B. Tech. (Hons) in Chemical Engineering (Total Credits: 180)

20 additional credits are to be acquired for Honors.

Of the 20 additional credits to be acquired, 16 credits shall be earned by undergoing specified courses listed as pools with four courses each carrying 4 credits. The remaining 4 credits must be acquired through MOOCs, which shall be domain specific, each with 2 credits and with minimum duration of /12 weeks as recommended by board of studies.

The courses that are offered for B.Tech. (Hons) in Chemical Engineering are

Course Code	Course	L-T-P	Credit
Pool 1: Advanced Chemical Engineering			
CHE 611 H	Advanced heat transfer	3-1-0	4
CHE 612 H	Advanced separation technology	3-1-0	4
CHE 613 H	Advanced reaction engineering	3-1-0	4
CHE 614 H	Advanced process control	3-1-0	4
	MOOCs - I		2
	MOOCs - II		2

Course Code	Course	L-T-P	Credit
Pool 2: Pharmaceutical Technology			
CHE 621 H	Pharmaceutical Technology	3-1-0	4
CHE 622 H	Pharmaceutical Kinetics	3-1-0	4
CHE 623 H	Pharmaceutical Analysis	3-1-0	4
CHE 624 H	Pharmaceutical Biotechnology	3-1-0	4
	MOOCs - I		2
	MOOCs - II		2

Course Code	Course	L-T-P	Credit
Pool 3: Biochemical Engineering			
CHE 631 H	Biochemistry and Microbiology	3-1-0	4
CHE 632 H	Bioprocess Engineering	3-1-0	4
CHE 633 H	Bio Separation Technology	3-1-0	4
CHE 634 H	Bio Analytical Techniques	3-1-0	4
	MOOCs - I		2
	MOOCs - II		2

Course Code	Course	L-T-P	Credit
Pool 4: Industrial Safety			
CHE 641 H	Principles of Safety Management	3-1-0	4
CHE 642 H	Chemical Process Safety	3-1-0	4
CHE 643 H	Environmental Issues and Management	3-1-0	4
CHE 644 H	Hazard Identification and Risk Assessment	3-1-0	4
	MOOCs - I		2
	MOOCs - II		2

Advanced Heat Transfer

Course Code – Category: CHE 611 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam:3Hours					End Exam Marks:60

Prerequisites: Chemical process calculations, Heat transfer

Course Objectives:

- To identify solution methods for three modes of heat transfer by conduction, convection and radiation
- To familiarize the advanced concepts like multi-phase flow and reacting flow in heat transfer
- To understand various heat exchanger equipment and its effectiveness

Course Outcomes:

By the end of the course, student will be able to

1. Solve steady state and transient heat conduction problems
2. Compute heat transfer coefficients in forced and free convection conditions.
3. Explain heat transfer concepts to multiphase flows
4. Formulate material and energy balances for the reacting systems
5. Compute the heat exchange by radiation between surfaces and effectiveness of tubular heat exchangers

Unit-1: **9L +3T**

Introduction: Fundamental concepts and definitions, thermo-physical properties, modes of heat transfer

Heat Conduction: One dimensional heat conduction – Fins and Extended surfaces, Multidimensional conduction - Cartesian Coordinates and Orthogonal Curvilinear Coordinates, Transient Heat Conduction - Lumped Capacitance Method and Unidirectional Conduction

Learning Outcomes:

At the end of this unit, student will be able to

- Summarize the thermo-physical properties of fluid
- Implement one dimensional heat conduction to Fins and extended surfaces
- Solve transient heat conduction problems by lumped capacity methods

Unit-2: **9L +3T**

Convection: Governing Equations, Boundary Layers, forced convection, cross flow and other flow configurations, internal flow, free convection, Introduction to turbulence.

Learning Outcomes:

At the end of this unit, student will be able to

- Select suitable governing equations and their solution methods in convective heat transfer.
- Solve forced and free convection problems
- Illustrate the turbulent convection

Unit-3: **9L +3T**

Gas Liquid-Two phase flows: Pool boiling, forced convection boiling on external flow, two-phase flow in vertical and horizontal flow, Film condensation, forced convection condensation.

Multiphase Flows with Droplets and Particles: Introduction, Dispersed phase equations, carrier phase equations, packed bed flow in tubes.

Learning Outcomes:

At the end of this unit, student will be able to

- Illustrate the physical processes of boiling, condensation, and two-phase flows
- Identify the solution methods for two-phase flows in vertical and horizontal tubes
- Represent the dispersed and carrier phase equations.

Unit-4: **9L +3T**

Solidification and Melting: Thermodynamics of phase change, Governing equations, one-dimensional problems, phase change with convection, cylindrical geometry.
Chemically Reacting Flows: Introduction, Mixture properties, reaction rates, material balance for chemical reactors, energy balance of reacting flows, Gas solid reacting mixtures, Fluidized beds.

Learning Outcomes:

At the end of this unit, student will be able to

- Solve one-dimensional problems of melting and solidification
- Implement material and energy balances for reacting systems
- Explain sinking core model and progressive conversion model for gas-solid reacting mixtures.

Unit-5: **9L +3T**

Thermal Radiation: Block body radiation, surface properties, radiation between surfaces, two surface radiation, solar radiation and solar collectors.

Heat Exchangers: Introduction, Tubular Heat Exchangers, cross flow and shell and tube heaty exchangers, Effectiveness-NTU method, thermal response to transient temperature changes, condensers and boilers.

Learning Outcomes:

At the end of this unit, student will be able to

- Calculate the heat exchange by radiation between two surfaces
- Represent the types of heat exchangers
- Compute the effectiveness of the tubular heat exchangers

Text Books:

1. Greg F. Naterer, Advanced Heat Transfer, 2nd Ed., CRC Press, 2018
2. J. P. Holman, Heat Transfer,10th Ed., McGraw-Hill, 2010

Reference Books:

1. Yunus A. Cengel, YunusCengel, Heat transfer: a practical approach, 2nd Ed., McGraw-Hill Science, 2002
2. McCabe W.L., Smith J.C., Harriott P, Unit Operations in Chemical Engineering, 7th Ed., 2017

Advanced Separation Methods

Course Code – Category: CHE 612 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks:60

Prerequisites: Chemical process calculations, Mass Transfer Operations

Course Objectives:

- To learn the concepts of multicomponent distillation.
- To familiarize with membrane separations and membrane modules
- To learn the principle and technical concept of advanced separationprocesses.

Course Outcomes:

By the end of the course, student will be able to

1. Calculate the stage requirements for multicomponent distillation by shortcut methods
2. Select a suitable synthetic membrane preparation method and characterization method
3. Represent and illustrate different membrane process operations
4. Identify various sorption methods and mechanisms
5. Explain various other novel separation methods

Unit-1: **9L +3T**

Multicomponent Distillation: Introduction to column distillation and multicomponent distillations, shortcut methods for multicomponent distillation – Fenske equation, Underwood equation, Gilliland correlation

Learning Outcomes:

At the end of this unit, student will be able to

- Identify the importance of multicomponent distillation
- Apply shortcut methods for multicomponent distillation

Unit-2: **9L +3T**

Membrane Separations: Introduction to membrane separations, materials used for membrane preparation, preparation of synthetic membranes – phase inversion, immersion precipitation and composite membrane preparation, characteristics of membranes, transport through membranes.

Learning Outcomes:

At the end of this unit, student will be able to

- Represent a membrane separation process
- Choose a suitable membrane preparation method for synthetic membranes
- Summarize membrane characterization methods

Unit-3: **9L +3T**

Membrane processes: Pressure driven membrane processes – microfiltration, ultrafiltration and reverse osmosis, concentration driven membrane processes – gas separation, pervaporation, polarization phenomena and membrane modules.

Learning Outcomes:

At the end of this unit, student will be able to

- Illustrate pressure driven membrane processes and concentration driven processes
- Select suitable membrane modules for different processes.

Unit-4: **9L +3T**

Adsorption Techniques: Mechanism, Thermal-Swing Adsorption, Pressure-Swing Adsorption, Continuous, Countercurrent Adsorption Systems, Slurry Adsorption, Fixed-Bed Adsorption(Percolation), Simulated-Moving-Bed Systems, affinity chromatography and immunochromatography, types of equipment and commercial processes, recent advances.

Learning Outcomes:

At the end of this unit, student will be able to

- Describe the mechanisms of different adsorption methods
- Represent the chromatographic techniques using sorption
- Identify the different equipment for various adsorption methods

Unit-5: **9L +3T**

Other Novel separation Techniques: Supercritical fluid extraction, Reactive extraction, Zone melting, separation based on thermal diffusion, separation based on surface science, adductive crystallization, electrophoresis, dielectrophoresis and electro dialysis.

Learning Outcomes:

At the end of this unit, student will be able to

- Describe supercritical and reactive extraction methods
- Summarize separations based on thermal diffusion and surface science
- Comprehend Ionic separation techniques like electrophoresis and electro dialysis

Text Books:

1. Phillip C. Wankat, Separation Process Engineering,3rd Ed., Prentice Hall, 2012
2. Marcel Mulder, Basic priciples of Membrane Technology, 2nd Ed., Kluwer Academic Publishers, 1996

Reference Books:

1. Charles D Holland,Fundamentals of Multicomponent Distillation, McGraw-Hill Primis Custom Publishing,1997
2. Ronald W. Rousseau, Handbook of Separation Process Technology, John Wiley & Sons, Inc, 1987

Advanced Reaction Engineering

Course Code – Category: CHE 613 H - HONORS

L	T	P	E	O	Credits: 4
3	0	0	1	2	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks: 60

Prerequisites: Thermodynamics and Chemical Reaction Engineering

Course Objectives:

- To develop fundamental understanding of reaction engineering
- To design isothermal and non-isothermal reactors
- To analyze heterogeneous reactors

Course Outcomes:

By the end of the course, student will be able to

1. Design isothermal reactors
2. Analyze the rate data
3. Design non-isothermal reactors
4. Determine conversion for non-ideal rectors.
5. Apply the rate limiting step to derive the rate law.

UNIT I **9L + 3T**

Isothermal reactor design:

Batch reactors, continuous stirred tank reactors, tubular reactors, molar flow rate balance algorithm, mole balances on CSTRs, PFRs, PBRs and batch reactors, unsteady state operation of stirred reactors, semi batch reactors.

Learning Outcomes:

At the end of this unit, student will be able to

Derive the performance equations for various reactors

Calculate the exit concentrations for various reactors

UNIT II **9L + 3T**

Collection and analysis of rate data:

Determining the reaction order, integral method, differential method of analysis, non-linear regression, reaction rate data from differential reactors, experimental planning.

Learning Outcomes:

At the end of this unit, student will be able to

Analyze the batch reactor data by integral and differential methods

Analyze the rate data by non-linear regression

UNIT III **9L + 3T**

Non-isothermal reactor design:

Energy balance, steady state tubular reactor with heat exchange, CSTR with heat effects, multiple steady states, non-isothermal multiple chemical reactions, radial and axial variations in tubular reactor, unsteady state energy balance, energy balance on batch reactors.

Learning Outcomes:

At the end of this unit, student will be able to

Estimate multiple steady states

Derive steady and unsteady state energy balance equations for tubular reactors

UNIT IV **9L + 3T**

Non-ideal reactors:

Residence time distribution, measurement of the RTD, Characteristics of RTD, RTD in ideal reactors, PFR/CSTR series RTD, zero adjustable parameter models, some guidelines for developing models, tanks in series model, dispersion one parameter model, flow, reaction and dispersion, tanks in series model vs. dispersion models.

Learning Outcomes:

At the end of this unit, student will be able to

Measure the residence time distribution.

Develop tanks in series models and dispersion models.

UNIT V **9L + 3T**

Catalysis and catalytic reactors:

Catalysts, steps in catalytic reaction, synthesizing a rate law, mechanism and rate limiting step, heterogeneous data analysis for reactor design, reaction engineering in microelectronic fabrication, model discrimination, catalyst deactivation.

Learning Outcomes:

At the end of this unit, student will be able to

Identify the rate limiting step.

Analyse heterogeneous reaction system

TEXT BOOK:

1. H. Scott Fogler., *Elements of Chemical Reaction Engineering*, 5thedition., PHI Learning Private Ltd..

REFERNCES:

1. Levenspiel, O., *Chemical Reaction Engineering*, 3rd Edition, John Wiley and Sons.
2. J. M. Smith., *Chemical Engineering Kinetics*, 3rdedition.,Mc-Graw Hill, Inc.

Advanced Process Control

Course Code – Category: CHE 614 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks: 60

Prerequisites:

Course Objectives:

- To analyze the stability of a process
- To familiarize with advanced controllers and multivariate controls
- To provide basic knowledge in digital controllers

Course Outcomes:

By the end of the course, student will be able to

1. Predict the response of a system for various inputs
2. Determine the stability of a system
3. Apply the advanced control techniques
4. Analyze the process containing two or more interrelated process variables.
5. Apply digital controllers to the process

UNIT I **9L + 3T**

Review of Systems:

Review of first and higher order systems, closed and open loop response, Response to step, impulse and sinusoidal disturbances, Transient response, Block diagrams. .

Learning Outcomes:

At the end of this unit, student will be able to

Estimate the response of a system for different disturbances

Develop block diagram for control system

UNIT II **9L + 3T**

Stability Analysis:

Frequency response, design of control system, controller tuning, Zigler-Nichols and Cohen-Coon tuning methods, Bode and Nyquist stability criterion, Process identification.

Learning Outcomes:

At the end of this unit, student will be able to

Plot Bode diagrams

Analyse the stability of control system

UNIT III **9L + 3T**

Special Control Techniques:

Advanced control techniques, cascade, ratio, feed forward, adaptive control, Smith predictor, internal model control.

Learning Outcomes:

At the end of this unit, student will be able to

Identify the importance of advanced control techniques

UNIT IV **9L + 3T**

Multivariable Control Analysis:

Introduction to state-space methods, Control degrees of freedom analysis, Interaction, Bristol arrays, Niederlinski index - design of controllers, Tuning of multivariable controllers.

Learning Outcomes:

At the end of this unit, student will be able to

Design and tune multi variable controllers

UNIT V **9L + 3T**

Discrete Controllers:

Basic review of Z transforms, Response of discrete systems to various inputs, Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems, Design of digital controllers, Introduction to PLC and DCS.

Learning Outcomes:

At the end of this unit, student will be able to

Design digital controllers

Estimate the response of a discrete systems for different disturbances

TEXT BOOK:

1. D.E. Seborg, T.F. Edger, and D.A. Millichamp, 'Process Dynamics and Control', John Wiley and Sons, 2nd Edition, 2004.

REFERNCES:

1. D.R. Coughanour, 'Process Systems analysis and Control', McGraw-Hill, 2nd Edition, 1991.
2. W.L.Luyben, 'Process Modelling Simulation and Control for Chemical Engineers', McGraw Hill, 2nd Edition, 1990.
3. B.W. Bequette, 'Process Control: Modeling, Design and Simulation', PHI, 2006.
4. B.A.Ogunnaike and W.H.Ray, "Process Dynamics, Modelling and Control", Oxford Press, 1994.
5. S. Bhanot, 'Process Control: Principles and Applications', Oxford University Press, 2008.

PHARMACEUTICAL TECHNOLOGY

Course Code – Category: CHE 621 H - HONORS

L	T	P	E	O	
3	1	0	1	3	**Credits: 4**
					Sessional Marks: 40
End Exam: 3 Hours					**End Exam Marks: 60**

Prerequisites: NIL

Course Objectives:

1. To know about various forms of drug development
2. To get acquaintance with semi solid and pharmaceutical aerosols
3. To have knowledge on pilot plant techniques

Course Outcomes:

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

1. Formulate and develop tablets and capsules
2. Distinguish the process and equipment for monophasic and biphasic liquids
3. Describe the various production processes of Parenterals and Ophthalmic preparations
4. Differentiate the manufacturing processes and equipments for semi solids and pharmaceutical aerosols.
5. Analyse the pilot plant and scale up techniques

SYLLABUS

UNIT I **9L + 3T**

Formulation Development of Solid Dosage Forms:

Historical development of pharmaceutical industry, Advances in materials, process, equipment and production of tablets and hard and soft gelatin capsules.

Learning Outcomes:

At the end of this unit, student will be able to

- Describe the materials and equipments used in tablet production.
- Illustrate the production of tablets and capsules.

UNIT II **9L + 3T**

Formulation Development of Liquid Dosage Forms:

Advances in materials, process, equipment and formulation of monophasic liquid dosage forms and biphasic liquid dosage forms including multiple and micro emulsions.

Learning Outcomes:

At the end of this unit, student will be able to

- Describe the advances in materials and equipments used in liquid dosage form production.
- Illustrate the production of liquid dosage form.

UNIT III **9L + 3T**

Formulation Development of Sterile Dosage Forms:

Parenterals: Advances in materials and production techniques, filling machines, sterilizers, and layout for production of parenterals.

Ophthalmic preparations: Advances in materials and production techniques, filling machines and sterilizers for production of eye drops & eye Lotions.

Learning Outcomes:

At the end of this unit, student will be able to

- Enumerate the production of parenterals.
- Illustrate the production of eye drops & eye Lotions.

UNIT IV **9L + 3T**

Formulation Development of Semisolid Dosage Forms and Pharmaceutical Aerosols

Semi-solids: study of the principles, formulation, manufacturing process and equipment for semisolid dosage forms.

Pharmaceutical Aerosols: study of the pharmaceutical propellents, principles, formulation, manufacturing process and filling equipments for Aerosols.

Learning Outcomes:

At the end of this unit, student will be able to

- Enumerate the production of semisolid forms.
- Illustrate the production of aerosols.

UNIT V **9L + 3T**

Scale-Up Techniques Used In Pharmaceutical Manufacturing:

Pilot plant: Technology transfer from R&D to pilot plant to pilot scale considerations of steps involved with manufacture (design, facility, equipment selection) of tablets, capsules, suspensions, emulsions & semisolids.

Scale up: Importance, Scale up process-size reduction, mixing, blending, granulation, compression, coating involved in tablets, capsules & liquid-liquid mixing.

Learning Outcomes:

At the end of this unit, student will be able to

- Explain technology transfer from R&D to pilot plant for manufacture of pharmaceuticals.
- Apply scale up process to unit operation and unit process equipments.

Text books

1. Roop K. Khar, S. P. Vyas, Farhan J. Ahmad and Gaurav K. Jain,*Lachman / Lieberman'sThe Theory and Practice of Industrial Pharmacy*, 4th edition, 2013, CBS.

References

1. Tripathi K.D., *Pharmacological Classification of Drugs With Doses And Preparations*, 5th edition, 2014, Jaypee Brothers Medical publishers.

PHARMACEUITICAL KINETICS

Course Code – Category: CHE 622 H - HONORS

L	**T**	**P**	**Credits: 4**
3	**0**	**0**	**Sessional Marks: 40**
End Exam: 3 Hours			**End Exam Marks: 60**

Prerequisites: NIL.

Course Objectives:

- To provide knowledge on drug administration and parameters.
- To impart knowledge on intra and extra vascular routes of drug administration
- To impart knowledge on compartment models.

Course Outcomes:

By the end of the course, student will be able to

1. Describe pharmacokinetic model and sketches.
2. Describe the drug administration.
3. Develop pharmacokinetic one compartment models
4. Develop pharmacokinetic multi compartment models
5. Estimate nonlinear parameter

UNIT I **9L + 3T**

Introduction: Uses of drugs in disease states, definitions and descriptions, site of drug administration, review of ADME process, pharmaco kinetic model, rate process

Mathematical review: Introduction, hierarchy of algebraic operations, exponents and logarithms, variables, constants and parameters, units and their manipulation, slope rate and derivatives, slope, rate, time expressions, construction of pharmacokinetic sketches.

Learning Outcomes:

At the end of this unit, student will be able to

- Describe the drug administration and pharmacokinetic model
- Plot pharmacokinetics sketches.

UNIT II **9L + 3T**

Drug absorption from the gastrointestinal tract: Gastrointestinal tract, mechanism of drug absorption, factors affecting passive drug absorption, pH-partition theory of drug absorption

Extravascular routes of drug administration: Introduction, Drug remaining to be absorbed, or drug remaining at the site of administration, Determination of elimination half life (t1/2) and elimination rate constant (K or Kel), Absorption rate constant (Ka), Lag time (t0).

Learning Outcomes:

At the end of this unit, student will be able to

- Describe the drug absorption from the gastrointestinal tract
- Describe the extravascular routes of drug administration

UNIT III **9L + 3T**

Pharmacokinetics: Introduction to Pharmacokinetics models, Compartment models, Non compartment models, physiological models, One compartment open model. a. Intravenous Injection (Bolus) b. Intravenous infusion, extra vascular administrations, calculations of Ka, KE from plasma and urinary excretion data

Learning Outcomes:

At the end of this unit, student will be able to

- Develop compartment models
- Develop non Compartment models

UNIT IV **9L + 3T**

Multi-compartment models: Two compartment open model. IV bolus

Multiple – Dosage Regimens: a). Repetitive Intravenous injections – One Compartment Open Model b). Repetitive Extravascular dosing – One Compartment Open model

Learning Outcomes:

At the end of this unit, student will be able to

- Develop multi compartment models
- Develop multi dosage regimens Compartment models

UNIT V **9L + 3T**

Nonlinear Pharmacokinetics: a. Introduction, b. Factors causing Non-linearity. c. Michaelis-Menton method of estimating parameters, Biotransformation of drugs

Learning Outcomes:

At the end of this unit, student will be able to

- Describe biotransformation of drugs
- Estimate nonlinear parameters.

Text Books:

1. D. M. Brahmankar and Sunil B.Jaiswal "Bio pharmaceutics and Pharmacokinetics-A Treatise", Vallabh Prakashan Pitampura, Delhi.
2. Sunil S Jambhekar and Philip J Breen "Basic Pharmacokinetics", Pharmaceutical Press, Noida, India, 2009

Reference Books:

1. Pharmacokinetics: ByMilo Glbaldi Donald, R. Mercel Dekker Inc.

Pharmaceutical Analysis

Course Code – Category: CHE 623 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	3	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks: 60

Prerequisites: Pharmaceutical Technology

Course Objectives:

- To impart knowledge in the field of Pharmaceutical Analysis
- To get familiarized with modern analytical techniques.

Course Outcomes:

By the end of the course, student will be able to

1. Identify the suitable titration technique for the drug.
2. Apply electrochemical methods for analyzing the drugs.
3. Identify the spectroscopic technique for analyzing the bulk drug.
4. Apply suitable chromatographic technique in analyzing the drug.
5. Apply NMR technique to formulate bulk drugs.

UNIT I **9L + 3T**

Titrations: Acid base titration: Theories of acid base indicators, classification of acid base titrations and theory involved in titrations of strong, weak, and very weak acids and bases, neutralization curves. Non aqueous titration: Solvents, acidimetry and alkalimetry titration and estimation of Sodium benzoate and Ephedrine HCl. Precipitation titrations: Mohr'smethod, Volhard's, Modified Volhard's, Fajans method, estimation of sodium chloride. Complexometric titration: Classification, metal ion indicators, masking and demasking reagents, estimation of Magnesium sulphate, and calcium gluconate. Gravimetry: Principle and steps involved in gravimetric analysis. Purity of the precipitate: co-precipitation and post precipitation, Estimation of barium sulphate. Basic Principles, methods and application of diazotisation titration. Redox titrations: Concepts of oxidation and reduction, Types of redox titrations (Principles and applications) Cerimetry, Iodimetry, Iodometry, Bromatometry, Dichrometry, Titration with potassium iodate.

Learning Outcomes:

At the end of this unit, student will be able to

- Analyze the drug by titrometric anaalysis.
- Identify the principles and methods of various titrations.

UNIT II **9L + 3T**

Electrochemical methods of analysis: Conductometry: Introduction, Conductivity cell, Conductometric titrations, applications. Potentiometry: Electrochemical cell, construction and working of reference (Standard hydrogen, silver chloride electrode and calomel electrode) and indicator electrodes (metal electrodes and glass electrode), methods to determine end point of potentiometric titration and applications. Polarography: Principle, Ilkovic equation, construction and working of dropping mercury electrode and rotating platinum electrode, applications.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply conductometry technique to identify the drug.
- Apply potentiometry and polarography technique to identify the drug.

UNIT III **9L + 3T**

Spectroscopy: UV-Visible spectroscopy: Introduction, electromagnetic spectrum, absorbance laws and limitations, instrumentation-design and working principle, chromophore concept, auxochromes, Wood-Fisher rules for calculating absorption maximum, applications of UV-Visible spectroscopy. IR spectroscopy: Basic principles -Molecular vibrations, vibrational frequency, factors influencing vibrational frequencies, sampling techniques, instrumentation, interpretation of spectra, FT-IR, theory and applications. Mass Spectroscopy: Mass spectroscopy: Theory, ionization techniques: electron impact ionization, chemical ionization, field ionization, fast atom bombardment, plasma desorption, fragmentation process: types of fission, resolution, GC/MS, interpretation of spectra and applications for identification and structure determination.

Learning Outcomes:

At the end of this unit, student will be able to

- Analyze the compound by UV-Vis and IR spectroscopy techniques.
- Investigate the drug by using mass spectroscopy.

UNIT IV **9L + 3T**

Chromatography: Column Chromatography: Adsorption and partition, theory, preparation, procedure and methods of detection. Thin Layer Chromatography: Theory, preparation, procedures, detection of compounds. Paper Chromatography: Theory, different techniques employed, filter papers used, qualitative and quantitative detection. Counter –current extraction, solid phase extraction techniques, gel filtration**.** Gas chromatography: Introduction, fundamentals, instrumentation, columns: preparation and operation, detection, derivatization. HPLC: Basic parameters, Principles and instrumentation, solvents and columns used, Operational modes, detection and applications of HPLC. HPTLC: Theory and principle, instrumentation, elution techniques and pharmaceutical applications.

Learning Outcomes:

At the end of this unit, student will be able to

- Analyze the compound by Gas chromatography techniques..
- Investigate the drug by using HPLC.

UNIT V **9L + 3T**

NMR: Theory, instrumentation, chemical shift, shielding and deshielding effects, splitting of signals, spin-spin coupling, proton exchange reactions, coupling constant(J), nuclear overhauser effect (NOE), 13CNMR spectra and its applications, 2D-NMR, COSY and applications in pharmacy.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply NMR technique to analyze the drug.
- Identify the principles involved in NMR technique.

Text Books:

1. J. Mendham, RC Denney, JD Barnes and M. Thomas, "Vogel's Textbook of Quantitative Chemical Analysis", Pearson education, 7th impression, 2008.

Reference Books:

1. B. K. Sharma, "Instrumental Methods of Chemical Analysis", Goel publishing house, 24th edition, 2005.

2. Kenneth A. Connors, “A Textbook of Pharmaceutical Analysis”, Wiley publications, 3rd edition, 2011.

Pharmaceutical Biotechnology

Course Code – Category: CHE 624 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	3	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks: 60

Prerequisites: Pharmaceutical Technology and Biology

Course Objectives:

- To understand the required parameters for lead molecule identification and optimization.
- To introduce various analytical tools employed in industrial sector during preclinical trials.
- To highlight the various drug delivery systems and production of biologicals in pharmaceutical market.

Course Outcomes:

By the end of the course, student will be able to

6. Model the drug metabolism.
7. Relate the physiochemical properties, stereochemistry and drug action.
8. Synthesis drugs by combinatorial chemistry.
9. Design the drug and drug delivery systems
10. Identify biologically derived therapeutic products.

UNIT I **9L + 3T**

Drug metabolism: Biotransformation of drugs – Microsomal and non-microsomal mechanisms and the enzymes involved. Mode of excretion – Biliary/ fecal excretion, Factors affecting drug metabolism. Drug metabolism in fetus and new born. Models to study drug metabolism, Dose effect relationships, Adverse drug reactions – Toxic reactions, Allergic reactions, Idiosyncrasy, Acute poisoning and treatment.

Learning Outcomes:

At the end of this unit, student will be able to

- Analyze the modes of excretion.
- Relate the dose effects and adverse drug reactions.

UNIT II **9L + 3T**

QSAR AND drug design: Drug Action – physicochemical properties and stereochemistry of compound. Isosterism and bioisosterism – metabolite, antagonist and structural variations. Methods for variation – Fibonacci search, Topliss tree, Craigsplot, Simplex methods, and Cluster analysis. Hansch's Liner method, Free and Wilson methods, mixed approached principal component analysis.

Learning Outcomes:

At the end of this unit, student will be able to

- Analyze the drug action.
- Apply methods of variation.

UNIT III **9L + 3T**

Computer assisted Combinatorial design: Combinatorial chemistry – Introduction, Principles, methodology, purification and analytical tools in solid phase synthesis with case studies. Compound library, interactive graphics program – with examples.

Learning Outcomes:

At the end of this unit, student will be able to

- Design using combinatorial chemistry.
- Apply purification and analytical tools in solid phase synthesis.

UNIT IV **9L + 3T**

New Drug Regulation and Drug Delivery system: Rational drug design – phases of preclinical and clinical trials. Role of regulatory authorities, Drug delivery system – Basic concepts and Novel advances. Cell specific drug delivery, Brain specific drug targeting strategies and Pulmonary delivery systems.

Learning Outcomes:

At the end of this unit, student will be able to

- Analyze the clinical trails and the role of regulatory authorities.
- Design the drug delivery system.

UNIT V **9L + 3T**

Biological Products: Properties of biotechnology derived therapeutic products. Production of Human insulin, Interferons, somatotropin, human growth hormone, somatostatin. Gene Therapy, vaccines, Monoclonal Antibody Based Pharmaceuticals, Recombinant Human Deoxyribonuclease.

Learning Outcomes:

At the end of this unit, student will be able to

- Synthesize human insulin, human growth harmones.
- Synthesize vaccines and antibodies.

Text Books:

1. Gary Walsh, "Pharmaceutical Biotechnology-Concepts and Applications," Wiley,2007.

Reference Books:

1. K. D. Tripathi, "Essentials of Medical Pharmacology," 6th Edition, Jaypee publications, 2008.
2. D. J. A. Crommelin, Robert D. Sindela, "Pharmaceutical Biotechnology," 2nd Edition, 2004.

Biochemistry and Microbiology

Course Code – Category: CHE 631 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks: 60

Prerequisites:

Course Objectives:

- To study about the biomolecules and importance of biochemistry in the advanced level.
- To study the detailed structure and function of biomolecules like carbohydrates, amino acids, proteins, lipids and nucleic acids.
- To study the metabolism of fatty acids, DNA, RNA, and proteins.
- To understand microbial diversity
- To learn about culture media, isolation methods and preservation methods of microorganisms.

Course Outcomes:

By the end of the course, student will be able to

1. Determine the structure and functions of carbohydrates, amino acids and proteins.
2. Determine the structure and functions of Lipids and nucleic acids
3. Obtain knowledge in the metabolism and bioenergetic principles.
4. Identify the microbial diversity and their characteristics
5. Isolate and culture microorganisms

UNIT I **9L + 3T**

Carbohydrates: classification of carbohydrates, structure and properties of monosaccharides (ribose, glucose, fructose), disaccharides (maltose, lactose, sucrose) and polysaccharides (Starch, glycogen and cellulose). Amino acids and proteins: Classification and properties of amino acids and proteins, peptide bond, structural organization of proteins: primary, secondary, tertiary and quaternary structure of proteins. Biochemical function of proteins, denaturation of proteins. .

Learning Outcomes:

At the end of this unit, student will be able to

Identify the structure and properties of carbohydrates

Identify the structure of proteins

UNIT II **9L + 3T**

Lipids: Classification, structure and physiological functions of triglycerides, fatty acids, phospholipids, cerebrosides, gangliosides and cholesterol.

Nucleic Acids: Structure and properties of purines and pyrimidine bases, nucleosides, nucleotides. Structure of nucleic acids-DNA and RNA.

Learning Outcomes:

At the end of this unit, student will be able to

Identify the functions of lipids

Identify the structure and properties of nucleic acids

UNIT III **9L + 3T**

Metabolism of Carbohydrates and Proteins:

Carbohydrate metabolism - Glycolysis, Glucogenesis, Citric acid cycle and Glycogen metabolism. Protein metabolism - Urea cycle, degradation of amino acids.

Fatty Acid and Nucleic Acid Metabolism: Overview of Fatty Acid Metabolism - synthesis and degradation of fatty acids. Nucleotides - De novo and salvage pathways.

Learning Outcomes:

At the end of this unit, student will be able to

Describe the citric acid and urea cycles

Describe the fatty acid and nucleic acid metabolisms

UNIT IV **9L + 3T**

Introduction to Microbiology: Origin and evolution of microorganisms, nature and scope of microbiology, major characteristics of prokaryotes and Eukaryotes, structure and functioning of bacterial cell.

Classification of microorganisms: Major characteristics of microorganisms, concepts of Classification, classification methods, principles of nomenclature and identification, Modem trends in classification. General features and classification of some groups of microorganisms - Algae, Fungi, Chlamydiae, Rickettsiae, Mycoplasmas, Viruses and Protozoa, economic importance of Microorganisms.

Learning Outcomes:

At the end of this unit, student will be able to

Characterize the prokaryotes and eukaryotes

Classify the microorganisms and their functions

UNIT V **9L + 3T**

Methods in microbiology: Nutritional requirements, nutritional types of bacteria, Characteristics of culture medium, type of culture media and preparation of culture media, isolation of microorganisms - general and selective methods, isolation of bacteria in pure culture, enrichment - enrichment methods, staining techniques, culture characteristics, maintenance and preservation of cultures, culture collections.

Learning Outcomes:

At the end of this unit, student will be able to

Describe the characteristics, types and preparations of culture media

Identify the enrichment methods, maintenance and preservation of cultures.

TEXT BOOK:

1. Principles of Biochemistry- Lehninger, Nelson and Cox-CBS Publishers and distributors, Delhi.
2. A text book of Biochemistry by A.V.S.S. Rama Rao, UBS Publishers and Distributors Ltd, New Delhi, Chennai.
3. Microbiology by M. J. Pelczer, E. C. S. Chan, N. R. Kries. Tata McGrew Hill publications
4. Microbiology fundamentals and applications by S. S. Purohit. Agro botanical. Publications.

REFERNCES:

1. Fundamentals of Biochemistry-J.L.Jain,S.Chand and company Ltd. New Delhi.
2. Microbiology by Prescott, Harley, Klein. Mc Graw-Hill publications
3. General Microbiology by Roger Y. Stainer, Edward A. Adebery, John L. Ingraham. Published by Macmillan Press LTD.

Bioprocess Engineering

Course Code – Category: Category: CHE 632 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks: 60

Prerequisites:

Course Objectives:

- To introduce enzymes, enzymatic and microbial growth kinetics
- To introduce transport of materials in biological systems with respect to mass transfer and heat transfer
- To introduce different types of bio-reactors and special reactors like animal and plant cell reactors

To introduce immobilization and sterilization techniques.

Course Outcomes:

By the end of the course, student will be able to

1. Determine the enzyme activity, parameters affecting activity and enzyme immobilization
2. Gain knowledge in gas liquid mass transfer, determine the K_La and know inter particle and intra particle diffusion
3. Understand working and analysis of all types of rectors
4. Know thermal death kinetics and sterilization of air and medium.

UNIT I **9L + 3T**

Enzyme Kinetics: Classification and applications of enzymes, Effects on enzyme activity, MM kinetics, enzyme inhibition - types and kinetics, immobilization of enzymes and immobilized enzyme kinetics.

Learning Outcomes:

At the end of this unit, student will be able to

Estimate the activity of enzymes

Describe the enzyme inhabitations and immobilizations

UNIT II **9L + 3T**

Microbial growth kinetics: Batch growth curve, Monod kinetics, unstructured models, growth in continuous culture, structured models, product formation kinetics, cell immobilization.

Learning Outcomes:

At the end of this unit, student will be able to

Identify the batch growth curve

Estimate the product formation in a reactor

UNIT III **9L + 3T**

Transport Phenomena: Gas-liquid Mass transfer; Theoretical models for K_{La}, interfacial area and bubble oxygen transfer, gas-liquid mass transfer of components other than oxygen. Mass transfer into solid particles: External transfer, intraparticle diffusion. Heat transfer correlations.

Learning Outcomes:

At the end of this unit, student will be able to

Determine the mass transfer coefficients for gas liquid operations

Determine the mass transfer coefficients in solid operations

UNIT IV **9L + 3T**

Bioreactors: Review of various types of bioreactors used in the fermentation industry. Multiphase bioreactors: packed bed, bubble-column, fluidized bed and trickle-bed reactors. Alternate fermenters: new bioreactor configurations used in the fermentation technology. Animal and plant cell reactor technology.

Learning Outcomes:

At the end of this unit, student will be able to

Identify the importance of various bioreactors

UNIT V **9L + 3T**

Sterilization: Sterilization methods, thermal death kinetics, design criterion, probability of sterlization, batch and continuous sterilization, air sterilization, calculation filter thickness.

Learning Outcomes:

At the end of this unit, student will be able to

Describe the sterilization methods

TEXT BOOK:

1. Shuler, M. L and F. Kargi, Bioprocess Engineering: Basic concepts, 2nd ed., Prentice Hall India, New Delhi, 2003.

REFERNCES:

1. Lee, J. M., Biochemical Engineering (e Book), Prentice Hall, Englewood Cliffs, 2001.
2. Bailey, J. E., and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd edition, Mcgraw-Hill, New York, 1986.
3. Blanch, H. W., and D. S. Clark, Biochemical Engineering, Marcel Dekker, New York, 1996.
4. Swamy,A.V.N.,' Fundamentals of Biochemical Engineering' , BS publications, 2007

Bio Separation Technology

Course Code – Category: Category: CHE 633 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks: 60

Prerequisites:

Course Objectives:

- Understand the methods to obtain pure proteins, enzymes and in general about product development R &D
- Have depth knowledge and hands on experience on Downstream processes to produce commercial therapeutically important proteins.

Course Outcomes:

By the end of the course, student will be able to

1. Define advanced downstream processing methods for product recovery.
2. Describe the components of downstream equipment and to understand the requirements for successful operations.
3. Enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.

UNIT I **9L + 3T**

Downstream Processing In Biotechnology:

Role and importance of downstream processing in biotechnological processes – Problems and requirements of bio product purification – Economics of downstream processing in Biotechnology, cost-cutting strategies – Separation characteristics of proteins and enzymes – size, stability, properties – Flocculation and conditioning of broth – Process design criteria for various classes of bio products (high volume, low value products and low volume, high value products) – Upstream production methods affect downstream purification strategies.

Learning Outcomes:

At the end of this unit, student will be able to

Identify the problems and requirements of bio product purification

UNIT II **9L + 3T**

Cell disruption techniques and separation of insolubles:

Cell disruption methods for intracellular products – Physical, chemical, mechanical – Removal of insoluble, biomass and particulate debris separation techniques –Types of filtration - Centrifugal and cross – flow filtration – Types of filtration equipments – Centrifugation – Basic principles, design characteristics – Types of centrifuges and applications – Sedimentation.

Learning Outcomes:

At the end of this unit, student will be able to

Describe the cell disruption techniques
Identify the types of filtration equipments

UNIT III **9L + 3T**

Membrane Separations:

Theory, Design consideration and configuration of membrane separation processes – Reverse osmosis, microfiltration, ultra filtration, dialysis and pervaporation – Structure and characteristics of membranes – Membrane modules

Learning Outcomes:

At the end of this unit, student will be able to

Describe various membrane separation processes

Characterize the membranes and modules

UNIT IV **9L + 3T**

Enrichment operations:

Enrichment Operations – Extraction–equipment for extraction– Aqueous two-phase extraction process – Evaporators – Types of evaporators – Adsorption isotherms and techniques – Protein precipitation – Methods of precipitation

Learning Outcomes:

At the end of this unit, student will be able to

Describe extraction and adsorption techniques for enrichment operations

Describe evaporators and protein precipitation techniques for enrichment operations

UNIT V **9L + 3T**

Finishing Operations And Formulations:

Crystallization – Nucleation , growth – Types of crystallizers – Tank, scrapped surface, Oslo, Circulating-magma evaporator, Drying – Mechanism, methods and applications, Types of dryers – Tray, spray, rotary, belt – Freeze drying – Principle, process, applications

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Learning Outcomes:

At the end of this unit, student will be able to

Describe various types of crystallizers for finishing operations

Describe various types of dryers for formulations

TEXT BOOK:

1. Belter, P.A., Gussler, E.L. and Hu, W.S., "Bioseparation: Downstream Processing for Biotechnology", John Wiley and Sons,2011.

REFERNCES:

1. Forciniti, D., "Industrial Bioseparation: Principles & Practice", Blackwell,2008.
2. Ghosh, R., "Principles of Bioseparations Engineering", World Scientific Publishers,2006.
3. Ladisch, M.R., "Bioseparations Engineering: Principles, Practice, and Economics", John Wiley & Sons,2001.
4. Roger, H., "Bioseparations Science and Engineering", Oxford University Press,2006

Bio Analytical Techniques

Course Code – Category: Category: CHE 634 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam: 3 Hours					End Exam Marks: 60

Prerequisites:

Course Objectives:

- To have a fundamental knowledge about the Light spectrum, Absorption, NMR, Mass spectroscopy
- To acquire knowledge on the different chromatographic methods for separation of biological products.
- To Understand the methods to obtain pure proteins, enzymes and in general about product development R &D

Course Outcomes:

By the end of the course, student will be able to

1. Understand spectroscopy and the separation techniques used for biological products.
2. Quantify Bio molecules using spectroscopy methods
3. Purify enzymes and metabolites using Chromatography techniques
4. Gain knowledge in various assay techniques for qualitative and quantitative estimation of biomolecules

UNIT I **9L + 3T**

pH - pH titrations - Determination of pKa values - Buffers - Preparation - Buffer Action - Physiological buffers - potentiometric titration - centrifugal dialysis - lyophilization - Electrophoresis - Ultra filtration - Assay techniques for proteins, lipids, sugars, amino acids and nucleic acids

Learning Outcomes:

At the end of this unit, student will be able to

Identify the importance of pH

Estimate the concentrations using titration techniques

UNIT II **9L + 3T**

Microscopic Techniques

Light Microscopy; Fluorescence microscopy, Atomic force microscope, Electron microscope, Scanning electron microscopy, Transmission Electron microscope. Application of microscope in analyzing biological samples

Learning Outcomes:

At the end of this unit, student will be able to

Apply different microscopic techniques for analyzing biological samples

UNIT III **9L + 3T**

Gas liquid chromatography - High Pressure liquid chromatography - Equipment - Applications

Learning Outcomes:

At the end of this unit, student will be able to

Apply gas liquid chromatography and HPLC for analyzing the bio samples.

UNIT IV **9L + 3T**

Chromatographic Techniques - Affinity - Adsorption - paper - Thin layer - Column - Ion Exchange - Gel Chromatography - Applications

Learning Outcomes:

At the end of this unit, student will be able to

Apply different chromatography techniques for analyzing the bio samples.

UNIT V **9L + 3T**

Spectrophotometric Techniques - IR - UV - Visible - NMR - ESR - Optical density.

Learning Outcomes:

At the end of this unit, student will be able to

Apply different spectroscopy techniques for analyzing the bio samples.

TEXT BOOK:

1. "Instrumental methods of Chemical Analysis - Chatwal, G & Anand, S. Himalaya Publishing House, Bombay.

REFERNCES:

1. "Instrumental methods of Chemical Analysis - Sharma, B.K. Goel Publishing House, Meerut.
2. "Instrumental Methods Analysis - Willard, Merritt, Dean & Settle, CBS Publishers & Distributors, Delhi.

Principles of Safety Management

Course Code – Category: CHE 641 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam:3Hours					End Exam Marks:60

Prerequisites: Nil

Course Objectives:

- To understand safety and importance of safety in work place.
- To find the common industrial hazards and their control
- To familiarize the safety laws and legislations

Course Outcomes:

By the end of the course, student will be able to

1. Comprehend concept of safety and safety psychology.
2. Develop a functional knowledge of the various accident prevention methods.
3. Implement the good housekeeping methods
4. Find out electrical and Noise hazards and their safety measures
5. Summarize safety laws and rules

Unit I: 9L +3T

Concept of Safety and Safety Psychology: Definition and Nature of concept of safety, safety terminology, need for safety psychology, general psychological factors, behaviour-based safety, elements of safety programs

Learning Outcomes:

At the end of this unit, student will be able to

- Define and summarize concept of safety
- Analyse safety psychology and general psychological factors

Unit II: **9L +3T**

Accident Causation and Prevention and Safety Management: Theories and principles of Accident Prevention, The Concept of Management, Safety Management and its Responsibilities, Safety Education and Training and Employee Participation in Safety

Learning Outcomes:

At the end of this unit, student will be able to

- Identify the accident causation and its prevention
- Apply the safety management principles

Unit III: **9L +3T**

Plant siting and housekeeping techniques: Indian standards, plant layout and design, methods of good housekeeping, purpose and benefits of good lighting and effect on safety, purpose and effect of ventilation and types of ventilation.

Learning Outcomes:

At the end of this unit, student will be able to

- Identify importance of good plant layout and housekeeping
- Explain the benefits of lighting and ventilation

Unit IV: **9L +3T**

Common Industrial Hazards: Electrical Hazards and safety procedures, Noise and vibration, working at different levels and safety, Tools and safety, use of PPE, First Aid

Learning Outcomes:

At the end of this unit, student will be able to

- Identify the industrial hazards like electrical, noise and vibration
- Apply safety procedures for different hazards

Unit V: **9L +3T**

Safety Laws and Legislation: History of the Safety Movement and the Factories Act, the Act and Rules at a Glance, role of ILO in safety and health, Specific safety Laws.

Learning Outcomes:

At the end of this unit, student will be able to

- Comprehend safety acts and rules
- Summarize safety laws

Text Books:

1. Dr. K.U. Mistry, Fundamentals of Industrial Safety andHealth, Gajjar Graphics & Printers, 2008
2. D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011

Reference Books:

1. Phil Hughes and Ed Ferrett, Introduction to Health and Safety at Work, 3rd Ed., Butterworth-Heinemann, 2007.
2. Jeremy Stranks, The Health & Safety Handbook, Kogan Page Limited, 2006

Chemical Process Safety

Course Code – Category: CHE 642 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam:3Hours					End Exam Marks:60

Prerequisites: --

Course Objectives:

- To understand safety and importance of safety in work place.
- To find the common industrial hazards and their control
- To familiarize the safety laws and legislations

Course Outcomes:

By the end of the course, student will be able to

1. Comprehend safety in chemical industries
2. Indicate the toxicants and its limits, hazards and its evaluation
3. Formulate the different models for hazard representation
4. Implement the suitable fire preventive methods
5. Select a suitable relief system and calculate its size

Unit I: **9L +3T**

Safety in Chemical Industry: Need for safety in chemical industry, types of chemical industry, types of chemical hazards and control, storage hazards and control, process hazards and control, pollution hazards and control, safe transfer of chemicals.

Learning Outcomes:

At the end of this unit, student will be able to

- Define and summarize safety in chemical industry
- Analyse chemical, storage and process hazards

Unit II: **9L +3T**

Toxicology: Effect of Toxicants on Biological Organisms, Toxicological Studies, Dose versus Response, Models for Dose and Response Curves, Relative Toxicity, Threshold Limit Values, National Fire Protection Association (NFPA) Diamond.

Industrial Hygiene: Government Laws and Regulations, OSHA: Process Safety Management, EPA: Risk Management Plan, DHS: Chemical Facility Anti-Terrorism Standards (CFATS) Industrial Hygiene: Anticipation and Identification, Evaluation, Control.

Learning Outcomes:

At the end of this unit, student will be able to

- Asses the effect of toxicants on biological organisms.
- Differentiate process safety management and risk management plan
- Anticipation of hazards and their evaluation

Unit III: **9L +3T**

Source and dispersion Models: Introduction to Source Models, Flow of Liquid through Holes, and Pipes, Flow of Gases or Vapors through Holes and Pipes, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis, Parameters Affecting Dispersion.

Learning Outcomes:

At the end of this unit, student will be able to

- Represent different source models
- Explain the parameters affecting dispersion

Unit IV: **9L +3T**

Fires and Explosions: The Fire Triangle, Distinction between Fires and Explosions, Definitions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram, Ignition Energy, Autoignition, Auto-Oxidation, Adiabatic Compression, Ignition Sources, Sprays and Mists, Explosions

Concepts to Prevent Fires and Explosions: Inerting, Static Electricity and its Control, Explosion-Proof Equipment and Instruments, Ventilation, Sprinkler Systems, Miscellaneous Concepts for Preventing Fires and Explosions.

Learning Outcomes:

At the end of this unit, student will be able to

- Compare fires and explosions
- Represent the fire triangle and flammability diagram
- Choose suitable methods to prevent fires and explosions

Unit V: **9L +3T**

Introduction to Reliefs: Relief Concepts, Definitions, Location of Reliefs, Relief Types and Characteristics, Relief Scenarios, Data for Sizing Reliefs, Relief Systems.

Relief Sizing: Conventional Spring-Operated Reliefs in Liquid and in Vapor or Gas Services, Rupture Disc Reliefs in Liquid in Vapor or Gas Services, Two-Phase Flow during Runaway Reaction Relief, Pilot-Operated and Bucking-Pin Reliefs, Deflagration Venting for Dust and Vapor Explosions,

Learning Outcomes:

At the end of this unit, student will be able to

- Identify the reliefs and location of reliefs
- Represent the types of relief systems
- Compute the area for relief systems

Text Books:

1. Dr. K.U. Mistry, Fundamentals of Industrial Safety andHealth, Gajjar Graphics & Printers, 2008
2. D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011

Reference Books:

1. Phil Hughes and Ed Ferrett, Introduction to Health and Safety at Work, 3rd Ed., Butterworth-Heinemann, 2007.
2. Jeremy Stranks, The Health & Safety Handbook, Kogan Page Limited, 2006

Environmental Issues and Management

Course Code – Category: CHE 643 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam:3Hours					End Exam Marks:60

Prerequisites: --

Course Objectives:

- To understand air pollution effects and plan for control methodologies
- To Demonstrate knowledge and understanding of the methods that are used for the design of a water andwastewater treatment plant.
- To anticipate and avoid, minimize or offset the significant adverse biophysical, social and other relevanteffects of development proposals

Course Outcomes:

By the end of the course, student will be able to

1. Identify major air pollution sources and use proper control measures
2. Asses the water quality and select suitable treatment methodologies
3. Implement the different disposal methods for solid waste
4. Execute a suitable EIA method to produce an environmentally sound project
5. Indicate importance of environmental auditing and acts

Unit I: **9L +3T**

Air Pollution Management: Air Pollution – sources, effects and standards, Air pollution Measurement, Air quality monitoring, Air pollution control Technology and methods –particulate emission control, gaseous pollutants control, generalized approach for assessment of Air pollution Impact

Learning Outcomes:

At the end of this unit, student will be able to

- Identify the different air polluting agents and their measurement
- Select a suitable air pollution control methodologies for particulates and gaseous pollutants

Unit II: **9L +3T**

Water Pollution Management: Concept of water pollution, sources and standards, characteristic of waste water, methodology of waste water treatment – primary, secondary and tertiary treatment methods, Methodology for the assessment of Impacts on surface water environment

Learning Outcomes:

At the end of this unit, student will be able to

- Characterise the waste water and its requirements
- Choose various treatment techniques for waste water management

Unit III: **9L +3T**

Solid Waste Management: Sources, classification and composition of solid waste, waste minimization methods, waste transport and treatment facilities, solid waste disposal methods, methodology for the assessment of soiland ground water

Learning Outcomes:

At the end of this unit, student will be able to

- Identify solid waste and its sources, classify them
- Use proper transport and disposal methods for solid waste

Unit IV: **9L +3T**

EIA and Methodologies: Evolution of EIA, steps in EIA, Environment Impact Statement, environmental and natural resources planning and management, Screening in the EIA process, criteria for selection of EIA methodologies, EIA methods, cost/benefit analysis.

.

Learning Outcomes:

At the end of this unit, student will be able to

- Explain the concept of EIA
- Implement EIA methods for a proposal/project
- Demonstrate cost/benefit analysis with EIA

Unit V: **9L +3T**

Environmental Management and Legislation: Principles and requirements of ISO 14001 EMS, Environmentalauditing and Auditing of waste minimization.The Environmental Acts, Preparation of Environmental Impact assessment statement for various Industries.

Learning Outcomes:

At the end of this unit, student will be able to

- Explain the importance of EMS and Environmental audit
- Summarize environmental acts and legislation
- Formulate environmental audit reports and EIA assessment reports

Text Books:

1. C.S.Rao, Environmental Pollution and Control Engineering, 2nd ed., Wiley Eastern Ltd.,, India, 1993.
2. Y. Anjaneyulu and Valli Manickam, Environmental Impact Assessment Methodologies, 3rd Ed., B.S. Publication, 2011.

Reference Books:

1. S.P. Mahajan, Pollution Control in Processes Industries, Tata McGraw Hill Education Pvt. Ltd., 1985.
2. M.N.Rao, A.K.Datta, Waste water Treatment, 3rded., Oxford and IHB, 2008.
3. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw-Hill, New Delhi, 2009.

Hazard Identification and Risk Assessment

Course Code – Category: CHE 644 H - HONORS

L	T	P	E	O	Credits: 4
3	1	0	1	2	Sessional Marks: 40
End Exam:3Hours					End Exam Marks:60

Prerequisites: --

Course Objectives:

- To understand Loss and loss prevention techniques.
- To learn different hazard identification techniques
- To use different hazard and risk assessment methods

Course Outcomes:

By the end of the course, student will be able to

1. Identify major process hazards and loss prevention
2. Explain the management attitude and safety management systems
3. Implement the different hazard identification methods
4. Execute the various risk and hazard assessment methods
5. Select a suitable process designs for inherent safety

Unit I: **9L +3T**

Hazard, Loss and hazard control: Introduction, Industrial safety and loss trends, loss prevention, the incident process, major process hazards, causes of loss and trends of loss, Hazard monitoring, Risk perception, risk management, process hazard control

Learning Outcomes:

At the end of this unit, student will be able to

- Define and summarize loss and loss prevention
- Identify the causes of loss and trends of loss

Unit II: **9L +3T**

Economics and Management systems:cost of losses and cost of prevention, property insurance, management attitude and organization, safety management systems.

Learning Outcomes:

At the end of this unit, student will be able to

- Asses the cost of loss and cost of prevention.
- Represent the systems and procedures of management

Unit III: **9L +3T**

Hazard Identification: Safety audits, Management system audits, Hazard indices, hazard studies, What if? analysis, preliminary hazard analysis, Hazard and operability study, FMEA, process safety review systems, safety review systems.

Learning Outcomes:

At the end of this unit, student will be able to

- Illustrate safety audits and hazard studies
- Use HAZOP, FMEA and review systems for hazard identification

Unit IV: **9L +3T**

Hazard Assessment: Hazard analysis, Risk assessment, Review of probability theory, event data, Fault trees, Event trees, cause-consequence diagram, Qualitative Risk Analysis (QRA) and Layer of Protection Analysis (LOPA).

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Learning Outcomes:

At the end of this unit, student will be able to

- Understand probability of failure
- Represent fault tree and event tree diagrams
- Implement QRA and LOPA methods

Unit V: **9L +3T**

Safety Procedures and Design: process safety hierarchy, conceptual front-end design, inherently safer design, Unit processes, unit operations and equipment, particular chemicals, designs for process safety.

Learning Outcomes:

At the end of this unit, student will be able to

- Identify the safe process designs
- Illustrate the safety procedure for unit processes and unit operations.

Text Books:

1. D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011

2. Dr. Sam Mannan, Lee's Loss Prevention inthe Process Industries, Hazard Identification, Assessment and Control, Volume 1, 3rd Ed., Elsevier Butterworth-Heinemann, 2005

Reference Books:

1. Phil Hughes and Ed Ferrett, Introduction to Health and Safety at Work, 3rd Ed., Butterworth-Heinemann, 2007.
2. Jeremy Stranks, The Health & Safety Handbook, Kogan Page Limited, 2006