humidification: General theory,Psychrometricchart. Concepts in humidification, dehumidification.Designofcoolingtowers.		10	L2,L3, L4
Module 3	**Content**		
Drying: Introduction,Equilibria,Dryingratecurves.Mechanismofdrying,typesofdryers. Designofbatch andcontinuousdryers.		10	L3,L4, L5
Module 4	**Content**		
Adsorption: Theoriesofadsorption.Isotherms,Industrialadsorbents.Equipment,Batch &continuousmultistageadsorption.		10	L4,L5, L6
Module 5	**Content**		
Crystallization: Factorsgoverningnucleationandcrystalgrowthrates.Controlledgrowth of crystals.Incorporationofprinciplesintodesignofequipment.Differenttypesofcrystallizer equipment. **IntroductiontoNovelSeparations:**Ionexchange**,**Membraneprocesses-ReverseOsmosis, Dialysis,UltraandMicro-filtrations,Super-criticalfluidextraction.(Workingprinciplesand operationsonly)		10	L2,L3, L4

Course outcomes:

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.

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

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

TEXT BOOKS:

1. **MassTransferOperations**-RobertE Treybal,3rdEdition,McGrawHill,1981.
2. **UnitOperationsof ChemicalEngineering**-McCabe&Smith,6thEdition,McGrawHill, 2001.

REFERENCE BOOKS:

1. **Chemical Engineering VolI, II, IV and V** - Coulson and Richardson, 4thEdition, PergamonPress,1998.
2. **IntroductiontoChemicalEngineering**-Badger&Banchero,TMH6thReprint1998.
3. **Principlesof UnitOperations**-Foust*et.al.*,2ndEdition,JohnWiley,1994.
4. **TransportProcessesandUnitOperations**-GeankoplisCJ,PrenticeHall(I),2000.
5. **AppliedProcessDesignforChemicalandPetrochemicalPlant**Ludwig,2ndEdition,Gulf Publishing,2002.

CHEMICAL REACTION ENGINEERING-I (Common to CH & PC)

Subject Code	:	15CH53	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	80
Credits	:	04			

Course Objectives:

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.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules		Teaching Hours	Blooms Taxonomy
Module 1	**Content**		
Introduction: ScopeofChemicalReactionEngineering.Classificationofreactions.Rate equationandrateofreaction.Factorsaffecting rateofreaction.Chemicalkineticsand ThermodynamicsEquilibrium.Temperaturedependency ofrateconstantfromArrhenius, CollisionandTransitionstatetheories.Molecularityandorderofreaction. **Non-ElementaryReactions:**Differencebetweenelementaryandnon-elementaryreactions. Kineticmodelsandmechanismsfornon-elementaryreactions.Typesofreactors.		10	L1,L2,L3
Module 2	**Content**		
HomogeneousReactions: Interpretationofbatchreactordata.Constant&VariableVolume batchreactor.Analysis:Differentialmethod,Integralmethod,half-lifemethod.Methodof excessandmethodofisolation(ForReversibleandIrreversible reactionsuptosecondorder). Autocatalyticreactions.		10	L2,L3,L4
Module 3	**Content**		
DesignOfIdealReactors: Conceptofideality.Developmentofdesignequationsforbatch, tubularandstirredtankreactorsforbothconstantandvariablevolumereactions.Evaluationof rateequationsfromdataobtainedinthesereactors. Numerical Problems.		10	L3,L4,L5
Module 4	**Content**		
ComparisonOfIdeal Reactors: Generalgraphicalcomparison. **MultipleReactorSystems:**Plugflowand/orMixedflowreactorsinSeries,parallelandseries parallel.Reactorsofdifferenttypesandsizesinseries. **DesignofReactorsforMultipleReactions:**DesignofBatchreactor,PlugandMixedflow reactorsforParallel,SeriesandSeries-Parallelreactions(Onlyirreversiblereactionsmustbe considered).		10	L4,L5,L6
Module 5	**Content**		

Non-IsothermalReactors: Introduction,effectoftemperatureonequilibrium constant andheat ofreaction,MaterialandEnergybalances,conversionsinadiabaticandnon-adiabaticreactors. **AnalysisofNonIsothermalReactor:**Designprocedure (Forsingle/simplereactionsonly). OptimumtemperatureProgression.	10	L3,L4,L5

Course outcomes:

After studying this course, students will be able to:

1. Apply theoretical knowledge for interpretation of experimental data.
2. Acquire practical knowledge of reactors.
3. Know the use of reactors, problems associated and modifications.

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.**ChemicalReactionEngineering,**OctaveLevenspiel,3rdedition,JohnWiley&Sons,2001.
2. **ElementsofChemicalReactionEngineering,**H.ScottFogler,3rdedition,PrenticeHall 2001.

REFERENCE BOOKS:

1. **ChemicalEngineeringKinetics,**J.M.Smith,3rdEdition,McGrawHill,1984.

CHEMICAL EQUIPMENT DESIGN (Common to CH & PC)					
Subject Code	:	15CH54	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	80
Credits	:	04			

Course Objectives:
Students will

1. Understand advances and types in the design of Chemical equipment and its accessories.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
Introduction: Basic considerations in design. General design procedure. Equipment classification. Variouscomponents ofprocess equipment.Designparameters.Pressure vessel codes. **DesignConsiderations**:Materialselection.Factorsaffectingdesign.Stressesduetostaticand dynamicloads(Internal&External).Temperatureeffects.Economicconsiderations. **DesignofPressureVessels:**Designparameters,conditions&stresses.Designofshell,andothe rvesselcomponents.Vesselatlow&highoperating temperatures.Designproblemsusing givenprocessparameters.	10	L1, L2, L3
Module 2 **Content**		
VesselComponentDesign: Designofsupportsforvessels-Bracket,Leg,Saddleand Skirtsupports. Designofflanges&nozzles,Classificationofflanges.Flangethickness calculation,Gasketselection,Boltselection,NozzleSelection. Design ofvesselclosures-Flatplates,Formedheads,Elliptical&Hemisphericalheads.	10	L2, L3, L5
Module 3 **Content**		
StorageVessels: Processconditionsanddesignparametersforstorageofvolatile,non-volatilefluids&gases.Designofcylindricaltankswithfixedroofs.Designofpartially filledspherical tanks.Designofcomponents, supports andselectionofvesselsaccessories&mountings. Numericalproblems.	10	L2, L3, L5
Module 4 **Content**		
ReactionVessels: Designof reactiontanks withagitationand jacket. Types of agitators,baffles. Powerrequirementcalculations.Designoftankdimensions andagitation systemcomponents. Drivecalculations&selectionofaccessories.Designofjackets.Support calculationsforthe system.Numericalproblems.	10	L1, L2, L3, L4
Module 5 **Content**		
Tall Vertical Vessels: Vessels subjected to various loads, Multi shell constructions. Determinationofshellthickness.Supportsforcolumns. **Pipe LineDesign:**Pipeline sizing,Condensateandsteam pipedesign,optimumsize of deliverylineinpumpingoperations.	10	L3, L4, L6

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 toalter 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. **ProcessEquipmentDesign**-M.V.Joshi,3rdEdn.,Macmillan&Co. India,Delhi,1998.
2. **ProcessEquipmentDesign–VesselDesign,**Brownell&Young,JohnWilley,1959.
3. **Process Design of Equipment – Vol1,** S. D. Dawande, 3rdEdn, Central Techno Publications.2003.

REFERENCE BOOKS:

1. **ChemicalEngineersHandbook,**Perry&Green,7thEdn,McGrawHill,1997.
2. **PressureVesselCode–IS2825,**ISCode,B.I.S.,NewDelhi,1969.
3. **Flowof FluidsthroughValves,Fittings&Pipes**,CraneAmazon,2006.

OILS AND FATS TECHNOLOGY					
Subject Code	:	15CH551	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

Course Objectives:

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.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
Introduction: Classificationoffatsandoil.Characteristicofoils. Utilizationoffatandoils. Compositionofoils(general). **Obtaining Oils and Fats from Source Materials:** Mechanical pretreatment. Mechanicalexpression.Solventextraction(twotypesofextractors).	8	L1, L2, L3
Module 2 **Content**		
ProcessTechniques: Refiningandhydrogenation(H_2productionandcatalyst). **ProcessTechniques(contd.):**Degumming.Alkalirefiningandbleaching.	8	L2, L3, L4
Module 3 **Content**		
Deodorization: Theoreticalconsiderationandoperationofcommercialdeodorizer. **Vegetable Oils:** Composition. Extraction. Refining processes and uses of coconut oil, cottonseedoil.	8	L2, L5, L6
Module 4 **Content**		
Vegetable Oils: Composition. Extraction. Refining processes and uses of coconut oil, cottonseedoil. **VegetableOils:**Refiningprocessesandusesofpalmoil,Soyabeenoil,peanutoil,sunfloweroil.	8	L3, L4, L6
Module 5 **Content**		
MarineOils: Composition.Extraction.Refiningprocessesandusesoffishoils.	8	L3, L4, L5

Course outcomes:

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, 2nd 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.

PETROLEUM REFINERY ENGINEERING					
Subject Code	:	15CH552	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

Course Objectives:

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 widespectrum of useful products such as petrochemicals, Chemicals, Plastics.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
Indian Petroleum Industry: Prospects &Future. Major companies. World production, Markets,Offshoreandonshore,Oilwelltechnology. **Compositionof Crude:**Classification.Evaluationofpetroleum.UOP-kfactor.TBP analysis. EFVanalysis.Averageboilingpoint.ASTMcurves.Thermalpropertiesof petroleumfractions. **ProductPropertiesandTestMethods:**Gas.VarioustypesofgasandLPG.Reid vapor pressureanalysis.Gasoline andnaptha.OctaneNo.Oxidation stability.Additives forgasoline. Kerosene.Characterizationforflashpointorfirepoint,volatility,burning qualitiesetc,Diesel, octanetesting,viscosity etc.Gradesofdieselse.g.HSD,LDO.Dieseladditives.Lubeoils:Types,tests-carbonresidueandviscosityindex.	8	L1, L2, L3
Module 2 **Content**		
CrudePretreatment: Pumpingof crude oils. Dehydrationof crude bychemical, gravity, centrifugal,electricalde-salterandcomparisonofeach.Heatingofcrude-heater, different typesofpipestillheatersincluding boxtype,cylindricaletc.Crudedistillation,arrangementof towersforvarioustypesofreflux.Designaspectsforatmospheric andvacuumcolumn. Atmosphericdistillationdistillationunit:internalsandoperational.	8	L1, L2, L3
Module 3 **Content**		
TreatmentTechniques: Typesofimpuritiespresentandvariousdesulfurisation processes. ProductionandtreatmentofLPG.LNGtechnology.Sweetening operationsforgasesincluding merox,ethanolamine,copperchloride,stertfordetc.Catalyticdesulphonisation. Treatmentof kerosene, De-aromatisationand merox. Treatment of diesel, naptha: desulpurisationby	8	L2, L3, L4

hydrogenandcatalysts.Treatmentoflubes:sulphuricacid,clay treatment,solventtreatment- phenol,furfura			
Module 4	**Content**		
ThermalProcesses: Thermalcrackingreactions-theoryofthermalcracking.Propertiesof crackedmaterials andfactorsinfluencingthe propertiesof crackedmaterials.Visbreaking, dubbstwocoil crackingprocess. **Catalytic Reforming:** Theory of reforming. Factors influencing reforming, reforming catalysts,feedstockrequirements.Plat-forming,isoplushondriforming,refiningforming,power formingandflexiformingetc.		8	L2, L3, L4
Module 5	**Content**		
CatalyticCracking: Comparisonofthermalandcatalyticcracking.Carbonium ionchemistry. Feedbackrequirements.Crackingconditions.Commercialcrackinganalysis.V ariouscatalytic crackingprocesses.Fixedbedcrackers.Moving bedcrackers.Fluidcatalyticcracking-flexi cracking-ortho-flow reactor.Theoryofcoking:varioustypesofcokingprocesses.Delayed coking,fluid coking,contactcoking,flexicoking. Napthacracking,napthacrackingfor ethylene asfeedselectionandgasyield.Hydrocracking.Theory ofhydrocracking.Catalystsforhydro cracking.		8	L2, L4, L5

Course outcomes:

After studying this course, students will be able to:

1. Introduce the petroleum refinery sector worldwide.
2. Develop knowledge of different refining processes
3. Develop knowledge of safety and pollution control in the refining industries.
4. To find the suitable refining technology for maximizing the yield.

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. **PetroleumRefineryEngineering**,Nelson,4th Edition,McGrawHill,14th Reprint,1982.
2. **Modern Petroleum Refining Processes,** BhaskaraRao, 3rd Edition, Oxford &IBH Publication,Reprint,1999.

REFERENCE BOOKS:

1. **PetroleumRefiningTechnology,**Ram Prasad,IEdition,KhannaPublishers,2000.
2. **Challengesin CrudeOil Evaluation,**NagnalJ.M.,Gate,McGrawHill, 1996.
3. **PetroleumProcessing,**BlandW.F.and DavidsonR.L.McGrawHill,1967.

PHARMACEUTICAL TECHNOLOGY					
Subject Code	:	15CH553	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

Course Objectives:

Students will

1. Learn formulations, tablet and capsule making.
2. Learn development, testing of cosmetics.
3. Learn manufacturing technology.
4. Learn patent intellectual property rights and regulatory affairs.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
ElectrophilicSubstitutionReaction: Preparationofcycloalkane.Bayer'sstraintheoryand orbitalpictureofanglestream. **ElectrophilicSubstitutionReactionMechanism&Application**:Dehydrogenationofalkylhalides. 1-2 elimination kinetics: E2 and E1mechanisms. Isotope effect. Dehydration of alcohols.Easeofdehydration.	8	L1, L2, L3
Module 2 **Content**		
Nucleophilic Addition Reaction: Mechanism. Important chemicals.Oxidation-Reductionreactions. Rheologyof FluidsinMixingand Blending.	8	L2, L3, L4
Module 3 **Content**		
Preparation: TestforpurityandmedicalusesofChlorobutal,Dimercopral,Glyceroltrinitrate.	8	L3, L4, L5
Module 4 **Content**		
Preparation: TestforpurityandmedicalusesofUrea,ethylenediaminedihydrate,vanillin, paraldehyde. **Preparation:**Testforpurityandmedicalusesoflacticacid,citricacid,salicylicacid,saccharinsodium	8	L3, L4, L6
Module 5 **Content**		
Preparation: Test forpurityandmedicalusesof Ethylborate,dimethylphthalate,aspirin.	8	L4, L5, L6

Course outcomes:

After studying this course, students will be able to:

1. Explain various formulations and formulate tablet and capsule.
2. Develop manufacturing technologies and apply for various cases.
3. Practice industrial safety and involve in patent intellectual property rights and regulatory

affairs.

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. **OrganicChemistry,**T.R.MorissonandR.Boyd,6th Edition,PrenticeHallofIndiaPvtLtd.,NewDelhi,1992.
2. **The Theory and Practice of Industrial Pharmacy,** Liberman, and Lachman, 3rd Edition, Lea &Febiger, Philedelphia, 1986.
3. **Pharmaceutical Product Development,** Jain N.K, CBS Publications and Distributions, New Delhi, 2006.

REFERENCE BOOKS:

1. **OrganicChemistryFundamentals,**I.L.Finar,2ndEdition,ELBS,PergemonPress,1965.
2. **Good Manufacturing of Pharmaceuticals,**Sidnay H. Willing, Murray M. Tuckerman, and Williams Hitchings, 3rd Edition, Marcell Dekker Inc., NY, 1982.

POLYMER TECHNOLOGY					
Subject Code	:	15CH554	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

Course Objectives:

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 structureprocessingproperties relationships for polymers and blends.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
PrinciplesofProcessingofPolymers: Meltprocessing ofthermoplastics.Classificationof processes.Thermosetplasticsprocessing,crystallization,orientation &shrinkage, copolymers blendings,compounding forengineeringapplication,stress–strainbehavior,WLFequation, practicalassessmentforlongtermbehavior.	8	L1,L2, L3
Module 2 **Content**		
PolymerExtrusion:RequirementsofPolymerforextrusion.Singlescrewanddoublescrewplasticatingextruderzonesinextrusion, breakerplates,extruderscrew,powercalculation.PVC extruder.Dieandcalibrationequipmentprimemoverforextrusion, coextrusion, extrusion coating,extrusionfilmblowing reactiveextrusion.ExtrusionblowmouldingforPETbottles, wiredrawing-PVC, spinning–varioustypesandapplications.Applicationofvariousextruded products.Rheologicalaspectsofextrusionandextrusiondefects.Operationalandmaintenance ofextrusionequipment,pultrusion.	8	L2,L3, L5
Module 3 **Content**		
Injection Moulding: Polymer characteristics for injection moulding. Reciprocating screwinjectionmoulding.Singleimpressionmould.Multiimpressionmoulds.Coolingrequirements inmoulds.Hotrunner moulds,gate,mouldclampingforce calculations. Controlofpressure, temperatureandtimeofinjectionthermostatandfiberreinforced polymerinjectionmoulding, sandwichmouldingandinjectionblowmoulding. Rheologicalaspectsanddefectsofinjection. Comparisonofinjectionmouldingandextrusion ofinjection.Operationalandmaintenanceof	8	L2,L3, L4

injectionmouldingequipment.Reactioninjectionmoulding.Applications.			
Module 4	**Content**		
Compression Moulding: Applications. Principles. Comparison with other processing methods.Derivationofcompressionmouldthicknessorcompactionforce.Transfer moulding. **Calendering**: Characteristics of polymer for calendering. Principles and operation of calendaring.Derivationoffilmthickness andpressurerequiredforrollers.Guagecontrolduring calendaring.ApplicationofPVCcalenderedproducts.		8	L3,L4, L5
Module 5	**Content**		
Thermoforming: Basic principles. Vacuum forming. Pressure forming. Description ofoperations.Productdesign.Application.Derivationofthermoformedproductthickness. **RotationalMoulding:**Principles.Operation&applications.Thickness.Coolingcalculations. **TestingofPlastics:**Thermal,electrical,optical,mechanicalpropertiestesting.		8	L2,L4, L5, L6

Course outcomes:

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.

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. **Principlesof PolymerProcessing,**MortonJohneschapman,Hall1989.
2. **PlasticEngineering,**R.J.Crawford,3rdEditionResearchStudies,1996.

REFERENCE BOOKS:

1. **Principlesof PolymerEngineering,**N.G.McCrum,Vol.1,C.P.BuckleyOxfordUniversity Press,1988.
2. **PolymerMaterials–**Vols.1,2&3,ManasChanda,Springer,UnivPress,1997.

PROCESS WASTE WATER MANAGEMENT					
Subject Code	:	15CH561	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

Course Objectives:

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.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules		Teaching Hours	Blooms Taxonomy
Module 1	**Content**		
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
Module 2	**Content**		
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
Module 3	**Content**		
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
Module 4	**Content**		
Design of complete treatment systems & disposal for industries: Distillery, diary, 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-		8	L4, L5, L6

Remediation of contaminated soils.			
Module 5	**Content**		
Environmental Auditing: Cost of Pollution, Environmental audit solutions, Financial and Managerial opportunities. Criminal and Regulatory liabilities.		8	L4, L5, L6

Course outcomes:

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.

PROCESS AIR POLLUTION & CONTROL					
Subject Code	:	15CH562	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

Course Objectives:

The students will

1. Understand knowledge on the principles and design of control of indoor/ particulate / gaseousair pollutant and its emerging trends.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
INTRODUCTION: 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
Module 2 **Content**		
AIR POLLUTION MONITORING AND MODELLING: 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
Module 3 **Content**		

CONTROL OF PARTICULATE CONTAMINANTS: 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
Module 4 **Content**		
CONTROL OF GASEOUS CONTAMINANTS: Control Equipments, Factors affecting Selection of Control Equipment - 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.	8	L1, L2, L5, L6
Module 5 **Content**		
AUTOMOBILE AND NOISE POLLUTION: 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

Course outcomes:

After studying this course, students will be able to:

1. Apply sampling techniques
2. Suggest suitable air pollution prevention Equipments andtechniques for various gaseous and particulate pollutants.

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. **Air Pollution Control Engineering,** Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, Tokyo, 2004.
2. **Air Pollution Control Engg,** Noel de Nevers, Mc.Graw Hill, New York, 1995.
3. **Air Pollution**, David H.F. Liu, Bela G. Liptak, Lewis Publishers, 2000.

REFERENCE BOOKS:

1. **Air Pollution & Control Technologies,**Anjaneyulu. Y, Allied Publishers (P) Ltd. India, 2002.
2. **Air Pollution** (Vol.I – Vol.VIII), Arthur C.Stern, Academic Press, 2006.
3. **Air Pollution Engineering Manual**, Wayne T.Davis, John Wiley & Sons, Inc., 2000.
4. **Fundamentals of Air Pollution**, Daniel Vallero, Fourth Edition, 2008.

SOLID WASTE MANAGEMENT IN PROCESS INDUSTRIES					
Subject Code	:	15CH563	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

Course Objectives:

The students will

1. Understand solid waste management from an environmental public health perspective.
2. Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules		Teaching Hours	Blooms Taxonomy
Module 1	**Content**		
Introduction: Definition,characteristicsandperspectivesofsolidwaste.Typesofsolidwaste. Physicalandchemicalcharacteristics.Variationofcompositionandcharacteristics.Municipal, industrial,specialandhazardouswastes. **GeneralAspects:**Overviewofmaterialflowinsociety.Reductioninrawmaterialusage. Reductioninsolidwastegeneration. Reuseandmaterialrecovery.Generaleffectsonhealthand environment.Legislations.		8	L1, L2, L3
Module 2	**Content**		
EngineeredSystems: Typicalgenerationrates.Estimationandfactorseffectinggeneration rates.Onsitehandling.Storageandprocessing.Collectionsystemsanddevices.Transferand transport.		8	L2, L3, L4
Module 3	**Content**		

Processing Techniques: Mechanicalvolumereduction.Thermalvolumereduction. Componentseparation.Land fillingandlandforming.Deepwellinjection.	8	L2, L3, L4
Module 4 **Content**		
MaterialRecovery: Mechanicalsizealteration.Electromagneticseparation.Drying and dewatering. Other material recoverysystems. Recovery of biological conversion products. Recoveryofthermalconversionproducts. **EnergyRecovery:**Energyrecoverysystemsandefficiencyfactors.Determinationofoutputandefficiency.Detailsofenergyrecoverysystems.Combustionincinerationandheatrecovery. Gasificationandpyrolysis.Refusederivedfuels(RDF).	8	L2, L3, L4
Module 5 **Content**		
HazardousWastes: Classification.Originandreductionatsource.Collectionandhandling. Managementissuesand planningmethods.EnvironmentalActs. **Case Studies:**Major industries andmanagementmethods usedintypical industries– Coalfiredpowerstations,textileindustry,oilrefinery,distillery,sugarindustry,andradioactive waste generationunits.	8	L2, L3, L4, L6

Course outcomes:

After studying this course, students will be able to:

1. Have the working knowledge of all unit operations involved in solid waste management.
2. Will be familiar with design and policy considerations regarding alternatives for solid waste management.

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. **IntegratedSolidWasteManagement,**GeorgeTchobanoglousetal,2nd Edition,McGrawHill&Co,1993.
2. **IndustrialSolidWasteManagementandLandFillingPractice,**Duttaetal,NarosaPublishingHouse,1999.

REFERENCE BOOKS:

1. **WasteTreatmentPlants,**SastryC.A.*et al*,NarosaPublishingHouse,1995.
2. **HazardousWasteManagement**,Lagrega,McGrawHill,1994

PROCESS SAFETY AND ENVIRONMENTAL MANAGEMENT					
Subject Code	:	15CH564	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

Course Objectives:

The students will

1. Understand and recognize hazardous conditions and practices affecting people, property and the environment.
2. Understand the importance of plant safety and safety regulations, different types of plant hazards and theircontrol, personal protective equipment, principles and procedures of safety audit.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules		Teaching Hours	Blooms Taxonomy
Module 1	**Content**		
Hazard identification methodologies,risk assessment methods-PHA,HAZOP,MCA, ETA, FTA. Consequence analysis, Probit Analysis. Hazards in work places. Workers' exposures tohazardouschemicals.Hazardsinindustries.		8	L1, L2, L3
Module 2	**Content**		
Guidelines for safeguarding personnel. Safety education and training-Safetymanagements, fundamentalsofsafetytenets. Measuring safety performance, motivating safety performance, legal aspects of industrialsafety,safetyaudits.		8	L2, L3, L4
Module 3	**Content**		
Introduction and need for impact assessment. Legislation and pollution control acts andRegulations.Methodologies-collectionofdataand analysis,costbenefitanalysis.		8	L2, L3, L4
Module 4	**Content**		
ApplicationsofImpactassessmentmethodsinspecificdevelopedprojects,advantagesand disadvantagesofdifferentmethods. Applicabilityofspecificmethodswithexamples.		8	L2, L3, L4
Module 5	**Content**		

CleantechnologyOption:Cleantechnologyandcleanuptechnology,materialreuse,wastereductionat sourceand cleansynthesis.	8	L2, L3, L4, L6

Course outcomes:

After studying this course, students will be able to:

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.
2. Recognize that the practice of safety requires ongoing learning, and undertake appropriate activities to address this need.

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. Research Skill

TEXT BOOKS:

1.**Losspreventioninprocessindustries,**F.P.Lees,2nd Edition,Butterworth-Heinemann,1996.
2.**EIA,TheoryandPractice**,PeterWathern,UnwinHymanLtd.,1988.

REFERENCE BOOKS:

1. **Environmental Healthand Safety Auditing Handbook,** Lee Harrison, 2nd Edition, McGrawHill, Inc.,NewYork,1994.

ESSENTIALS OF NCC					
Subject Code	:	15 NC565	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	03	**Exam Hours**	:	03
Total No. of Lecture Hours	:	40	**Exam Marks**	:	80
Credits	:	03			

SYLLABUS COMMON FOR ALL BRANCHES OF ENGINEERING.

HEAT TRANSFER LABORATORY					
Subject Code	:	15CHL57	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	1I + 2P	**Exam Hours**	:	03
Total No. of Lecture Hours	:	42	**Exam Marks**	:	80
Credits	:	02			

Course Objectives:

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.

Revised Bloom's Taxonomy Levels: 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 onthe 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

Course outcomes:

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.

Conduct of Practical Examination:

1. Minimum of 10 experiments are to be conducted andall 10experiments 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 procedurepart to be made zero.

Graduate Attributes

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., 5th edn., McGraw Hill, NewYork, 2000
1. **Unit Operations of Chemical Engineering,** Coulson J.M. and Richardson J.F., Vol-I, 5th edn.Chemical Engg, Perganon& ELBS, McGraw Hill, New York, 2000

REFERENCE BOOKS:

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

POLLUTION CONTROL &INSTRUMENTAL ANALYSIS LABORATORY					
Subject Code	:	15CHL58	**IA Marks**	:	20
No. of Lecture Hrs/Week	:	1I + 2P	**Exam Hours**	:	03
Total No. of Lecture Hours	:	42	**Exam Marks**	:	80
Credits	:	02			

Course Objectives:

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.

Revised Bloom's Taxonomy Levels: 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 onthe 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_2 in air	L4,L5
7. Analysis of exhaust be 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

Course outcomes:

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.

Conduct of Practical Examination:

1. Minimum of 10 experiments are to be conducted andall 10experiments 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 procedurepart to be made zero.

Graduate Attributes

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.