30.09.2022

III Semester

Transform Calculus, Fourier Series and Numerical Techniques			
Course Code	**21MAT 31**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives: The goal of the course Transform Calculus, Fourier series and Numerical techniques 21MAT 31 is

- To have an insight into solving ordinary differential equations by using Laplace transform techniques
- Learn to use the Fourier series to represent periodical physical phenomena in engineering analysis.
- To enable the students to study Fourier Transforms and concepts of infinite Fourier Sine and Cosine transforms and to learn the method of solving difference equations by the z-transform method.
- To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods

Teaching-Learning Process (General Instructions):

ThesearesampleStrategies,whichteacherscanusetoacceleratetheattainmentofthevariouscourse outcomes.

1. Inadditiontothetraditionallecturemethod,differenttypesofinnovativeteachingmethodsmay be adopted so that the delivered lessons shall develop students' theoretical and applied mathematicalskills.
2. StatetheneedforMathematicswithEngineeringStudiesandProvidereal-lifeexamples.
3. Supportandguidethestudentsforself–study.
4. Youwillalsoberesponsibleforassigninghomework,gradingassignmentsandquizzes,and documenting students'progress.
5. Encouragethestudentsforgrouplearningtoimprovetheircreativeandanalyticalskills.
6. Showshortrelatedvideolecturesinthefollowingways:
   - Asanintroductiontonewtopics(pre-lectureactivity).
   - As a revision of topics (post-lectureactivity).
   - As additional examples (post-lectureactivity).
   - Asanadditionalmaterialofchallengingtopics(pre-andpost-lectureactivity).
   - Asamodelsolutionforsomeexercises(post-lectureactivity).

Module-1: Laplace Transform

Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace's Transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of Periodic functions (statement only) and unit-step function – problems.

Inverse Laplace transforms definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) problems. Laplace transforms of derivatives, solution of differential equations. **(8 Hours)**

Self-study: Solution of simultaneous first-order differential equations.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2: Fourier Series

Introduction to infinite series, convergence and divergence. Periodic functions, Dirichlet's condition. Fourier series of periodic functions with period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis. **(8 Hours)**

Self-study: Convergence of series by D'Alembert's Ratio test and, Cauchy'sroot test.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3: Infinite Fourier Transforms and Z-Transforms

Infinite Fourier transforms definition, Fourier sine and cosine transforms. Inverse Fourier transforms, Inverse Fourier cosine and sine transforms. Problems.
Difference equations, z-transform-definition, Standard z-transforms, Damping and shifting rules, Problems. Inverse z-transform and applications to solve difference equations. **(8 Hours)**
Self Study: Initial value and final value theorems, problems.
(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Numerical Solution of Partial Differential Equations

Classifications of second-order partial differential equations, finite difference approximations to derivatives, Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank- Nicholson method, Solution of the Wave equation. Problems.
(8 Hours)
Self Study: Solution of Poisson equations using standard five-point formula.
(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5: Numerical Solution of Second-Order ODEs and Calculus of Variations

Second-order differential equations - Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae).
Calculus of Variations: Functionals, Euler's equation, Problems on extremals of functional. Geodesics on a plane, Variational problems. **(8 Hours)**
Self Study: Hanging chain problem
(RBT Levels: L1, L2 and L3)

Course outcomes: After successfully completing the course, the students will be able :

- To solve ordinary differential equations using Laplace transform.
- Demonstrate the Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- To use Fourier transforms to analyze problems involving continuous-time signals and to apply Z-Transform techniques to solve difference equations
- To solve mathematical models represented by initial or boundary value problems involving partial differential equations
- Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

First test at the end of 5th week of the semester

Second test at the end of the 10th week of the semester

Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

First assignment at the end of 4th week of the semester

Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

The question paper will have ten questions. Each question is set for 20 marks. Marks scored are proportionally reduced to 50 marks

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. **B.S.Grewal**:"HigherEngineeringMathematics",Khanna publishers,44thEd.2018
2. **E.Kreyszig**:"AdvancedEngineeringMathematics",JohnWiley&Sons,10thEd.(Reprint),2016.

Reference Books

1. **V.Ramana:**"HigherEngineeringMathematics"McGraw-HillEducation,11thEd.
2. **SrimantaPal&SubodhC.Bhunia:**"EngineeringMathematics"OxfordUniversityPress,3rdReprint, 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co.Newyork, Latested.
5. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc- Graw Hill Education(India) Pvt. Ltd2015.
6. **H.K.DassandEr.RajnishVerma:**"HigherEngineeringMathematics"S.ChandPublication(2014).
7. **JamesStewart:"**Calculus"Cengagepublications,7thedition,4thReprint2019.

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- http://www.bookstreet.in.
- VTU e-ShikshanaProgram
- VTU EDUSATProgram

Momentum Transfer			
Course Code	**21CH32**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- Understand concepts on nature of fluids, pressure concepts and measurement of pressure by various experimental methods and by mathematical relations and enhancement of problem-solving skills.
- Learn detailed explanation on types of fluids, stress and velocity relations, type of fluid flow and boundary layer relations.
- Understand relationship between pressure energy, kinetic energy, and potential energy using Bernoulli's equation with application to industrial problems.
- Understand clear concepts on Flow of incompressible fluids in conduits and thin layers and friction factor variations with velocity and friction losses using Bernoulli's Equations and they will be demonstrated experimentally.
- Study Flow of compressible fluids, Dimensional analysis, Dimensional homogeneity and various dimensionless numbers and their applications.
- Understand principles and working of various types of pumps, transportation and metering of fluids using various experimental techniques and applications to industry.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
2. Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding,and higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

FLUID STATICS AND ITS APPLICATIONS: Concept of unit operations, Concept of momentum transfer, Nature offluids and pressure concept, variation of pressure with height – hydrostatic equilibrium, Barometric equation, Measurement of fluid pressure –manometers, Continuous gravity decanter, Centrifugal decanter.

FLUID FLOW PHENOMENA: Type of fluids – shear stress and velocity gradient relation, Newtonian and non-Newtonian fluids, Viscosity of gases and liquids. Types of flow – laminar and turbulent flow, Reynold's stress, Eddyviscosity. Flow in boundary layers, Reynolds number, and Boundary layer separation and wake formation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

BASIC EQUATIONS OF FLUID FLOW: Average velocity, Mass velocity, Continuity equation, Euler and Bernoulli equationsModified equations for real fluids with correction factors, Pump work in Bernoulli equation, Angular momentumequation.

FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS: Laminar flow through circular and non-circularconduits, Hagen Poiseuille equation, Laminar flow of non-Newtonian liquids, turbulent flow in pipes and closedchannels.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS: Friction factor chart, friction from changes in velocity or direction, Form friction losses in Bernoulli equation, Flow of fluids in thin layers.

FLOW OF COMPRESSIBLE FLUIDS: Continuity equation, Concept of Mach number, Total energy balance, Velocity of sound, Ideal gas equations, Flow through variable-area conduits, Adiabatic frictional flow, Isothermal frictional flow (elementary treatment only).

Teaching-Learning	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual

Process	activity.

Module-4

TRANSPORTATION AND METERING OF FLUIDS: Pipes, Fittings and valves, Measurement of fluid and gas flow rates by venturi meter, orifice meter, rotameter and pitot tube, Elementary concept of target meter, vortex-shedding meters, turbine meters, positive displacement meters, magnetic meters, Coriolis meters and thermal meters, Flow through open channel-weirs and notches.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

PUMPS: Performance and Characteristics of pumps-positive displacement and centrifugal pumps, Fans, compressors, and blowers.

DIMENSIONAL ANALYSIS: Dimensional homogeneity, Rayleigh's, and Buckingham Π- methods, Significance of different dimensionless numbers, Elementary treatment of similitude between model and prototype.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend the concepts of fluid statics and applications to manometer and decanters
2. Explain types of fluids and flow and analyse the effect of temperature and pressure on viscosity of fluids
3. Derive and apply Bernoulli equation, angular momentum equation and Hagen-Poiseuille equation
4. Explain the concept of Mach number and derive the Bernoulli equation for compressible fluids
5. Explain construction and working principle of fluid flow, flow measuring instruments.
6. Apply principles of dimensional analysis and comprehend Dimensionless Nos., similarity between model and prototype

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after

Suggested Learning Resources:

Books

1. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition
2. K L Kumar, Engineering Fluid Mechanics, S. Chand Publishing, 2008
3. R. K. Bansal, A Textbook of Fluid Mechanics, Laxmi Publications (P) Ltd., New Delhi
4. Coulson J.H. and Richardson J.F., "Chemical Engineering", Vol-I, 5thedn., Asian Books (p) Ltd., New Delhi, 1998
5. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, New York, 1997

Momentum Transfer Lab.

Course objectives:

- To compare the results of analytical models introduced in lecture to the actual behaviour ofreal fluid flows.
- to discuss and practice standardmeasurement techniques of fluid mechanics and theirapplications.
- to analyse results and detailed discussions based on the results obtained.
- to work on small design projects.

Sl.NO	Experiments
1	Frictionincircular pipes.
2	Frictioninnon-circularpipes.
3	Frictioninhelical/spiralcoils.
4	Flowmeasurementusingventuri/orificemeters(incompressiblefluid).
5	LocalvelocitymeasurementusingPitot tube.
6	Flowover notches.
7	Hydrauliccoefficients–openorifice.
8	Packedbed.
9	Fluidizedbed.
10	Studyofcharacteristicsforcentrifugal,Positivedisplacementpump
11	Studyof variouspipefittingsandtheirequivalent lengths.
12	Compressiblefluidflow.
13	Reynoldsapparatus.
14	Unsteadyflows-EmptyingofTank
15	Bernoulli'sExperiment.

Note: Minimum 10 experiments are to be conducted

Course outcomes (Course Skill Set):

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

1. Identify different fluid flow measuring devices and fluid moving machinery.
2. Evaluate Coefficient of Discharge for various devices
3. Calculate losses and efficiency of pumps
4. Analyse and classify friction losses
5. Determine suitability of fluid measuring devices for different applications
6. Determine the dimensionless numbers and demonstrate applications of the same

Mechanical Operations			
Course Code	**21CH33**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- Study different properties of particulate solids, handling and mixing of solid particles.
- Study principles of comminution and different types of equipment for size reduction like crushers, grinders etc.
- Understand mechanical separation aspect such as screening, filtration, sedimentation, transportation of solids etc.
- Understand energy requirements in solids handling, agitation and mixing, solid conveying and storage.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

PARTICLE TECHNOLOGY: Particle shape, particle size, different ways of expression of particle size, shape factor, sphericity, particle size analysis, screens – ideal and actual screens, Differential and cumulative size analysis, effectiveness of screen, Specific surface of a mixture of particles, Number of particles in a mixture, standard screens, Industrial screening equipment, Motion of screen, Grizzly, Gyratory screen, Vibrating screen, Trommels.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

SIZE REDUCTION: Introduction – types of forces used for comminution, Criteria for comminution, Characteristics of comminated products, Laws of size reduction, Work Index, Energy utilization, methods of operating crushers – Free crushing, choke feeding, open circuit grinding, Closed circuit grinding, wet and dry grinding, Equipment for size reduction – Classification of size reduction equipment, equipment – Blake jaw crusher, Gyratory crusher, Smooth roll crusher, Toothed roll crusher, impactor, Ball mill, Critical speed of ball mill, Cutters – Knife cutter.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

FLOW OF FLUID PAST IMMERSED BODIES: Drag, Drag coefficient, Pressure drop – Kozeny-Carman equation, Blake-Plummer, Ergun equation, Fluidization, conditions for fluidization, Minimum fluidization velocity, Pneumatic conveying.

MOTION OF PARTICLES THROUGH FLUIDS: Mechanics of particle motion, Equation for one dimensional motion of particles through a fluid in gravitational and centrifugal field, Terminal velocity, drag coefficient, motion of spherical particles in Stoke's region, Newton's region, and Intermediate region, Criterion for settling regime, Hindered settling, Modification of equation for hindered settling, Centrifugal separators, Cyclones and Hydro cyclones.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

SEDIMENTATION: Batch settling test, Coe and Clevenger theory, Kynch theory, thickener design.

FILTRATION: Introduction, Classification of filtration, Cake filtration, Clarification, batch and continuous filtration, Pressure and vacuum filtration, Constant rate filtration and cake filtration, Characteristics of filter media, Industrial filters, Sand filter, Filter press, Leaf filter, Rotary drum filter, Centrifugal filtration – Suspended batch centrifuge, Filter aids, Application of filter aids, Principles of cake filtration.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

AGITATION AND MIXING: Application of agitation, Agitation equipment, Types of impellers – Propellers, Paddles and Turbines, Flow patterns in agitated vessels, Prevention of swirling, Standard turbine design, Power correlation and power calculation, mixing of solids, Types of mixers –, Muller mixers, Mixing index, Ribbon blender, Internal screw mixer.

SAMPLING, STORAGE AND CONVEYING OF SOLIDS: Sampling of solids, Storage of solids, Open and closed storage, Bulk and bin storage, Conveyors – Belt conveyers, Chain conveyor, Apron conveyor, Bucket conveyor, Screw conveyor.

MISCELLANEOUS SEPARATION: Magnetic separation, Electrostatic separation, Jigging, Heavy media separation, Froth floatation process.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. List different Standard Sieve Series, Equivalent Diameters and Screening equipment
2. Comprehend the forces and laws of size reduction and explain the working principle of size reduction equipment
3. Comprehend flow of fluids through solid beds and apply the same to filtration
4. List and summarize different sampling techniques and solids conveying machinery
5. Explain principle of size separation in Magnetic, Electrostatic, Froth Floatation techniques and size enlargement techniques

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

6. The question paper will have ten questions. Each question is set for 20 marks. Marks scorded shall be proportionally scaled down to 50 Marks
7. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
8. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 3rdedn. Tata McGraw Hill International Edition, Singapore, 1999
3. Coulson J.H. and Richardson J.F., "Coulson and Richardson's Chemical Engineering", Vol-II Particle Technology and Separation Process, 6thedn., Asian Books (p) Ltd., New Delhi, 1998
4. Brown G.G., et.al., "Unit Operations", 1st edn., CBS Publisher, New Delhi, 1995
5. Foust A.S., et.al., "Principles of Unit Operations", 3rd edn., John Wiley and Sons, New York, 1997

Mechanical Operations Lab.

Course objectives:

- To enable the students to develop a sound working knowledge on different types of crushing equipment and separation characteristics of different mechanical operation separators.
- Determine particle size distribution of particulate solid using sieve analysis
- Determine the effectiveness of screen using sieve analysis
- Determine particle size distribution of particulate solid using pipette analysis
- Determine particle size distribution of particulate solid using beaker decantation

Sl.NO	Experiments
1	Ballmill
2	Batchsedimentation
3	Freesettling
4	Dropweightcrusher
5	Screeneffectiveness
6	Sieveanalysis
7	Jawcrusher
8	Leaffilter

9	Airelutriation
10	Grindabilityindex
11	Gyratorycrusher
12	Frothfloatation
13	Plateandframefilter press
14	Cycloneseparator
15	BeakerDecantation

Note: Minimum 10 experiments are to be conducted

Course outcomes (Course Skill Set):

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

1. Determine Equivalent diameters of non-spherical particles, Specific surface area, No of particles by experimental and calculate using spread sheet
2. Discuss applications of size reduction equipment and determine Energy required for commination
3. Determine equivalent diameter for irregular shaped particles in sub sieve range
4. Comprehend applications of fluid - solid separations and determine separation efficiency
5. Design and determine diameter of continuous thickener using data from experimentation
6. Determine effectiveness of screen and grindability index

Chemical Process Calculations			
Course Code	**21CH34**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Learn basic laws about the behaviour of gases, liquids and solids and some basic mathematical tools.
- Understand systematic problem solving skills, enhance confidence, and generate careful work habits.
- Learn what material balances are, how to formulate and apply them, how to solve them.
- Learn what energy balances are, and how to apply them and finally, to learn how to deal with the complexity of big problems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

UNITS AND DIMENSIONS: Fundamental and derived units, Conversion, Dimensional consistency of equations, Dimensionless groups and constants, conversions of equations.

BASIC CHEMICAL CALCULATIONS: Concept of mole, mole fraction, Compositions of mixtures of solids, liquids and gases, Concept of Normality, Molarity, Molality, ppm, Ideal gas law calculations.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

MATERIAL BALANCE WITHOUT REACTION: General material balance equation for steady and unsteady state, Typical steady state material balances in distillation, absorption, extraction.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

MATERIAL BALANCE WITHOUT REACTION contd.: Drying, mixing and evaporation, Elementary treatment of material balances involving bypass, recycle and purging.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

STEADY STATE MATERIAL BALANCE WITH REACTION: Principles of Stoichiometry, Concept of limiting, excess reactants and inerts, fractional and percentage conversion, fractional yield and percentage yield, selectivity, related problems, Ultimate and proximate analysis of fuels, Calculations involving burning of solid, liquid and gaseous fuels, excess air, air-fuel ratio calculations.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

ENERGY BALANCE: General steady state energy balance equation, Thermo physics, Thermo chemistry and laws, Heat capacity, Enthalpy, Heat of formation, Heat of reaction, Heat of combustion and Calorific values. Heat of solution, Heat of mixing, Heat of crystallization, determination of ΔH_R at standard and elevated temperatures, Theoretical flame temperature and adiabatic flame temperature.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend the basic theories in stoichiometry and perform unit conversions and calculations
2. Apply knowledge of humidity for solving humidification problems
3. Solve numerical associated with the chemical engineering processes and calculations
4. Formulate and solve material and energy balance numerical
5. Formulate and solve material balance with chemical reactions problems
6. Compute conversion, yield, limiting reactant and selectivity for chemical reactions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored are proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Bhatt, B.L. and Vora, S.M., Stoichiometry (SI Units), Third Edition, 1996, Tata McGraw Hill Publishing Ltd., New Delhi, 1996.
2. Hougen, O.A., Waston, K.M. and Ragatz, R.A., Chemical Process Principles Part –I, Material and Energy Balances, Second Edition, CBS publishers and distributors, New Delhi, 1995.
3. Himmelblau, D.M., Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall Of India, New Delhi, 1997.
4. Richard M. Felder and Ronald W. Rousseau, Elementary Principles of Chemical Processes, John Wiley & Sons, 3rd Edition, 2005.

Technical Chemistry Lab.			
Course Code	**21CHL35**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	3

Course objectives:

- Students are able to estimate the impurities present in water.
- Ability to select lubricants for various purposes.
- Ability to prepare advanced polymer materials.
- Ability to know the strength of an acid present in secondary batteries.
- Ability to find the presence of ions in unknown substances/ ores..

Sl.NO	Experiments
1	Critical Solution Temperature- Water – Phenol System.
2	Distribution Coefficients - Iodine in Water Chloroform.
3	Boiling Point Elevation -Water acetic acid solution.
4	Estimation of dissolved oxygen in given sample of water by Winkler's method.
5	Estimation of Iodine & Saponification number of vegetable oil .
6	Analysis of alloy- Stainless steel/ Brass.
7	Analysis of Bleaching Powder -Available chlorine.
8	Molecular weight determination -Victor Mayers Method
9	Freezing point depression- Ice-salt system.
10	Refractometric Estimation - Sugar content of solution.
11	Heats of mixing -Water –HCl system.
12	Conductometric estimation- Water hardness estimation.
13	Calorimetric Estimation – Potassium dichromate Estimation
14	Analysis of coal- Moisture Volatile matter & Ash content.
15	Study of kinetics of reaction between K2S2O8 and KI.
16	Study of kinetics of hydrolysis of ester.
17	Conductometric determination of equivalent conductance of acetic acid at infinite.
18	Dilution (using Kohlrausch Law).
19	Estimation of phenol by iodometric method.
20	Preparation of p-bromo acetanilide from acetanilide.
21	Colorimetric estimation of fluoride in water using SPADNS reagent.

Note: Minimum 10 experiments are to be conducted

Course outcomes (Course Skill Set):

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

1. Explain and perform analytics of quantitative estimation by volumetric method of metal and alloys, oil and proximate analysis of coal.
2. Determine disinfectant and water quality parameter analysis to assess the quality of water.
3. Analyse kinetics, partition co-efficient, transition temperature, percentage composition of binary mixture, critical solution temperature and molecular weight of chemical components.
4. Predict the organic reaction mechanism and to estimate functional groups employing different techniques.
5. Have knowledge of handling instruments for precise analysis.
6. Perform physico-chemical experiments.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE). Overall the students has to score average of 40% marks (out of 100) of CIE and SEE put together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in - 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. ArunBahl and Bahl B.S., "A text book of Organic Chemistry", 15thedn., Chand S. and Company, New Delhi, 1998
2. Morrison B.R. and Boyd L.L., "Organic Chemistry", 6thedn, ELBS, New Delhi, 1998
3. Tiwari Melhotra and Vishnoi, "Organic Chemistry", 7thedn., Chand S. and Company, New Delhi, 1996
4. Puri L.R. and Sharma B.R., "Physical Chemistry", 14th edn., Chand S. and Company, New Delhi, 1998
5. James Huheey, "Inorganic Chemistry", 19thedn. Wiley Publishers, New Delhi, 1997.

30.09.2022

Advanced Ms Excel for Chemical Engineers			
Course Code	**21CH381**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	2

Course objectives:

This course offers the students an insight into:

- All the tools necessary to create and use basic spread sheets.
- Overview of the interface and learn the various methods for entering and editing data.
- Will learn the various ways to write simple formulas.
- Apply spread sheet tools to solve chemical engineering

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Topics

Excel Basics: Spread sheet concepts and exploring the Microsoft Office Excel environment. Create, open and view a workbook. Save and print workbooks. Enter and edit data. Modify a worksheet and workbook. Work with cell references. Learn to use functions and formulas. Create and edit charts and graphics. Filter and sort table data. Work with pivot tables and charts. Import and export data. Using Excel Help

Advanced topics: Set up by formulas, Introduction to Logical functions, Solver, Goal Seek functionality. Generating One-way/two-way Data Table, histogram, and graphical representations.

Teaching-Learning Process	The teaching learning process should encourage and students to Experiential Learning by using free and open-source software, Discussion among the peer group, learning through analysis case studies, group projects, reflective learning, collaborative learning, and scaffolding technique.

Course outcomes (Course Skill Set)

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

1. Be comfortable navigating the Excel user interface, entering, manipulating and formatting data.
2. Use formulas and functions to perform calculations on data. Automate choices and data lookups using functions.
3. Analyse data and present the results in a user-friendly way. Create charts and tables that effectively summarize raw data.
4. Create easy-to-use spread sheets. Validate data, find and correct errors. Create navigation aids for large workbooks.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Examination:

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in - 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 02 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Books

1. Excel for Scientists and Engineers: Numerical Methods, E. Joseph Billo, Wiley Online Library, November 2006, ISBN:9780471387343
2. Excel for Engineers and Scientists, S. C. Bloch, Wiley, 2000, ISBN, 0471321699, 9780471321699.

30.09.2022

Understanding Equipment Datasheet			
Course Code	**21CH382**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	1

Course objectives:

- Give a better understanding of equipment design and operating principles
- Help order the right equipment
- Enables adherence to accurate specification standards

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Topics

- Process Flow Diagram
- Basics of Data Sheets and Specifications
- Types of data sheets (process datasheet, instrument data sheet, piping and instrumentation diagram, utility head diagram, product data sheet, material safety data sheet)
- Exercises on data sheets to capture information pertaining to process, mechanical, electrical, and control requirements for equipment and instruments.

Teaching-Learning Process	The teaching learning process should encourage and students to Experiential Learning by using free and open-source software / simulators, learning by doing, discussion among the peer group, learning through analysis case studies, group projects, reflective learning, collaborative learning, and scaffolding technique.

Course outcomes (Course Skill Set)

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

1. Ability to work in collaborative manner with others in a team.
2. Familiarize with different data specification sheets
3. Prepare the technical specification sheet
4. Understand the needs and applications of equipment data sheets.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 01 hour)**

1. The question paper will have 50 questionsof MCQ type of one mark each.

Suggested Learning Resources:

Books

1. Rules of Thumb for Chemical Engineers, Stephen Hall, Butterworth-Heinemann, Fifth Edition, 2012, ISBN 978-0-12-387785-7
2. Practice and Economics of Plant and Process Design By R. K. Sinnott
3. Chemical Engineering: Chemical Engineering Design-Vol.6, 5e, by R.K. Sinnott Gavin Towler

30.09.2022

Personality Development Skills			
Course Code	**21CH383**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	1

Course objectives:

- The course intends to develop talent, facilitate employability enabling the incumbent to excel and sustain in a highly competitive world.
- The programme aims to bring about personality development with regard to the different behavioural dimensions that have far reaching significance in the direction of organisational effectiveness.
- To make students aware the need of self-awareness, life skills, and soft skills, for personal development.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Topics

Introduction to Personality Development: Personality traits and theories, Self-Image and Self-Concept, Dressing Sense and Table Mannerisms, Diet, Exercise and Mental Health, Body Language.

Self-Grooming: Group Dynamics, Team Building, Time Management, Positive Attitude, Self-esteem, Self-confidence, Assertiveness, Motivation

Social and Corporate Etiquettes: Interpersonal Relations, Communication in organizations, Personal Branding, Leadership Skills, Presentation Skills, Personal skills- Stress Management, Negotiation skills, Conflict Management, Anger Management

Teaching-Learning Process	The teaching learning process should encourage and students to Experiential Learning by using free and open-source software, learning by doing, discussion among the peer group, learning through analysis case studies, group projects, reflective learning, collaborative learning, and scaffolding technique.

Course outcomes (Course Skill Set)

The student will be able to:

- Understand, analyse develop and exhibit accurate sense of self.
- Think critically.
- Demonstrate knowledge of personal beliefs and values and a commitment to continuing personal reflection and reassessment.
- Learn to balance confidence with humility and overcome problems associated with personality.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 01 hour)**

1. The question paper will have 50 questions of MCQ type of one mark each.

Suggested Learning Resources:

Books

1. Personality Development and Soft Skills by Mitra Barun, OUP India, 2012 ISBN: 9780199459742
2. Personality Development and Soft Skills: Preparing for Tomorrow by Shikha Kapoor ISBN: 9789389583090
3. Soft Skills Training: A Workbook to Develop Skills for Employment by Frederick H. Wentz ISBN 10:1468096494, ISBN 13:9781468096491

30.09.2022

Career Options After Engineering			
Course Code	**21CH384**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	1

Course objectives:

- The course aims at creating awareness of career opportunities in Chemical Engineering.
- Creating identifying career opportunities in view of climate change, global warming, depleting fossil fuels, green technologies, and eco-friendly and renewable sources of energy.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Students should be taught through case studies and role play about chemical engineering career options, roles and responsibilities and challenges as a:

- Biotechnologist
- Process and production engineer
- Colour technologist
- Energy Auditor
- Energy Engineer
- Environmental engineer
- Material Scientist
- Mining engineer
- Nuclear engineer
- Petroleum Engineer
- Product/process development Engineer
- Production manager
- Quality control engineer
- R & D Engineer
- Safety Specialist
- Waste management engineer
- Water and Effluent engineer
- Legal / Intellectual property specialist
- Future specialization studies

Teaching-Learning Process	The teaching learning process should encourage and students to Experiential Learning by using free and open-source software, learning by doing, discussion among the peer group, learning through analysis case studies, group projects, reflective learning, collaborative learning, and scaffolding technique.

Course outcomes (Course Skill Set)

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

1. Will be able to pursue wide range of job opportunities.
2. Will be able to acquire necessary skills and expertise to handle multiple work commitments while also possessing issue-resolving, decision-making, time management, and effective communication abilities.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 01 hour)**

1. The question paper will have 50 questions of MCQ type of one mark each.

Suggested Learning Resources:

Books

1. Study of Engineering and Career : A Career Guidance Hand Book for Engineering Students 1st Edition, by J Vinay Kumar ISBN-13 978-1642493061

IV Semester

Complex Analysis, Probability and Statistical Methods			
Module – 1			
Module – 2			
Module – 3			

Module – 4

Module – 5

Course Outcomes

ASSESSMENT PATTERN (BOTH CIE AND SIE)

30.09.2022

Process Heat Transfer			
Course Code	**21CH42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- Study various modes of Heat transfer and their fundamental relations
- Study conduction heat transfer and develop mathematical relations for various solid geometries.
- Understand properties of insulation and critical thickness of insulation
- Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
- Study the Boiling phenomenon and to generate pool boiling curve
- Understand the working of Heat exchangers and to learn design of double pipe, shell and tube heat exchangers and design of evaporators and conduct experiments and to submit the report
- Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

INTRODUCTION: Various modes of heat transfer Viz. Conduction, Convection and Radiation.
CONDUCTION: Fourier's law, Steady state unidirectional heat flow through single and multiphase layersslabs, cylinders, and spheres for constant and variable thermal conductivity.
INSULATION: Properties of insulation materials, Types of insulation, Critical and Optimum thickness.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

EXTENDED SURFACES: Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness, Elementary treatment of unsteady state heat conduction.
CONVECTION: Individual and overall heat transfer coefficient, LMTD, LMTD correction factor, Dimensionless numbers, Dimensional analysis, Empirical correlation for forced and natural convection.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

ANALOGY: Analogy between momentum and heat transfer- Reynolds, Colburn and Prandtl analogies.
HEAT TRANSFER WITH PHASE CHANGE: Boiling phenomena, Nucleate and Film boiling, Condensation - Film and Drop wise condensation.
HEAT TRANSFER EQUIPMENT: Double pipe heat exchangers, Shell and tube heat exchangers – Types of shell and tube heat exchangers, Construction details, Condenser, types of condensers

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

DESIGN OF HEAT TRANSFER EQUIPMENT: Elementary design of double pipe heat exchanger, shell and tube heat exchangers and condensers. Numerical Problems.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

EVAPORATORS: Types of evaporators, performance of tubular evaporator – Evaporator capacity, Evaporator economy, Multiple effect evaporator – Methods of feeding, effect of liquid head and boiling point elevation. **RADIATION:** Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation, Gray body radiation, Stefen – Boltzmann law, Wein's displacement law, Kirchhoff's law.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend basic laws of HT & derive steady state expression for determination of temperature distribution and heat conduction in different geometries
2. Determine critical thickness of insulation and efficiency of extended surfaces
3. Derive and determine LMTD, overall heat transfer coefficient & temperature distribution under unsteady-state heat conduction
4. Establish the analogy between momentum and heat transfer and describe pool boiling regimes.
5. Explain construction and working principle of heat exchangers and concepts of radiation
6. Comprehend significance of Dimensionless numbers in heat transfer coefficient calculation, HT equipment design and explain working principle of evaporators and apply principles of Dimensional Analysis

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

11. The question paper will have ten questions. Each question is set for 20 marks. Marks scorded shall be proportionally scaled down to 50 Marks
12. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
13. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Kern D.Q., "Process Heat Transfer", McGraw Hill., New York, 1965
2. McCabe W.L., et.al., "Unit Operations of Chemical Engineering", 5thedn., McGraw Hill, New York, 2000
3. Coulson J.M. and Richardson J.F., "Unit Operations of Chemical Engineering", Vol-I, 5thedn., Chemical Engg, Pergamon & ELBS, McGraw Hill, New York, 2000.
4. Rao Y.V.C., "Heat Transfer", 1stedn. Universities Press (India) Ltd., New Delhi, 2001.
5. Dutta, Binay K., "Heat Transfer: Principles and Applications", PHI Learning. 2000

Process Heat Transfer Lab.

Course objectives:

- Experimentally verify the Heat Exchanger concepts studied in theory.
- Carry out experiment and make observations for various heat transfer equipment.
- Study the effect of U, h_i and h_o in design of equipment.
- Evaluate the performance characteristic for different heat transfer cases.

Sl.NO	Experiments
1	Natural Convection in Bare tube
2	Vertical Shell and tube Heat exchanger (Condenser)
3	Horizontal Shell and tube Heat exchanger (Condenser)
4	Helical Coil Heat exchanger
5	Emissivity Determination
6	Effect of Geometry on Natural convection/Lagged pipe
7	Heat Transfer in Packed Beds
8	Double Pipe Heat Exchanger
9	Heat Transfer in Jacketed Vessel
10	Determination of Insulation Thickness
11	Transient Heat Conduction
12	Heat Transfer in Fluidized Beds
13	Evaporator
14	Solar Heater
15	Spiral Plate Heat Exchanger
16	Cross Flow Heat Exchanger
17	Natural Convection in Finned tube
18	Determination of thermal conductivity of a metal rod
19	Heat transfer through composite wall
20	Stefan-Boltzman constant evaluation

Note: Minimum 10 experiments are to be conducted

Course outcomes (Course Skill Set)

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

1. Experimentally verify the heat transfer concepts studied in theory.

2. Evaluate Thermal conductivity of a given metal Rod and composite wall.
3. Determine the Heat transfer coefficient for Fin, Forced convection, Natural Convection, and parallel and counter flow heat exchanger.
4. Test Emissivity, Stefan Boltzmann Constant and Critical Heat flux.
5. Asses the performance of different heat transfer equipment.
6. Develop the ability to write laboratory reports.

Industrial Pollution and Control			
Course Code	**21CH43**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- Understand about source, sampling and wastewater analysis
- Understand the causes of water pollution and treatment
- Understand various concepts of water usage and importance
- Understand about air, soil and noise pollution and its control.
- Comprehend the concepts of 3 R's and its importance in sustainable development.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Importance of environment for mankind. Biosphere and layers of atmosphere. Hydrological cycle and nutrient cycles. Types of pollution. Damages from environmental pollution. Need of environmental legislations and environmental Acts in India. Functions of central and state pollution control boards.

Sources, Sampling and Analysis of Wastewater: Water resources. Origin of wastewater. Evaluation, classification and characterization of wastewater. Physical and chemical characteristics. BOD, COD and their importance. Types of water pollutants and their effects.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Wastewater Treatment: Preliminary, primary, secondary and tertiary treatments of wastewater. Sludge treatment and disposal. Advanced wastewater treatment. Recovery of materials from process effluents.

Applications to Industries: Norms and standards of treated water. Origin, characteristics, and treatment methods in typical industries – petroleum refinery, pulp and paper, distillery, and textile processing.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Air Pollution: Nature of air pollution. Classification of air pollutants. Sources of air pollutants. Air quality criteria and standards. Plume behaviour and dispersion of air pollutants. Effects of air pollution on health and vegetation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Air Pollution Control: Sampling of pollutants. Methods of estimation of air pollutants. Automobile pollution. Control methods for particulates and gaseous pollutants. Origin, control methods, and equipment used in typical industries- metallurgical industries, and cement industries.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Solid Waste Treatment: Origin, Classification, and microbiology. Properties and their variation. Engineered systems for solid waste management – generation, onsite handling, storage, collection, transfer and transport, composting, sanitary land filling.

Noise Control: Sources and definitions. Determination of noise levels. Noise control criteria and noise exposure index. Acoustic absorptive materials.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Identify various components of Environment and relevant legislation pertaining to protection of environment
2. Comprehend parameters affecting quality of water, methods for sampling and analysis and effluent treatment techniques
3. Analyse various treatment techniques for effluent treatment in process industries
4. Comprehend parameters affecting quality of air, classify air pollutants, their effects and air pollution control equipment.
5. Illustrate the collection and transportation of solid wastes, volume reduction, size reduction, chemical reduction and biological processing problems.
6. Identify various sources of noise and administrative and engineering controls for noise reduction.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

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Industrial Pollution and Control Lab.

Course objectives:

- Experimentally verify the principles and working of instruments studied in theory.
- Carry out experiment and make observations for various parameters.
- Study and use various analytical instruments for analysis of various parameters.
- Evaluate the data and compare with reported literature.

Sl.NO	Experiments
1	Analysis of effluents for pH, alkalinity and turbidity
2	Determination of COD and BOD
3	Volatile, Fixed, Filterable and Dissolved solid analysis
4	Analysis by ion selective electrode (any two anions)
5	Measurement of particulate matter in Air
6	Measurement of SO_2 in air
7	Analysis of exhaust by ORSAT apparatus
8	Analysis of flue gases by Gas chromatograph
9	UV Spectrophotometer
10	KF Auto titrator
11	Flame photometer
12	Turbidimeter
13	Dissolved Oxygen measurement
14	Bomb calorimeter
15	Viscometer
16	Polarograph
17	Potentiometer titration

Suggested Learning Resources:

Books

1. Air Pollution, H.C. Perkins, McGraw Hill, 1974.
2. Environmental Engineering, G.N. Pandey and G.C. Carney, Tata McGraw Hill, 11th Reprint, 2002.
3. Environmental Pollution Control Engg, C.S. Rao, 2nd edn, New Age International Reprint, 2002.
4. Industrial Pollution Control Handbook, Lund, H.F., 6th edn, Vol.1, McGraw Hill, 1971.
5. Integrated Solid Waste Management, George Tchobanoglous et al, 2nd edn, McGraw Hill & Co, 1993.
6. Introduction to Environmental Engg, Davis., 3rd edn, McGraw Hill, 1998.
7. Noise Abatement, Duerden, Buttreworth, 1970.
8. Pollution Control in Process Industries, S.P. Mahajan, Tata Mc Graw Hill, 22nd Reprint, 1999.
9. Principles and Practices of Air Pollution Control and Analysis, J.R. Mudakavi, I.K. International Publishing, Home Pvt. Ltd., New Delhi, 2010.
10. Solid Waste Management, D.J. Hagery et.al., Van Nostrand Reinhold, 1973.
11. Waste Water Engineering Treatment Disposal Reuse, Metcalf and Eddy, 4th edn, Tata McGraw Hill, 2003.

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Mass Transfer Operations			
Course Code	**21CH44**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Be able to formulate equations for estimation of diffusivities in fluids & solids using first principles of engineering sciences.
- Be able to apply mass transfer fundamentals to calculate mass transfer rates and design the mass transfer equipment.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

INTRODUCTION: Types of diffusion in fluids. Types of diffusion in solid. Measurement and calculations of diffusivities. Mass transfer coefficients and their correlations. Theories of mass Transfer. Interphase mass transfer. Materialbalance for co-current, cross-current and counter-current operations. Concept of stages, cascades operation, NTU and HTU concepts.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Humidification: General theory, Psychrometric chart. Concepts in humidification, dehumidification. Design of cooling towers.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Drying: Introduction, Equilibria, Drying rate curves. Mechanism of drying, types of dryers. Design of batch and continuous dryers.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Adsorption: Theories of adsorption. Isotherms, Industrial adsorbents. Equipment, Batch & continuous multistage adsorption.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Crystallization: Factors governing nucleation and crystal growth rates. Controlled growth of crystals.Incorporation of principles into design of equipment. Different types of crystallizer equipment.

Introduction to Novel Separations: Ion exchange, Membrane processes-Reverse Osmosis, Dialysis, Ultraand Micro-filtrations, Super-critical fluid extraction(Working principle and operations only)

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Apply the basics of mass transfer in various mass transfer operations.
2. Comprehend diffusion in fluids and solids and solve problems on molar flux and diffusivity.
3. Comprehend co-current and counter current operations and apply the knowledge in various mass transfer operations.
4. Apply the properties of vapour gas mixture to solve humidification problems.
5. Explain theory of adsorption, crystallization and solve problems on adsorption and crystallization.
6. Apply the knowledge of drying and novel separations to separate various mixtures

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored are proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books:

1. Mass Transfer Operations | 3rd Edition Paperback – 1 July 2017, by Robert Treybal,
2. Unit Operations in Chemical Engineering - McCabe & Smith, 6thedn McGraw Hill, 2001
3. Chemical Engineering Vol I, II, IV and V - Coulson and Richardson, 4thedn, Pergamon Press, 1998.
4. Introduction to Chemical Engineering - Badger &Banchero, TMH 6th Reprint 1998
5. Principles of Unit Operation - Foust et.al., 2ndedn, John Wiley, 1994

Computer Aided Drawing Lab.			
Course Code	**21CHL46**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	3

Course objectives:

- Demonstrate basic concepts of the computer aided drawing software
- Apply basic concepts to develop construction (drawing) techniques
- Ability to manipulate drawings through editing and plotting techniques
- Understand geometric construction, Produce 2D Orthographic Projections
- Understand and demonstrate dimensioning concepts and techniques, Section and Auxiliary Views
- Familiarisation with Solid Modelling concepts and techniques.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Sl.NO	Experiments
1	**SECTIONAL VIEWS**: Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.
2	**PROPRTIONATE DRAWINGS** Equipment and piping symbols, Vessels components: Vessel openings, Manholes, Vessel enclosures, Vessel support, Jackets, Shell and tube heat exchanger, Reaction vessel and different types of Evaporators. P & I Diagrams
3	**ASSEMBLYDRAWINGS:** CotterjointwithsleeveSocketandSpigotjoint,Flangedpipejoint,Unionjoint,StuffingboxandExpansion joint(Screwtype orflanged type)

Course outcomes (Course Skill Set):

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

1. Analyse the general projections of given object.
2. Represent two-dimensional proportionate drawings of process symbols of various pipes and fittings.
3. Demonstrate the proportionate drawings of reaction vessel, jacked vessels, evaporator, STHE and DPHE
4. Identify the parts of industrial used equipment.
5. Draw the assembly drawings of socket and spigot, flanged pipe and union joints showing sectional, front, top, and side views.
6. Demonstrate the usage of solid edge software tool for engineering drawing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in - 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Gopal Krishna K.R., "Machine Drawing", 2ndrevised edn., Sudhas stores, Bangalore, 1998
2. Bhat N.D., "Machine Drawing", 22ndedn., Charoter Publishing House, Anand, 1987
3. Joshi M.V., "Process Equipment Design", 3rdedn., Macmillan India publication", New Delhi, 1999
4. Walas S.M., "Chemical Process Equipment", Butterworth Heinemann Pub., 1999
5. Ludwig E.E., "Applied Process Design", 3rdedn., Gulf Professional Publishing, New Delhi, 1994

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Entrepreneurship Development			
Course Code	**21CH481**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	1

Course objectives:

The objective of this course is to:

- Develop conceptual understanding of the entrepreneurship among the students.
- Learn qualities of a "technopreneur" and explore various methods for identifying opportunities
- Learn basics of market research and provide evidence for the viability of the business idea
- Develop a viable business proposition and learn to pitch your ideas for various audiences
- Understand the dynamics of new venture development and team building
- Develop the ability to translate a business idea into marketing and financial plans

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Topics

- Evolution of 'Technopreneur-ship'
- Entrepreneurial Motivation in the current economic scenario
- Creativity and entrepreneurship
- Innovation and inventions, &Legal Protection of innovation
- New Ventures - Industrial Parks, Special Economic Zone, Export oriented units
- Incentives to entrepreneurs
- Organisational Assistance to an entrepreneur
- Financial assistance by different agencies
- Rules And Legislation
- Basics of Project Report

Teaching-Learning Process	The teaching learning process should encourage and students to Experiential Learning by using free and open-source software, learning by doing, discussion among the peer group, learning through analysis case studies, group projects, reflective learning, collaborative learning, and scaffold

Course outcomes (Course Skill Set)

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

1. Explore and identify opportunities as a "technopreneur"
2. Conduct market research and look for business ideas
3. Develop a feasibility report and learn to pitch your ideas for various audiences
4. Develop an ability to translate a business idea into marketing and financial plans

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 01 hour)**

1. The question paper will have 50 questions of MCQ type of one mark each.

Suggested Learning Resources:

Books

1. Entrepreneurship for Engineers, Badhai, B Dhanpat Rai & co. (p) Ltd.
2. Project Management and Entrepreneurship, Desai, Vasant, Himalayan Publishing House, Mumbai, 2002.
3. Entrepreneurial Development, Gupta and Srinivasan, S Chand & Sons, New Delhi.
4. Entrepreneurial Development, Khanka, S S. S Chand & Company Ltd. New Delhi
5. Entrepreneurial Development, Ram Chandran, Tata McGraw Hill, New Delhi
6. Entrepreneurial Development Programmes and Practices, Saini, J. S., Deep & Deep Publications (P), Ltd.

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Data Analytics			
Course Code	21CH482	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	1

Course objectives:

The objective of this course is to create an interest for:

- Chemical engineers to use data science tools and take advantage of the increasing amount of data available to them.
- Data storage, analysis, and visualization.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Topics

- Data management tools and methods to organize, sort, and process datasets.
- Basics of real-time processing of data from sensors, instruments, and simulations.
- Statistical and machine learning.
- Visualization.

Teaching-Learning Process	The teaching learning process should encourage and students to Experiential Learning by using free and open-source software, learning by doing, discussion among the peer group, learning through analysis case studies, group projects, reflective learning, collaborative learning, and scaffold

Course outcomes (Course Skill Set)

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

1. Understand the basic terminologies of data processing and the different analysis techniques.
2. Identify the analysis techniques to appropriately apply in problems.
3. Know the fundamental of data different analysis techniques.
4. Apply the learned techniques to projects.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 01 hour)**

1. The question paper will have 50 questions of MCQ type of one mark each.

Suggested Learning Resources:

Books

1. Fundamentals of data science by B. Dwarakanath
2. Advanced Data Analysis & Modelling in Chemical Engineering, Denis Constales, Gregory S. Yablonsky, Dagmar R. D'hooge, Joris W. Thybaut, Guy B. Marin, 2017, ,Elsevier, ISBN: 978-0-444-59485-3

30.09.2022

V Semester

Chemical Engineering Thermodynamics			
Course Code	**21CH51**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Learn fundamentals of thermodynamics such as types of properties, processes and laws of thermodynamics for flow and non-flow process.
- Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility and problem solving skills.
- Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.
- Study the estimation of partial molar properties, property changes of mixing, and ideal and non ideal solutions.
- Learn the fundamentals of phase equilibrium, concept of chemical potential and generation and consistency check for VLE data.
- Understand fundamentals of chemical reaction equilibrium to find feasibility and extent of conversion for the industrial reactions.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

BASIC CONCEPTS: System, Surrounding and processes, Closed and Open systems, state and Properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase rule, Zeroth law of thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes.

FIRST LAW OF THERMODYNAMICS: General statement of First law of thermodynamics, First law for cyclic process and non-flow processes, Heat capacity.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

P-V-T BEHAVIOUR: P-V-T behavior of pure fluids, Equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equation of state for real gases: vanderWaals's equation, Redlich – Kwong equation, Peng – Robinson equation, Virial equation, Compressibility charts: Principles of corresponding states, generalized compressibility charts.

SECOND LAW OF THERMODYNAMICS: General statements of the Second law, Concept of Entropy, The Carnot Principle, calculation of entropy changes, Clausius Inequality, Entropy and Irreversibility, Third law of Thermodynamics.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

THERMODYNAMIC PROPERTIES OF PURE FLUIDS: Reference Properties, Energy Properties, Derived Properties, Work function, Gibbs free energy, Relationships among thermodynamic properties, Exact differential equations, Fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Modified equations for U & H, Effect of temperature on U, H & S, Relationships between CP & CV, Gibbs- Helmholtz equation, Fugacity, Fugacity coefficient, Effect of temperature and pressure on Fugacity, Determination of Fugacity of pure gases, Fugacities of solids and liquids, Activity, Effect of temperature and pressure on activity.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

PROPERTIES OF SOLUTIONS: Partial molar properties, Chemical potential, Fugacity in solutions, Henry's law and dilute solutions, activity in solutions, Activity coefficients, Gibbs – Duhem's equation, Property changes of mixing, excess properties.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

PHASE EQUILIBRIA: Criteria of phase Equilibria, Criterion of stability, Duhem's theorem, Vapor – Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, VLE at low pressures, VLE at high pressures, consistency test for VLE data, Calculation of Activity coefficients using Gibbs – Duhem's equation.

CHEMICAL REACTION EQUILIBRIUM: Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, Pressure on equilibrium constants and other factors affecting equilibrium conversion, Liquid phase reactions, heterogeneous reaction equilibrium, phase rule for reacting systems.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Develop basics of thermodynamics and apply First Law of thermodynamics to unit processes and unit operations.
2. Comprehend equations of state and determination of PVT for ideal and real gases.
3. Comprehend second law of thermodynamics, Carnot principle and perform entropy calculations.
4. Enumerate different thermodynamic properties for pure fluids and solutions.
5. Apply the knowledge of phase and chemical equilibrium to chemical processes.
6. Analyse systems using concepts of equilibrium constant and standard free energy change.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored are proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Smith J.M. and Vanness H.C., "Introduction to Chemical Engineering Thermodynamics", 5thedn., McGraw Hill, New York, 1996
2. Rao Y.V.C., "Chemical Engineering Thermodynamics", New age International Publication, Nagpur, 2000
3. Narayanan K.V., "Text book of Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.

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Separation Processes			
Course Code	**21CH52**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- This course aimsat providing students with an understanding of principles of advanced separation processes that are not covered in mass transfer course.
- To learn conceptual design of separation processes and design of equipment involved.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Gas Liquid Contacting Systems: Types, construction and working of plate and packed columns, types and properties of industrial packing's, plate efficiencies, HETP and HTU concepts.
Absorption: Absorption. Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Multistage absorption columns. Design of Plate columns. Absorption and desorption factors.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Packed Tower Absorption: Liquid phase hold up and pressure drop in absorption towers. Design of packed towers (process design-height and diameter). Multi-component absorption. Absorption with chemical reaction. **Distillation:** Introduction. Vapour liquid equilibria (T-x,y, P-x,y. H-x,y and x-y diagrams for binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult's law. VLE for multi-component systems. Non-ideal systems. Azeotropes. Immiscible systems. Atmospheric distillation, Flash and simple distillation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Distillation (Contd.): Multi-stage rectification column. Design using McCabe Thiele and Lewis-Sorel methods for binary mixtures.Ponchon-Savarit method. Introduction to Multicomponent distillation, Vacuum, extractive and azeotropic distillations.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Liquid-Liquid Extraction: Ternary equilibrium. Solvent selection. Single stage. Multi-stage cross-current, counter-current extraction. Equipment for liquid-liquid extraction.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Leaching Operation: Equipment for leaching. Preparation of solids for leaching. Equilibrium diagrams. Calculation of single stage and multi-stage leaching operation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend the gas – liquid operation and apply the knowledge of gas-liquid operations in distillation and absorption
2. Study the absorption process and apply to a wide variety of process such as recovery of vapours from dilute mixture with gases, solute recovery
3. Apply the knowledge of distillation in separation of liquid mixtures
4. Evaluate the number of plates required in distillation by McCabe and Thiele method and Ponchon and Savarit method.
5. Solve problems associated with leaching and extraction operations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 02/03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

17. The question paper will have ten questions. Each question is set for 20 marks. Marks scorded shall be proportionally scaled down to 50 Marks
18. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
19. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Mass Transfer Operations - Robert E Treybal, 3rd edn, McGraw Hill, 1981.
2. Unit Operations in Chemical Engineering - McCabe & Smith, 6thedn McGraw Hill, 2001.
3. Chemical Engineering Vol I, II, IV and V - Coulson and Richardson, 4thedn, Pergamon Press, 1998.
4. Introduction to Chemical Engineering - Badger &Banchero, TMH 6th Reprint 1998
5. Principles of Unit Operation - Foust et.al., 2nd edn, John Wiley, 1994

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Separation Processes Lab.

Course objectives:

- Experimentally verify the mass transfer concepts studied in theory.
- Carry out experiment and make observations for various mass transfer equipment.
- Study the effect of mass transfer coefficients in design of equipment.
- Evaluate the performance characteristic for different mass transfer cases.

Sl.NO	Experiments
1	Diffusion of organic vapours in air
2	Simple Distillation
3	Packed column/ plate column distillation
4	Steam distillation
5	Solid – liquid leaching
6	Surface evaporation
7	Tray dryer
8	Adsorption studies
9	Liquid-liquid/Vapour –liquid equilibrium
10	Liquid extraction – (cross current: 1 and 2 or 3 stage)
11	Hold up studies in packed columns
12	Rotary/ vacuum dryers
13	Wetted wall column
14	Cooling tower
15	Solid dissolution
16	Gel-electrophoresis

Note: Minimum 10 experiments are to be conducted

Course outcomes (Course Skill Set)

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

1. Determine diffusivity for organic vapours in air
2. Evaluate adsorption constants for liquid mixtures
3. Calculate percentage extraction for leaching and extraction
4. Analyse distillation process and determine VLE data for liquid mixtures
5. Estimate mass transfer coefficient for absorption operation
6. Evaluate height of packing bed for extraction operation.

Chemical Process Industries			
Course Code	**21CH53**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Understand industrial scale operations and processes employed at inorganic chemical industries.
- Be exposed to various types of reactions and reactor types involved.
- Understand various types of engineering problems encountered at these industries.
- Be exposed to National importance and major plant locations of these industries.
- Understand safety and environmental concerns of these industries.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Sulphur: Elemental Sulphur mining, Sulphur from ores, Oxides of Sulphur (SO_2, SO_3). Industrial Gases: CO_2, H_2, O_2, N_2, Water gas and Shift gas.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Acids: Sulphuric, Nitric, Hydrochloric, phosphoric acid.
Chlor-Alkali Industries: Sodium chloride, Soda ash, Caustic soda, Chlorine, Bleaching powder.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Fertilizers: Ammonia, Urea, Ammonium chloride, Ammonium nitrate, Ammonium phosphate, Ammoniumsulphate, DAP, Bio fertilizers.
Phosphorous Industries: Manufacture of white and Red Phosphorus, Pentoxide, Phosphoric Fertilizers, Super Phosphate and Triple Super Phosphate.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Fermentation Industries: Production of alcohol, acetic acid and citric, penicillin.
Petroleum Industries: Constituents of crude petroleum refining and processing. Production of Ethylene, Propylene.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Polymers and Rubber: Polymerization, PVC, LDPE, Polyproylene, cross linked polymers, natural rubber, synthetic rubber and rubber compounding.
Miscellaneous Industries: Paints, Pigments, Vanishes, Enamel, Lacquers - White Lead and Zinc oxide, Hydrogen peroxide (H_2O_2), Silicon carbide (SiC), Glass, Cement, Chlorine and Fluorine based industries.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Explain production of sulphur, sulphur oxides, industrial gases with flow diagram and identify MOC & major engineering problems in misc. industries.
2. Identify unit operations and culminate to prepare flow diagram for manufacture of acids, chlor alkali chemicals.
3. Explain the production of Fertilisers using Process Flow Diagram
4. Compare different process for manufacture of Phosphorus and by-products.
5. Comprehend fermentation technology and apply to produce alcohol and organic acids.
6. List constituents of crude and manufacture of petroleum products petrochemicals, rubber, and polymers.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Shreve's Chemical Process Industries, 4thedn, McGraw Hill.
2. Dryden – Outlines of Chemical Technology for 21st Century, Gopal Rao & Marshall Sittig, 3rd Edn., EWP.
3. Unit Processes in Organic Chemical Industries, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.
4. Encyclopedia of Chemical Technology, Kirk and Othmer, 27th volume, 5thEdn, Wiley, 2004.

Chemical Reaction Engineering			
Course Code	**21CH54**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- The students will be able to:
- Analyse and interpret the data to determine rate equation and estimate the performance equation of ideal systems
- Formulate and analyse the rate equations for various reactions using suitable mechanisms

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Scope of Chemical Reaction Engineering. Classification of reactions. Rate equation and rate of reaction. Factors affecting rate of reaction. Chemical kinetics and Thermodynamics Equilibrium. Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reaction.

Non-Elementary Reactions: Difference between elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions. Types of reactors.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Homogeneous Reactions: Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis: Differential method, Integral method, half-life method. Method of excess and method of isolation (For Reversible and Irreversible reactions up to second order). Autocatalytic reactions.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Design of Ideal Reactors: Concept of ideality. Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors. Numerical Problems.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Comparison of Ideal Reactors: General graphical comparison. Multiple Reactor Systems: Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series. Design of Reactors for Multiple Reactions: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Non-Isothermal Reactors: Introduction, effect of temperature on equilibrium constant and heat of reaction, Material and Energy balances, conversions in adiabatic and non-adiabatic reactors.

Analysis of Non Isothermal Reactor: Design procedure (For single/ simple reactions only). Optimum temperature Progression.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Estimate the order, molecularity of elementary and non-elementary reactions.
2. Analyse and design the ideal batch, plug flow and mixed flow reactors.
3. Estimate the rate of reactions for various types of reactions with various methods
4. Determine the rates for different reactions and combination of reactors
5. Analyse the reactions with effect of various parameters
6. Design the combination of different ideal reactors for non-isothermal and adiabatic reactors.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Chemical Reaction Engineering, Octave Levenspiel, 3rd edn, John Wiley & Sons, 2001.
2. Elements of Chemical Reaction Engineering, H. Scott Fogler, 3rd edn, Prentice Hall 2001
3. Chemical Engineering Kinetics, J.M. Smith, 3rd edn, McGraw Hill, 1984

Chemical Reaction Engineering Lab.			
Course Code	**21CHL55**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	3

Course objectives:

- Experimentally verify the principles and working of reactors studied in theory.
- Carry out experiment and make observations for various parameters.
- Study and use various reactors for determining rate constant and conversion.
- Evaluate the data and compare with reported literature.

Sl.NO	Experiments
1	Batch Reactor
2	Isothermal plug flow reactor
3	Mixed flow reactor
4	Semi batch reactor
5	Heterogeneous catalytic reactor
6	Segregated flow reactor r
7	Adiabatic reactor
8	Packed bed reactor
9	RTD Studies in tubular Reactor
10	Effect of temperature on rate of reaction
11	Biochemical Reaction (Batch)
12	Enzyme catalysed reactions in batch reactor
13	RTD Studies in mixed flow reactor
14	CSTR in series
15	Study of catalyst properties

Note: Minimum 10 experiments are to be conducted

Course outcomes (Course Skill Set):

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

1. Estimate the rate constant of reaction in various types of ideal reactors
2. Analyse the non-ideal behaviour of a reactor
3. Estimate the rate constants of reaction at various temperatures and at adiabatic conditions
4. Determine the rates in packed bed, sono chemical, photochemical, catalytic reactors
5. Analyse the reactions with biochemical and enzymatic reactions
6. Analyse the semi batch reactors

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} week of the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Books:

1. Chemical Reaction Engineering, Octave Levenspiel, 3rd edn, John Wiley & Sons, 2001.
2. Elements of Chemical Reaction Engineering, H. Scott Fogler, 3rd edn, Prentice Hall 2001
3. Chemical Engineering Kinetics, J.M. Smith, 3rd edn, McGraw Hill, 1984

Energy and Environmental Auditing			
Course Code	21CH581	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	1

Course objectives:

- To learn methodologies of Environmental Management System through ISO Guidelines, Life Cycle
- To learn the implementation of Environmental Management System through Environmental Audits.
- Understand energy scenario and general aspects of energy audit, Understand the energy utilization pattern including wastage and its management
- Comprehend methodologies of Environmental Management System through ISO Guidelines, Life Cycle
- Comprehend the implementation of Environmental Management System through Environmental Audits.
- Comprehend methods and concepts of energy audit
- Understand the energy utilization pattern including wastage and its management

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Topics

Environmental Audit: Types of Audits, Planning and Organising Audits, Offsite and Onsite Audit; Evaluation and Presentation; Exit Interview; Audit Report, Action Plan. Overview of Life Cycle Assessment (LCA) approach. Inventory and Impact Assessment.

Introduction and Formulation of Guidelines in Environmental Management Systems: ISO 14000 Series, Continual Improvement. Benefits of EMS.

Social Accountability: Elements of Social Management System, Corporate Social Responsibility (CSR).

Energy Audit Concepts: Need of Energy audit – Types of energy audit, Energy audit instruments – Procedures and Techniques.

Principles and Objectives of Energy Management: Importance of energy management systems, Energy audit reports,Few case study leading to potential energy savings.

Teaching-Learning Process	The teaching learning process should encourage and students to Experiential Learning by using free and open source software, learning by doing, discussion among the peer group, learning through analysis case studies, group projects, reflective learning, collaborative learning, and scaffold

Course outcomes (Course Skill Set)

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

1. The students will learn environmental management system and various auditing processes.
2. The students will be able to prepare the statutory Environmental Statement for various industries.
3. The students will be able to serve and guide the industrial sector as good corporate citizens.
4. Understand energy scenario and general aspects of energy audit.
5. Learn about methods and concept of energy audit
6. Understand the energy utilization pattern including wastage and its management

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 01 hour)**

1. The question paper will have 50 questions of MCQ type of one mark each.

Suggested Learning Resources:

Books

1. ISO 14001 Auditing Manual - Gayle Woodside and Patrick Aurrichio, McGraw-Hill,1999.
2. Planning and Implementation of ISO14001, Environmental Management System- Girdhar Gyani & Amit Lunia, Raj Publishing House, Jaipur, 2000.
3. Introduction to Environmental Audit- R. D. Tripathi, Alfa Publication.
4. The ISO: 14000 Handbook - Joseph Caseio (Ed), Published - CEEM Information Services. 2000.
5. INSIDE ISO: 14000 - The Competitive Advantage of Environmental Management - Don Sayre,Vinity Books International, New Delhi, 2001.
6. A Guide to the Implementation of the ISO: 14000 Series on Environmental Management - Ritchie, I and Hayes W, Prentice Hall, New Jersey, 1998.
7. Murphy, W. R., Energy Management, Elsevier, 2007.
8. Smith, C. B., Energy Management Principles, Pergamum, 2007
9. Handbook of Energy Audit, Sonal Desai, Mcgraw Hill Education Private Ltd.

Problem Based Learning (Case Studies)			
Course Code	21CH582	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	1

Course objectives:

- To emphasize learning activities that is long-term, interdisciplinary and student-centric.
- To inculcate independent learning by problem solving with social context.
- To engages students in rich and authentic learning experiences.
- To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Topics

Introduction to Problem Based Learning: Traditional vs. Cognitive Learning, Behavioural Learning, Cognitive Learning, Constructivist Learning. Improved Learning Strategies and Thinking Skills, Learning To Learn, Life Long Learning, Active Learning, Cooperative Learning

Developing Problems and Tutorial Process: Steps of Problem Design, PBL Tutorial Process, PBL Curriculum, Online PBL Changing Roles and need for increasedparticipation, Role of Tutors & students.

Implementation Issues in Problem Based Learning:,

Assessment and Evaluation: Introduction to Assessment and Evaluation, Different forms of Assessment in PBL, Grading Criteria in PBL

PBL Applications and Research Trends: Case Study in Chemical Engineering, Case Study in Interdisciplinary domains

Teaching-Learning Process	The teaching learning process should encourage and students to Experiential Learning by using free and open-source software, learning by doing, discussion among the peer group, learning through analysis case studies, group projects, reflective learning, collaborative learning, and scaffold

Course outcomes (Course Skill Set)

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

1. Project based learning will increase their capacity and learning through shared cognition.
2. Students able to draw on lessons from several disciplines and apply them in practical way.
3. Learning by doing approach in PBL will promote long-term retention of material and replicable skill, as well as improve teachers' and students' attitudes towards learning

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 01 hour)**

1. The question paper will have 50 questions of MCQ type of one mark each.

Suggested Learning Resources:

Books

1. ISO 14001 Auditing Manual - Gayle Woodside and Patrick Aurrichio, McGraw-Hill,1999.
2. Planning and Implementation of ISO14001, Environmental Management System- Girdhar Gyani & Amit Lunia, Raj Publishing House, Jaipur, 2000.
3. Introduction to Environmental Audit- R. D. Tripathi, Alfa Publication.
4. The ISO: 14000 Handbook - Joseph Caseio (Ed), Published - CEEM Information Services. 2000.
5. INSIDE ISO: 14000 - The Competitive Advantage of Environmental Management - Don Sayre,Vinity Books International, New Delhi, 2001.
6. A Guide to the Implementation of the ISO: 14000 Series on Environmental Management - Ritchie, I and Hayes W, Prentice Hall, New Jersey, 1998.
7. Murphy, W. R., Energy Management, Elsevier, 2007.
8. Smith, C. B., Energy Management Principles, Pergamum, 2007
9. Handbook of Energy Audit, Sonal Desai, Mcgraw Hill Education Private Ltd.

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VI Semester

Process Engineering Economics and Management			
Course Code	**21CH61**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives: The students will be able to

- Comprehend various phases in process design & development.
- Determine cost involved in various processes.
- Estimation of capital cost, alternative investments, and replacement analysis.
- Comprehend direct, indirect expenses involved and profitability evaluation methods.
- Comprehend various financial statements, significance of financial ratios and cash flow diagram

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Process Design Development: Overall planning of a plant, Feasibility studies and Material & energy balance, Equipment sizing and selection, Process flow sheet, P & I diagram, Plant layout and location.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Cost Analysis: Factors affecting investment & production cost, Estimation of capital investment, Factors in capital investment, Estimation of working capital, cost index. Time value of money: **Types of interests**: Effective and nominal interest rates, present worth and discount.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Depreciation & Taxes: Types of Depreciation and calculation methods
Profitability: Theory of profitability and its evaluation methods.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Replacements: Theory of replacements, causes for replacement, types of replacements
Alternatives investments: Theory of alternative investments and causes for the same

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Financial statements and Design report: Introduction to financial statements, Cash flow diagrams, balance sheet and Break-even analysis.
Design report: Introduction to design of reports. Types of reports, Organization of report and purpose of Report

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend concepts of plant location, plant layout as applicable petroleum to fertiliser industrial complexes
2. Understand various components of cost and estimate requirements of Fixed and working capital
3. Evaluate value of money and its equivalence to present and future
4. Comprehend factors affecting life of equipment and Determine depreciation by various methods
5. Interpret cash flow diagrams, break even analysis, and apply to evaluate profitability.
6. Comprehend alternative investments, replacement alternatives and prepare financial reports.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1. .T.R.Banga&S.C.Sharma Industrial Organization & Engineering Economics 22nd edn. Khanna Publishers 1999
2. Plant design and Economics for Chemical Engineers-Peters& Timmerhaus,4th edn McGraw Hill,1991

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Process Control &IIoT (Industrial IoT)			
Course Code	**21CH62**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	4	Exam Hours	3

Course objectives: The students will be able to

- Comprehend basic techniques, devices for temperature and pressure measurements and characteristics of measuring devices, Discuss fundamental laws and apply to summarise behaviour of thermometer and manometers
- Comprehend servo, regulatory control systems and final control elements, Arrange basic control components and summarise and represent in block diagram
- Determine stability of system by Routh Hurwitz and Root Locus techniques, comprehend basics of controller tuning
- Comprehend knowledge of Designing Industrial IOT Systems for various application.
- Knowledge for the design and analysis of Industry 4.0 Systems for Chemical Engineering applications.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Instrumentation: Fundamentals Static and dynamic characteristics. Indicators and recorders. Pressure measurement- Bourdon, diaphragm, and bellow type gages. Vacuum measurements. Temperature measurement- Bimetal and resistance thermometers, thermocouples and pyrometers.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

First Order Systems: Thermometer, level, mixing tank, STR, Linearization, I order systems in series. Response for various input forcing functions.

Second Order Systems: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case – Terms associated with it. Transportation lag.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Closed Loop System: Basic components. Servo and regulator control. Controllers – P, I, D and on–Off modes. Controller combinations - Final control elements - Valves, actuators and valve positioners. Closed Loop Response: Block diagram, Closed loop transfer function, Transient response of servo and regulator control systems with various controller modes and the characteristics

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Stability: Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams.

Control System Design By Frequency Response: Bode criterion. Gain and Phase margins, Ziegler – Nichols controller tuning, Cohen-Coon controller tuning. Root Locus: Rules for plotting and problems.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Introduction to Industrial IIoT Systems: The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories. Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive

Maintenance with IIoT technology.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend basic techniques, devices for temperature and pressure measurements and characteristics of measuring devices
2. Discuss fundamental laws and apply to summarise behaviour of thermometer and manometers
3. Comprehend servo, regulatory control systems and final control elements, arrange basic control components and summarise and represent in block diagram
4. Determine stability of system by Routh Hurwitz and Root Locus techniques, Comprehend basics of controller tuning
5. Ability to identify, formulate and solve engineering problems by using Industrial IoT and Ability to implement real field problem by gained knowledge of Industrial applications with IoT capability.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

20. The question paper will have ten questions. Each question is set for 20 marks. Marks scorded shall be proportionally scaled down to 50 Marks
21. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
22. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1. Process System Analysis and Control, Coughner& Koppel, 2nd edn, McGraw Hill, NewDelhi, 1991.
2. Process Modeling, Simulation & Control for Chemical Engineers, Luyben, 2nd edn, McGraw Hill, 1990.
3. Chemical Engineering Vol. III, III Edition, Coulson & Richardson, Pergamon Press,1998.
4. Chemical Process Control-An Introduction to Theory & Practical, George Stephanopoules,Vol.3, Prentice Hall, New Delhi, 1998.
5. Industry 4.0: The Industrial Internet of Things Alasdair Gilchrist Publications: Apress
6. Dr. OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers

ProcessControlLAB

CourseLearningObjectives: Studentswill

1. Experimentallyverifytheprinciplesandworkingof instrumentsstudiedintheory.
2. Carryoutexperimentandmakeobservationsforvariousparameters.
3. Studyanduseof variousfirst order systemandcontrollers.
4. Evaluatethedataandcomparewithreportedliterature.

Sl. No.	Experiments
1	Thermometer
2	LiquidLevel System-StepResponse
3	Non-InteractingTanks -Step Response
4	InteractingTanks -Step Response
5	PressureTank
6	U– TubeManometer
7	Singletank-ImpulseResponse
8	Non-InteractingTanks-ImpulseResponse
9	InteractingTanks-ImpulseResponse
10	Level/Flow/Pressure/pH/Temperaturecontrol–Pcontroller, PIcontroller, PDcontroller, PIDcontroller
11	ValveCharacteristics
12	ValvePositioner
13	ValveHysteresis
14	Mixingtank
15	Flapper NozzleSystem

Note: Minimum 10 experiments are to be conducted

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Course outcomes (Course Skill Set)

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

1. Demonstrateknowledgeandunderstandingofchemicalprocesssystemsaswellastheoperatingprinciplesofcommoninstruments, instrumentationnetworks, sensorsand displayunits.
2. Toapplyanddeterminetimeconstantsfor variousfirstorder systems.
3. Applyacquiredengineeringknowledgetoanalyze,assessandsolvecommonprocesscontrolandinstrumentationproblems
4. Usetechnicalliteratureandotherinformationsourcestotreatwithindustrialcontrolandinstrumentationengineeringproblems
5. Utilizeappropriatecontrolengineeringandinstrumentationdocumentationandstandards
6. Usecontrolvalvesandobtainitsinherentcharacteristics.

Computer Applications & Modelling			
Course Code	**21CH63**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives: The students will be able to

- To make the students understand physical systems in chemical engineering and to develop their mathematical models and solutions for these models.
- The students will also learn to use the commercial process simulators.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1	
Review of Computational Methods: Simultaneous linear algebraic equation – Gauss Jordan., Non-linear Algebraic equation-Newton Raphson. Ordinary Differential Equation- R-K Method. Numerical IntegrationSimpson's 1/3 Rule. Curve Fitting-Least Squares.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2	
Applications: Vapour: Liquid equilibrium for binary mixtures. Calculation of Bubble Pressure and Bubble Point. Dew Pressure and Dew point for Ideal Binary and multi-component system. **Flash Vaporization**: for multi-component system.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3	
Design of Reactors: Design of: Adiabatic Batch Reactor, Adiabatic PFR, Adiabatic CSTR and Combinations. **Design of Heat Exchangers**: Double Pipe Heat Exchanger (Area, Length and Pressure drop). Shell & Tube Heat Exchanger (Area, Number of tubes, Pressure drop)..	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4	
Absorption & Distillation Columns: Calculations for Plate and Packed Columns.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5	
Modelling: Models and model building, principles of model formulations, precautions in model building, Fundamental laws: Review of shell balance approach, continuity equation, energy equation, equation of motion, transport equation of state equilibrium and Kinetics, classification of mathematical models. **Mathematical Modelling**: Basic tank model – Level V/s time. Batch Distillation – Vapour composition with CSTRs in series time.	
Teaching-Learning	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual

Process	activity.

Course outcomes (Course Skill Set)

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

1. Develop algorithms and programs to solve problems based on Numerical Techniques
2. Develop programs to solve Heat Exchanger and Plate and packed Columns
3. Apply principles of BP, DP to Flash Calculations, Generate codes for reactors design
4. Develop algorithms and programs based on Numerical Technique application to Reactor Design
5. Interpret concepts of VLE, Bubble and Dew Point calculations and code programs
6. Summarise concepts of Models, fundamental laws of model building, apply to Distillation and CSTR

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1. Computer based Numerical Analysis, M. Shantha Kumar, 1st edn, KPS Publisher, 1987.
2. Introduction to Chemical Engineering and Computer Calculations, Myers, A.L and Seider W.D, Prentice Hall, 1976.
3. Process Modeling Simulation and Control for Chemical Engineering, William. L Luyben, 2ndedn., McGraw Hill, 1990.
4. Elements of Chemical Reaction Engineering, H. Scott Fogler, 2nd edn, Prentice Hall, 2001.
5. 2.Introduction to Chemical Engineering Thermodynamics, Smith J. M. and H. C. Vanness, 5thedn, McGraw Hill, 1996.

Material Science and Engineering			
Course Code	**21CH641**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Use the fundamental science and engineering principles relevant to materials that include the relationships between nano/microstructure, characterization, properties, processing, performance and design of materials.
- Use their knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.
- Use the technical and communication skills developed in the program as a foundation for careers in engineering, research and development, the pursuit of advanced education and other professional careers.
- Use lifelong learning skills to develop knowledge and skills, to pursue new areas of expertise and careers, and to take advantage of professional development opportunities.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Introduction to material science, classification of engineering materials, Level of structure, Structure property relationships in materials.

Crystal Geometry and Structure: Determination Geometry of crystals-the Bravais lattices, Crystal directions and planes-the miller indices, Structure determination-X-Ray diffraction Bragg law, The powder method, Scanning electron microscope.

Atomic Structure, Chemical Bonding and Structure Of Solids: Structure of atom, Periodic table, Ionization potential, Electron affinity and electro-negativity, Primary and secondary bonds, Variation of bonding character and properties, Covalent solids, Metals and alloys, Ionic solids, Structure of silica and silicates, Polymers.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Phase Diagram and Phase Transformations: Phase rule, Single component systems, Binary phase diagrams, Lever rule, Typical phase diagrams for Magnesia-Alumina, Copper-Zinc, Iron – Carbon systems, Nucleation and growth, solidification, Allotropic transformation, Cooling curve for pure iron, Iron-carbon equilibrium diagram, Isothermal transformations (TTT Curves), Eutectic, Eutectoid, Peritectic, Peritectoid reactions.

Crystal Imperfections: Point imperfections, Line imperfections-edge and screw dislocations, Surface imperfections.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Deformation of Materials and Fracture: Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture. **Heat Treatment**: Annealing Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-4	
Corrosion and its Prevention: Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, Factor influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings, glass lining, lead lining, FRP lining.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-5	
Typical Engineering Materials: Ferrous metals, Nonferrous metals and alloys – Aluminium and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Mechanical, electrical and thermal properties of ceramic phase.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Capable of applying core concepts in Materials Science to solve Engineering problems.
2. Comprehend Importance of ceramics, polymers and composites, its types and applications and
3. study crystal imperfections, its characteristics and corrosion prevention methods.
4. Identify the phase transformation due to temperature in alloys and properties of metals and non-metals.
5. Apply the knowledge of visco-elastic behaviour in material science and engineering.
6. Categorize various heat treatment methods employed in the industry and its effect on the mechanical properties.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1. Materials Science and Engineering – A First Course, Raghavan V, 3rdEdn., Prentice Hall of India Pvt. Ltd., New Delhi, 1996.
2. Material Science and Processes, Hajra Choudhury S.K., 2nd Edition, Indian Book Distributing Co., 1982.
3. Elements of Material Science, Van Valck H.L., 2ndEdn., Addision – Wesly Publishing Company, New York, 1964.

Chemical Equipment Design			
Course Code	**21CH642**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:
The objective of this course is to:

- Understand types in the design of Chemical equipment and its accessories.
- Acquire basic understanding of design parameter.
- Comprehend knowledge of design procedures for commonly used process equipment and their attachments (e.g. internal and external pressure vessels, tall vessels, high pressure vessels, supports).
- Understand different types of equipment testing methods.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Basic considerations in design. General design procedure. Equipment classification. Various components of process equipment. Design parameters.
Design Considerations: Material selection. Factors affecting design. Stresses due to static and dynamic loads (Internal & External).
Design of Pressure Vessels: Design parameters, conditions & stresses. Design of shell, and other vessel components. Vessel at low & high operating temperatures. Design problems using given process parameters.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Vessel Component Design: Design of supports for vessels- Bracket, Leg, Saddle and Skirt supports. Classification of flanges. Flange thickness calculation, Gasket selection, Bolt selection, Nozzle Selection.
Design of vessel closures- Flat plates, Formed heads, Elliptical & Hemispherical heads.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Storage Vessels: Process conditions and design parameters for storage of volatile, non-volatile fluids & gases. Design of cylindrical tanks with fixed roofs. Design of partially filled spherical tanks, Numerical problems.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Reaction Vessels: Design of reaction tanks with agitation and jacket. Types of agitators, baffles. Power requirement calculations. Design of tank dimensions and agitation system components. Drive calculations & selection of accessories. Design of jackets. Numerical problems.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5	
Tall Vertical Vessels: Vessels subjected to various loads, Multi shell constructions. Determination of shell thickness. Supports for columns. **Pipe Line Design**: Pipe line sizing, Condensate and steam pipe design.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Explain the basic considerations, factors, parameters involved in the design, and the types of codes available for the design.
2. Explain mechanical properties of materials and MOC, and apply the knowledge of static and dynamic loads in equipment designing.
3. Design the pressure vessel and storage vessel in detail.
4. Design the various types of accessories or components used for the different equipments.
5. Design the tall vertical vessel and reaction vessel with various jackets.
6. Solve the problems related to pipe line and designing the same.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Process Equipment Design - M. V. Joshi, 3rdedn., Macmillan & Co. India, Delhi, 1998.
2. Process Equipment Design - Vessel Design, Brownell & Young, John Willey, 1959

3. Process Design of Equipment - Vol 1, S. D. Dawande, 3rdedn, Central Techno Publications. 2003
4. Chemical Engineers Handbook, Perry & Green, 7thedn, McGraw Hill, 1997
5. Pressure Vessel Code - IS 2825, IS Code, B.I.S., New Delhi, 1969
6. Flow of Fluids through Valves, Fittings & Pipes, Crane Amazon, 2006

Petroleum Refinery Engineering			
Course Code	**21CH643**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To provide the concept of petroleum refining and explain the different methods of petrochemical reactions and theirapplications
- To provide the importance of various refining processes and their applications
- To explain the significance petrochemicals productions

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Indian Petroleum Industry: Prospects & Future. Major companies. World production, Markets, Offshore and onshore, Oil well technology.

Composition of Crude: Classification. Evaluation of petroleum. UOP-k factor. TBP analysis. EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions.

Product Properties and Test Methods: Gas. Various types of gas and LPG. Reid vapour pressure analysis. Gasoline and naptha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities, octane testing, and viscosity. Grades of diesels: HSD, LDO. Diesel additives. Lube oils: Types, tests-carbon residue, and viscosity index.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Crude Pre-treatment: Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter and comparison of each. Heating of crude- heater, different types of pipe still heaters including box type, cylindrical etc. Crude distillation, arrangement of towers for various types of reflux. Design aspects for atmospheric and vacuum column. Atmospheric distillation unit: internals and operational.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Treatment Techniques: Types of impurities present and various desulfurisation processes. Production and treatment of LPG. LNG technology. Sweetening operations for gases including merox, ethanolamine, copper chloride, stertford etc. Catalytic de sulphonisation. Treatment of kerosene, De-aromatisation and merox. Treatment of diesel, naptha: desulpurisation by hydrogen and catalysts. Treatment of lubes: sulphuric acid, clay treatment, solvent treatment- phenol, furfural.

Teaching-Learning	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual

Process	activity.
Module-4	
Thermal Processes: Thermal cracking reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. Vis breaking, dubbs two coil cracking process. **Catalytic Reforming**: Theory of reforming. Factors influencing reforming, reforming catalysts, feedstock requirements. Plat-forming, hondi forming, flexi forming.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-5	
Catalytic Cracking: Comparison of thermal and catalytic cracking. Carbonium ion chemistry. Feedback requirements. Cracking conditions. Commercial cracking analysis. Various catalytic cracking processes. Fixed bed crackers. Moving bed crackers. Fluid catalytic cracking-flexi cracking-ortho-flow reactor. Theory of coking: various types of coking processes. Delayed coking, fluid coking, contact coking, flexi coking. Naptha cracking, naptha cracking for ethylene as feed selection and gas yield. Hydro cracking. Theory of hydro cracking. Catalysts for hydro cracking.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend introductory information about petroleum and refinery. (Understand the history of refinery development and composition of petroleum, learn the refinery products, test methods and petroleum properties).
2. Recognize the characteristics of petroleum refinery process(Recognize the distillation processes. solvent treating and extraction processes. Related fluid mechanics. combustion, vaporization and condensation. fractionation and towers.)
3. Assimilate information about thermal cracking(Understand heat transfer and exchangers, thermal cracking, catalytic cracking, and reforming, Perform typical design calculation and economics of design.)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1. Petroleum Refinery Engineering, Nelson, 4thedn McGraw Hill, 14th Reprint, 1982.
2. Modern Petroleum Refining Processes, Bhaskara Rao, 3rdedn, Oxford & IBH Publication, Reprint, 1999.
3. Petroleum Refining Technology, Ram Prasad, 1stedn, Khanna Publishers, 2000
4. Challenges in Crude Oil Evaluation, Nagnal J.M., Gate, McGraw Hill, 1996.
5. Petroleum Processing, Bland W.F. and Davidson R.L. McGraw Hill, 1967.

Heterogeneous Reaction Systems			
Course Code	**21CH644**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives: This course aims to:

- Establish fundamental knowledge in the area of reaction kinetic
- Apply catalytic phenomena with extensions to reactor design and catalyst characterization.
- Develop general methodologies for analysis and design of a variety of systems for which engineering of reactions is needed.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Basics of Non Ideal Flow: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. Dispersion model. Tanks in series model. Conversion in non- ideal flow reactors for simple systems.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Introduction to Heterogeneous Systems: Rate equations, contacting patterns, fluid-particle non catalytic reactions, URC model, Spherical particles of unchanging size, shrinking spherical particles, determination of rate controlling steps.

Fluid-Fluid Non Catalytic Reactions: Kinetic regimes for mass transfer and reaction; rate equations.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Catalysis: Introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, inhibitors. Mechanism of catalysis. Rate equations for different rate controlling step. **Deactivation**: Deactivating catalyst. Mechanism, rate & performance equation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Solid Catalysed Reactions: Heterogeneous reactions- Introduction, Kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Thiele modulus and enhancement factor, Porous catalyst particles. Heat effects during reaction.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Catalysed Reactors: Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates. Packed bed catalytic reactor & reactors with suspended solid catalyst. Fluidized reactors of various types.

Gas-Liquid Reactors: Trickle bed, slurry reactors. 3-phase fluidized bed.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Knowledge of heterogeneous catalytic reactions and their applications in industry
2. Understanding of the mechanism and kinetics of heterogeneous catalytic reactions
3. Choice of catalytic materials, preparation and characterization of catalysts
4. Consideration of mass and heat transfer effects in heterogeneous catalysis
5. Ability to design reactors for heterogeneous catalytic reactions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

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Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks

Suggested Learning Resources:

Books

1. Chemical Reaction Engineering, Octave Levenspiel, 3rdedn, John Wiley & Sons, 2001.
2. Chemical Engineering Kinetics, J.M. Smith, 3rdedn, McGraw Hill.
3. Elements of Chemical Reaction Engineering, H. Scott Foggler, 3rdedn, Prentice Hall, 2001
4. Chemical & Catalytic Reaction Engineering, James J. Carberry, McGraw Hill, 1976

Industrial Pollution and Control			
Course Code	**21CH651**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Understand about source, sampling and waste water analysis
- Understand the causes of water pollution and treatment
- Understand various concepts of water usage and importance
- Understand about air, soil and noise pollution and its control.
- Comprehend the concepts of 3 R's and its importance in sustainable development.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Importance of environment for mankind. Biosphere and layers of atmosphere. Hydrological cycle and nutrient cycles. Types of pollution. Damages from environmental pollution. Need of environmental legislations and environmental Acts in India. Functions of central and state pollution control boards.
Sources, Sampling and Analysis of Wastewater: Water resources. Origin of wastewater. Evaluation, classification and characterization of wastewater. Physical and chemical characteristics. BOD, COD and their importance. Types of water pollutants and their effects.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Wastewater Treatment: Preliminary, primary, secondary, and tertiary treatments of wastewater. Sludge treatment and disposal. Advanced wastewater treatment. Recovery of materials from process effluents. **Applications to Industries**: Norms and standards of treated water. Origin, characteristics, and treatment methods in typical industries – petroleum refinery, pulp and paper, distillery, and textile processing.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Air Pollution: Nature of air pollution. Classification of air pollutants. Sources of air pollutants. Air quality criteria and standards. Plume behaviour and dispersion of air pollutants. Effects of air pollution on health and vegetation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Air Pollution Control: Sampling of pollutants. Methods of estimation of air pollutants. Automobile pollution. Control methods for particulates and gaseous pollutants. Origin, control methods, and equipment used in typical industries- metallurgical industries, and cement industries.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5	
Solid Waste Treatment: Origin, Classification, and microbiology. Properties and their variation. Engineered systems for solid waste management – generation, onsite handling, storage, collection, transfer and transport, composting, sanitary land filling. **Noise Control**: Sources and definitions. Determination of noise levels. Noise control criteria and noise exposure index. Acoustic absorptive materials.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Identify various components of Environment and relevant legislation pertaining to protection of environment
2. Comprehend parameters affecting quality of water, methods for sampling and analysis and effluent treatment techniques
3. Analyse various treatment techniques for effluent treatment in process industries
4. Comprehend parameters affecting quality of air, classify air pollutants, their effects and air pollution control equipment.
5. Illustrate the collection and transportation of solid wastes, volume reduction, size reduction, chemical reduction and biological processing problems.
6. Identify various sources of noise and administrative and engineering controls for noise reduction.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Air Pollution, H.C. Perkins, McGraw Hill, 1974.

2. Environmental Engineering, G.N. Pandey and G.C. Carney, Tata McGraw Hill, 11th Reprint, 2002.
3. Environmental Pollution Control Engg, C.S. Rao, 2nd edn, New Age International Reprint, 2002.
4. Industrial Pollution Control Handbook, Lund, H.F., 6th edn, Vol.1, McGraw Hill, 1971.
5. Integrated Solid Waste Management, George Tchobanoglous et al, 2nd edn, McGraw Hill & Co, 1993.
6. Introduction to Environmental Engg, Davis., 3rd edn, McGraw Hill, 1998.
7. Noise Abatement, Duerden, Buttreworth, 1970.
8. Pollution Control in Process Industries, S.P. Mahajan, Tata Mc Graw Hill, 22nd Reprint, 1999.
9. Principles and Practices of Air Pollution Control and Analysis, J.R. Mudakavi, I.K. International Publishing, Home Pvt. Ltd., New Delhi, 2010.
10. Solid Waste Management, D.J. Hagery et.al., Van Nostrand Reinhold, 1973.
11. Wastewater Engineering Treatment Disposal Reuse, Metcalf and Eddy, 4th edn, Tata McGraw Hill, 2003.

Nano Science & Technology			
Course Code	**21CH652**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To foundational knowledge of the Nanoscience and related fields.
- To make the students acquire an understanding the Nanoscience and Applications
- To help them understand in broad outline of Nanoscience and Nanotechnology.
- To make students understand the use of concept of nanotechnology and nanoscience in the chemical industries and in consumer products.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Generic methodologies for nanotechnology: Classification and fabrication: Introduction and classification, Summary of the electronic properties of atoms and solids, Effects of the nanometer length scale, Fabrication methods, Preparation, safety and storage issues.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Strategies for the scalable synthesis of quantum dots and related Nano dimensional materials: Introduction, Defining Nano dimensional Materials, Potential Uses for Nano dimensional Materials, The General Methods Available for the Synthesis of Nano dimensional, Materials, Precipitative Methods, Reactive Methods in High Boiling Point Solvents.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Advanced methods for synthesis of Nano dimensional materials: Reactive methods in high boiling point solvents, hydrothermal and solvo-thermal methods, gas-phase synthesis of semiconductor nanoparticles, synthesis in a structured medium, the suitability of such methods for scaling

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Nanotechnology and ceramics: Introduction, Synthesis, Vapour Condensation Methods, Sputtering, Laser Method, Spray Pyrolysis, Thermo Chemical /Flame Decomposition of metal organic Precursors methods.
Applications of nanomaterials:Cosmetics and Consumer Goods, Nano Sensor, Nano catalysts, Water Treatment and the Environment, Paints, Food and Agriculture Industry.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Tools to characterize nanomaterials: X-Ray Diffraction (XRD), Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy,UV/Visible Spectroscopy	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Understand bulk and Nanostructured materials.
2. Understand synthesis of nanomaterial with different.
3. Understand the basic principles of various characterization technique.
4. Understand the use of nanoscience and nanotechnology for various applications.
5. Students can understand the difficulties in synthesizing Nano particles and can work in the field of commercialization of Nano materials.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question fromeach module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by G. Cao, Imperial College Press, 2004.
2. Nanoscale Science and technology by Robert Kelsall (editor), Ian W. Hamley (co-editor), Mark Geoghegan (co-editor) , ISBN: 978-0-470-85086-2
3. The Chemistry of Nanomaterials: Synthesis, Properties and Applications by C. N. R. Rao, A.Muller, A. K. Cheetham, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN:3-527-30686-2.

4. Nanoscale Materials in Chemistry Edited by Kenneth J. Klabunde, John Wiley & Sons, Inc.,ISBNs: 0-471-38395-3 (Hardback); 0-471-22062-0.
5. Textbook of Nanoscience and Nanotechnology, B.S. Muty, P. Shankar, Baldev Raj, B.B Rathand James Murday, University Press, IIM (ISBN-978 81 7371 738 3).
6. Introduction to Nanotechnology by Charles P. Poole Jr and. Frank J. Owens, Wiley-Interscience, 2003.

Solid Waste Management in Process Industries			
Course Code	**21CH653**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:
The students will be able to

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

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.
General Aspects: Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Engineered Systems: Typical generation rates. Estimation and factors affecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Processing Techniques: Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Material Recovery: Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.
Energy Recovery: Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Hazardous Wastes: Classification. Origin and reduction at source. Collection and handling. Management issues and planning methods. Environmental Acts.
Case Studies: Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system
2. Select appropriate engineered methods for handling, collection and transportation of solid waste.
3. Comprehend various processing techniques employed in solid waste management
4. Assess various material and energy recovery methods employed in solid waste management
5. Identify and discuss the different hazardous wastes handling associated with solid waste
6. Justify solid waste management from an environmental, public health perspectiv

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books:

1. Integrated Solid Waste Management, George Tchobanoglous et al., 2ndedn, McGraw Hill & Co, 1993.
2. Industrial Solid Waste Management and Land Filling Practice, Dutta et al., Narosa Publishing House, 1999.

3. Waste Treatment Plants, Sastry C.A. et al, Narosa Publishing House, 1995
4. Environmental Engineering. Howard S. Peavy, Donald R. Rowe, George Tchobanoglous. McGraw-Hill, 1 July 2017. ISBN-10 9351340260
5. Hazardous Waste Management, Lagrega, McGraw Hill, 1994.

Air Pollution Control Techniques			
Course Code	**21CH654**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:
The students will be able to

- appraise fundamentals of sources, effects, sampling & monitoring of air pollutants
- evaluate air quality and specific source of air pollution
- determine appropriate air pollution control systems for the industries
- compare various methods to control specific air pollutant

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Air pollution in India and the World, sources and classification of air pollutants, global concern of air pollutants, effects of air pollutants, emission inventory
Air Quality Criteria and Standards: Air quality criteria, criteria pollutants, types of emission standards, variant forms of emission standards, means for implementing emission standards, other rules and regulations related to air pollution.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Air quality monitoring: Sampling, and analysis, Gaseous and particulate pollutants sampling and analysis, ambient air sampling,stack sampling, online monitoring of air pollutants

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Air pollution control methods and equipment: Source correction methods, particulate control techniques like gravity settling chambers, cyclone separator, filters, electrostatic precipitator, wet scrubbers, control technologies for gaseous pollutants like Scrubbers, absorption and adsorption, control of specific gaseous pollutants like SO_x, NO_x. recent trends in air pollution control techniques

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Control of Specific Pollutants: Control of volatile organic compounds (VOCs) and odour: source, characteristics, measurement, environmental significance and its control
Control of Mobile Sources: Introduction; gasoline-powered vehicles; diesel-powered vehicles; gas turbines and jet engines; alternatives to existing mobile sources.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Industrial air pollution control system: Emissions & its control from thermal power plant, petroleum refinery, Metallurgical Industries and other industrial processes

Indoor Air Quality: Factors influencing indoor air quality, indoor air pollutants, effects of indoor airpollutants, control of indoor pollutants	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system
2. Select appropriate engineered methods for handling, collection and transportation of solid waste.
3. Comprehend various processing techniques employed in solid waste management
4. Assess various material and energy recovery methods employed in solid waste management
5. Identify and discuss the different hazardous wastes handling associated with solid waste
6. Justify solid waste management from an environmental, public health perspectiv

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books:

1. Bouble R. W., Fox D. L., Turner D. B., Stern A. C., Fundamentals of Air Pollution, Academic Press.
2. Rao C. S., Environmental Pollution Control Engineering, New Age International.
3. Rao M. N., Rao H. V. N., Air Pollution, Tata McGraw Hill.
4. Mudakavi J. R., Principles and Practices of Air Pollution Control and Analysis, I. K.International.

5. Bhatia S. C., Textbook of Air Pollution and its Control, Atlantic Publishers & Distributors.
6. Trivedy R. K., Goel P. K., An Introduction to Air Pollution, BS Publications.

Computer Applications & Simulation Lab.			
Course Code	**21CHL66**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	1	Exam Hours	3

Course objectives:

- Identify applications of numerical techniques in solving chemical engineering problems
- Develop algorithm and write program for Bubble point, Dew point, Flash drum and Adiabatic flame temperature
- Develop algorithm and write program for elementary design of heat exchangers, distillation column
- Comprehend utilization of simulation software for determination of thermo-physical properties of pure components & generation of VLE data of binary component system
- Simulate heat exchanger, distillation column and flash drum using simulation software

PREREQUISITES: Students should have pursued the following courses as part of their degree program / have good working knowledge in:
(i) Fluid mechanics (ii) Chemical Reaction Engineering (iii) Chemical Engineering Thermodynamics (iv) Heat and Mass Transfer (v) Process Equipment Design (vi) Numerical analysis

Experiments: The following experiments are to be carried out; the data are to be analysed based on the theoretical aspects, and recorded with comments.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Sl. No.	Part – A
1	Non-linear algebraic equation- Newton Raphson (Specific volume of binary mixture)
2	Ordinary Differential Equation- R-K Method ($dCa/dt=kCa^2$)
3	Numerical Integration - Simpson's 1/3 Rule (Batch Reactor to find time)
4	Curve Fitting –Least Square (Nre vs f)
5	Calculation of Bubble Point and Dew Point for Ideal multi-component system
6	Flash Vaporization for multi-component system
7	Design of Adiabatic Batch Reactor, PFR
8	Adiabatic Flame Temperature
9	Double pipe heat exchanger (Area, Length and Pressure drop)
10	Distillation Column (Bubble cap)
The above applications can be solved using Programming Language already learnt at First year or Spread Sheet	
PART – B	
1	Introduction to suggested software available (flow sheeting)
2	Mixing of ideal liquid streams
3	Determination of thermo-physical properties of pure components
4	Generation of VLE data of binary component system
5	Determination of equilibrium conversion of reversible reactions
6	Material balance on reactor based on yield/conversion data
7	Simulation of a flash column

8	Simulation of a distillation column
9	Determination of heat duty
10	Detailed Simulation of heat exchanger
11	Simulation of a CSTR for liquid phase reaction
12	Shortcut Simulation of heat exchanger to determine outlet stream temperature
13	Simulations Studies of pump, compressor, cyclone and heater
14	Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following: • Ethylene Glycol from Ethylene oxide • Atmospheric distillation of crude oil • Propylene Glycol from Propylene oxide • Aromatic stripper with recycle stream (Benzene, Toluene, Xylene) Styrene from Ethyl Benzene

Note: Minimum 10 experiments are to be conducted

SOFTWARES SUGGESTED:

- AspenPlus
- ChemCAD
- COCOsimulator
- Design-II
- DWSIM
- Hysys
- OpenModelica
- Prosim

CourseOutcomes: On successful completion of this course students will be able to

- Apply theoretical knowledge of numerical methods to solve chemical engineering problems.
- Understand the application of simulation and data processing in chemical engineering.
- Simulate basic equipment used in unit operations.
- Utilize simulation software to verify and analyze different solutions obtained through programming.
- Use simulation software to determine optimal Solutions.
- Apply theoretical knowledge of numerical methods to solve chemical engineering problems.

ConductofPracticalExamination:

- Minimum of 10 programs/simulations are to be conducted and all are to be included for practical examination. Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of VTU answer script for breakup of marks.

Mini Project			
Course Code	**21CHMP67**	CIE Marks	100
Contact Hours/Week	2	SEE Marks	-
Total Hours of Pedagogy	25	Total Marks	100
Credits	2	Exam Hours	-

Mini Project work: Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini Project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini project, shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for MiniProject.

Course outcomes (Course Skill Set)

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

1. Apply fundamentals of science and engineering to identify, formulate and solve chemical engineering problems
2. Conduct experimental investigation, data interpretation and develop solutions for chemical engineering problems.
3. Analyse and design solutions for chemical engineering problems using modern engineering and IT tools.
4. Assess the impact of chemical engineering solutions on the society and industry and demonstrate the need for sustainable development.
5. Develop the ability to communicate effectively in verbal and written forms and prepare project reports and presentations.
6. Apply the principles of management in chemical engineering and function effectively as member or leader of a team.

VII Semester

Process Equipment Design & Drawing			
Course Code	**21CH71**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	4

Course objectives:

The students will be able to

- Understand advances and types in the design of heat and mass transfer equipment and its accessories.
- Develop modifications based on design.

Note:

Detailed chemical engineering process design of the following equipment should be studied. Standard code books are to be used. The detailed proportionate drawings shall include sectional front view, full top/side view depending on equipment and major components.

Class work: Students are to design the equipment. They shall also be trained to draw free hand proportionate sketches.

Final Examination: Students have to answer any one of the two questions given in the examination. After completing the design, free hand proportionate sketches are to be drawn as required.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Content

1. Shell and Tube Heat exchanger
2. Condenser – Horizontal
3. Condenser – Vertical
4. Evaporator – Single effect
5. Sieve Tray Distillation Column
6. Packed Bed Absorption Column
7. Rotary Drier

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Design and analyse the heat transfer equipment without phase change
2. Design Mass transfer equipment with tray column
3. Design Mass transfer equipment with packed columns
4. Design Combined Heat and Mass Transfer equipment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

23. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
24. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
    1. The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Process Equipment Design - M. V. Joshi, 3rd edn., Macmillan & Co. India, Delhi, 1998.
2. Process Equipment Design - Vessel Design, Brownell & Young, John Wiley, 1959.
3. Process Design of Equipment - Vol 1, S. D. Dawande, 3rdedn, Central Techno Publications. 2003.
4. Chemical Engineers Handbook, Perry & Green, 8thedn, McGraw Hill, 1997.
5. Pressure Vessel Code - IS 2825, 4503, IS Code, B.I.S., New Delhi, 1969.
6. Flow of Fluids through Valves, Fittings & Pipes, Crane Amazon, 2006.

Biochemical Engineering			
Course Code	**21CH72**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	25	Total Marks	100
Credits	2	Exam Hours	3

Course objectives:

- To apply the chemical engineering principles in biological systems.
- Calculate the kinetic parameters of enzymatic reactions.
- Calculate and analyse the kinetic parameters for microbial growth.
- Analyse bioprocess design and operation.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Enzymes and Proteins: Role of a chemical engineer in bioprocess industries, Detailed structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes. Kinetics and mechanism of Enzyme action: Michaelis–Menten and Briggs-Haldane approach. Derivation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Kinetics of Enzyme Action: Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Lineweaver–Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods)

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Enzyme Inhibition: Effect of Inhibitors (Competitive, non-competitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalysed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses. Methods of enzyme immobilization.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Fermentation Technology: Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: Sources of nutrients. Alternate bioreactor configurations. Introduction to sterilization of bioprocess equipment.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Downstream Processing: Strategies and Steps involved in product purification. Methods of Cell disruption, Filtration, Centrifugation, Sedimentation, Chromatography, Freeze drying / lyophilization. Membrane separation Technology: Reverse Osmosis, Ultra filtration, Micro filtration, Dialysis.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Explain the nomenclature, classification, and production of enzymes; derive the rate equation by M-M and Brigs-Haldane approach
2. Derive rate equation for given enzyme mechanisms and estimate the kinetic rate parameters
3. Describe the effects of pH, temperature and inhibitors on enzyme catalysed reactions and explain the methods of enzyme immobilization
4. Describe the growth cycle phases for batch cultivation and fed-batch reactors and, derive an expression to determine optimum dilution rate.
5. Explain medium formulation and sterilization of bioprocess equipmentand steps involved in product purification

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Biochemical Engineering Fundamentals, Bailey and Ollis, II Edition, McGraw Hill,1976.
2. Bioprocess Engineering, Shuler M. L. and Kargi F., 2nd Edition, Prentice Hall, 2002.

3. Biochemical Engineering, James Lee, Prentice Hall, 1992.
4. Biochemical Reactors, Atkinson B, Pion Ltd., London, 1974.
5. Principles of Fermentation Technology, Stanbury and Whitekar, 2nd edition, Butterworth Heinemann An Imprint of Elsevier

Instrumental Methods of Analysis			
Course Code	**21CH721**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- The course is designed to impart the knowledge in the field of Instrumental Analysis.
- The various modern analytical techniques like UV-Visible, IR, NMR, Mass, GC, HPLC, different chromatographic methods and other important topics are taught to enable the students to understand and apply the principles involved in the determination of different bulk drugs and their formulation.
- In addition to the theoretical aspects, the basic practical knowledge relevant to the analysis is also imparted.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

CHROMATOGRAPHY: Classification of chromatographic methods based on the mechanism of separation. 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.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

GAS CHROMATOGRAPHY: Introduction, fundamentals, instrumentation, columns: preparation and operation, detection, dramatization. HPLC: Principles and instrumentation, solvents and columns, detection and applications, HPTLC: Theory and principle, instrumentation, elution techniques.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

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.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

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.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

NMR: Theory, instrumentation, chemical shift, shielding and de-shielding effects, splitting of signals, spinspin coupling, proton exchange reactions, coupling constant (J), nuclear over Hauser effect (NOE), 13CNMR spectra and its applications, 2D-NMR, COSY and applications.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Discuss types of spectroscopies, instrumentation, and applications of UV Spectroscopy
2. Explain theory, instrumentation, and applications of IR spectroscopy
3. Explain theory, instrumentation, and applications of NMR spectroscopy
4. Discuss principle, instrumentation and applications of Mass Spectroscopy, Flame Emission Spectroscopy (FES) and Atomic Absorption Spectroscopy (AAS)
5. Discuss principle, instrumentation, and applications of polarography
6. Discuss classification of chromatography and explain Thin Layer, Gas Chromatography and High-Performance Liquid Chromatographic methods.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Instrumental Methods of Chemical Analysis by B.K Sharma
2. Organic Spectroscopy by Y.R Sharma.
3. Textbook of Quantitative Chemical Analysis by Vogel's A.I.

4. Organic Spectroscopy by William Kemp

Oils and Fats Technology			
Course Code	**21CH722**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

This course aims to:

- Provide students with the knowledge of oils, fats and their derivatives as fundamental ingredients of many food products.
- Provide students with the knowledge necessary for a conscious use of oils and fats in food formulations and for the optimization of production processes of the foods containing fats and oils.
- Comprehend structure of fats and oils, sources and classification of fats and oils, chemical and physical characteristics
- Processing of fats and oils, Pre-extraction operations, extraction/processing, filtering and refining. quality and nutritive values of processed products.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Classification of fats and oil. Characteristic of oils. Utilization of fat and oils. Composition of oils (general). Obtaining Oils and Fats from Source Materials: Mechanical pre-treatment. Mechanical expression. Solvent extraction (two types of extractors).

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Process Techniques: Refining and hydrogenation (H2 production and catalyst). degumming. alkali refining and bleaching.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Deodorization: Theoretical consideration and operation of commercial deodorizer. Vegetable Oils: Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Vegetable Oils: Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil. Refining processes and uses of palm oil, Soya bean oil, peanut oil, sunflower oil.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Marine Oils: Composition. Extraction. Refining processes and uses of fish oils.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

1. At the end of the teaching course the students will be able to choose the best oils and fats for food formulation, considering their chemical and physical characteristics, technological properties, production, and modification processes.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Bailey's Industrial Oil and Fat Products - Vol I to V, Y .H. Hery John Wiley International, 2ndedn, 1976.
2. Chemistry and Technology of Oil and Fats, Devine J and Williams P.N, 1961.
3. Chemical process Industries, Austin G. T., Shreve's 5thedn, McGraw-Hill international Book Company, Singapore, 1984
4. Outlines of Chemical Technology, Dryden C. E., Edited by Gopala Rao. M and M. Sittig, 2ndedn, Affiliated East West Press, 1993.
5. Hand Book of Industrial Chemistry, Kent J.A (Ed) Riegel's Van Nostrand Reinhold, 1974

Pharmaceutical Technology			
Course Code	**21CH723**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Understand the importance of drug design and different techniques of drug design.
- Understand the chemistry of drugs with respect to their biological activity.
- Know the metabolism, adverse effects and therapeutic value of drugs.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Electrophilic Substitution Reaction: Preparation of cyclo alkane. Bayer's strain theory and orbital picture of angle stream.

Electrophilic Substitution Reaction Mechanism & Application: Dehydrogenation of alkyl halides. 1-2 elimination kinetics: E2 and E1mechanisms. Isotope effect. Dehydration of alcohols. Ease of dehydration.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Nucleophilic Addition Reaction: **Mechanism**: Important chemicals. Oxidation-Reduction reactions. Rheology of Fluids in Mixing and Blending.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Preparation: Test for purity and medical uses of Chlorobutal, Dimercopral, Glycerol trinitrate.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Formulations: Test for purity and medical uses of Urea, ethylene diamine dihydrate, vanillin, paraldehyde. Testing for purity and medical uses of lactic acid, citric acid, salicylic acid, saccharin sodium.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Preparation: Test for purity and medical uses of Ethyl borate, dimethyl phthalate.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

Upon completion of the course student shall be able to:

1. Understand the importance of drug design and different techniques of drug design.
2. Understand the chemistry of drugs with respect to their biological activity.
3. Know the metabolism, adverse effects and therapeutic value of drugs.
4. Comprehend the terminology and concepts used in Pharmaceutical Technology and the technical, scientific aspects inherent to drugs, in particular - powders, granules, tablets, coated tablets, and capsules.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Organic Chemistry, T.R. Morisson and R. Boyd, 6thedn, Prentice Hall of India Pvt Ltd., New Delhi, 1992.
2. The Theory and Practice of Industrial Pharmacy, Liberman, and Lachman, 3rdedn, Lea &Febiger, Philedelphia, 1986.
3. Pharmaceutical Product Development, Jain N.K, CBS Publications and Distributions, New Delhi, 2006
4. Organic Chemistry Fundamentals, I. L. Finar, 2ndedn, ELBS, Pergamon Press, 1965.
5. Good Manufacturing of Pharmaceuticals, Sidnay H. Willing, Murray M. Tuckerman, and Williams Hitchings, 3rdedn, Marcell Dekker Inc., NY, 1982.

Novel Separation Techniques			
Course Code	**21CH724**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To identify the multiple factors influencing the choice of separation techniques.
- To be able to qualitatively and quantitatively address the fundamental aspects of specialty separation processes.
- To understand the underlying principles and modelling and design concepts of novel separation techniques and their applications.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Adsorptive Separations: Review of fundamentals. Mathematical modelling of column factors. Pressure swing & thermal swing adsorption. Counter current separations. Chromatography: Chromatography fundamentals. Different types, Gradient & affinity chromatography, Design Calculations for chromatographic columns.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Membrane Separation Processes: Types, Thermodynamic considerations. Mass transfer considerations. Design of RO &UF. Ion selective membranes. Micro filtration. Electro dialysis. Pervaporation. Gaseous separations.

External Field Induced Separations: Electric & magnetic field separations. Centrifugalseparations and calculations.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Surfactant Based Separations: Fundamentals. Surfactants at inter phases and in bulk. Liquid membrane permeation. Foam separations. Micellar separations.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Super Critical Fluid Extraction: Thermodynamics and physico chemical principles. Process description. Application. Case Study.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Mechanical–Physical Separation Process: Introduction, Classification, Filtration in solid liquid separation. Settling & sedimentation in particle fluid separation.

Other Separations: Separation by thermal diffusion, Electrophoresis, crystallization.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Develop models and the solutions for adsorptive separation processes.
2. Characterize the membrane.
3. Use the concepts of membrane separation techniques for industrial separations.
4. Solve problems involving separation based on liquid membrane.
5. Exposure to other new separation techniques - surfactant based, supercritical fluid extraction and bio filtration.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. D. M. Ruthven, Principles of Adsorption and Adsorption Processes, John Wiley (1984).
2. M. Mulder, Basic Principles of membrane Technology, Springer (1996).
3. M. A. McHugh and V.J. Krukonis, Supercritical Fluid Extraction, Butterworth (1985).
4. S. Sourirajan and T. Matsuura, Reverse Osmosis and Ultra-Filtration Process Principles, NRC Canada (1985).
5. C.J. King, Separation Processes, Tata McGraw Hill (1981).
6. D. M. Ruthven, S. Farooq and K. S. Knaebel, Pressure Swing Adsorption, Wiley-VCH (1994).
7. W. S. Ho and K. K. Sirkar, Membrane Handbook, Kluwer (2001).
8. R W Rousseau, Handbook of Separation Process Technology, John Wiley & Sons (2009).

Chemical Plant Utilities and Safety			
Course Code	**21CH725**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To gain knowledge about different process utilities used in the chemical process industry and issues related to hazards & safety.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1	
Introduction: Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities. **Water**: Water resources. Quality Standards for Process water, cooling water, drinking water and boiler feed water. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Water pre-treatment.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-2	
Air: Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance, and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system- piping and accessories. Air-water vapor system: humidification/ dehumidification and evaporative cooling-related calculations. Insulation: Insulation Materials & Selection- Economics of insulation. Insulating factors. Properties & Classification.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-3	
Steam and Power: Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Cogeneration power plants. CHPs and Boiler performance. Related calculations. Economy of steam generation with different fuels. Steam storage and handling-piping and accessories. Boiler performance. Economy of steam generation with different fuels. Steam storage and handling-piping and accessories.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-4	
Refrigeration: Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect- related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants. Cold insulation and cryogenic insulation.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-5	

Process Safety: Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire, Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.
Safety Devices: Pressure relief valves. Rupture discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices. Process Safety Analysis: HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. calculate the requirements of water and air and their applications as utilities.
2. calculate the steam requirement and its applications as utility.
3. evaluate and apply the various risk assessment methods in industries.
4. Perform hazard analysis for different industries using HAZOP.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Vasandhani, V. P., and Kumar, D. S, Heat Engineering, Metropolitan Book Co. Pvt. Ltd. (2009).
2. Crowl, D.A. and Louvar, J.F., Chemical Process Safety-Fundamentals with Applications, Prentice Hall, (2002).

3. Lees, F.P., Prevention in Process Industries. Butterworth's (1996).
4. Banerjee, S., Industrial Hazards and Plant Safety, Taylor & Francis 2003).
5. Sanders, R. E. Chemical Process Safety-Learning from Case Histories, Oxford (2005).
6. Perry, R.H., and Green, D. W, Chemical Engineer's Handbook, McGraw Hill (1997).

Chemical Process Integration			
Course Code	**21CH731**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To understand the energy and mass targets in design of processes.
- To learn the concept of Process Intensification.
- To apply the techniques of intensification to a range of chemical processes andprocess equipment.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding, and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction to Process Integration: Graphical Techniques. Overall mass targeting, Synthesis of Mass Exchange Network: Graphical approach. Direct recycle strategies.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Visualization Strategies: for development of mass integrated system: Algebraic approach to targeting direct

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Algebraic Approach to targeting mass exchange, networking. Recycle strategies using property integration.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Heat Integration: Combined heat and power integration. Optimization: Mathematical approach to direct recycle, Graphical method, simplex method, single variable optimization, multivariable optimization.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Mathematical Techniques: Synthesis of mass & heat exchange excluding Lingo optimization techniques for mass integration. Initiatives and applications. Case studies.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

Upon completion of this course, the students will be able to:

1. Understand of the fundamentals of process integration.
2. Perform pinch analysis.
3. Analyse and design heat exchanger networks.
4. Minimize the water consumption and waste generation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Linnhoff, D.W., User Guide on Process Integration for the Efficient Use of Energy Institution of Chemical Engineers (1994).
2. Smith, R., Chemical Process Design and Integration, John Wiley & Sons (2005).
3. Shenoy, V. U., Heat Exchanger network synthesis, Gulf Publishing (1995).
4. Kumar, A., Chemical Process Synthesis and Engineering Design, Tata McGraw Hill (1977).

Transport Phenomena			
Course Code	**21CH732**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To be able to analyse various transport processes with understanding of solution approximation methods and their limitations.
- To introduce the students about basic laws of momentum, heat and mass transfer.
- To determine the heat transfer rate and temperature distribution for different heat transfer situations.
- To determine the mass transfer rate and concentration distribution for different mass transfer situations.
- To study the different analogies between mass, momentum and mass transfer

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Momentum Energy and Mass Transport Newton's law of viscosity (NLV). Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction (FLHC), Fick's law of diffusion (FLD), Effect of temperature and pressure on transport properties of fluids.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Velocity Distribution in Laminar Flow: Different Flow situations, Steady state Shell momentum balances, Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flow through Annulus.

Steady State Shell Energy Balances: General Boundary conditions applicable to energy transport problems of chemical engineering. Heat conduction through compound walls. Overall heat transfer coefficient.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Temperature Distribution in Solids and in Laminar Flow: Different situations of heat transfer: Heat conduction with internal generation by electrical and nuclear energy sources, Heat conduction in a cooling fin: Forced and free convection heat transfer.

Concentration Distributions in Laminar Flow: Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Equimolar counter diffusion. Numerical problems.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Concentration Distributions in Laminar Flow: Diffusion through stagnant gas and liquid films, Diffusion with homogeneous reaction, Diffusion with heterogeneous reaction Diffusion into falling film – Forced convection mass transfer.

Teaching-Learning	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual

Process	activity.

Module-5

Analogies between Momentum, Heat and Mass Transport: Reynold's, Prandtl's and Chilton & Colburn analogies.

Equations of Change: Equation of continuity, Equation of motion; Navier – Stokes equation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Explain types of fluids, comprehend effect of temperature and pressure on transport properties of fluids and apply transport laws to solve numerical
2. Derive overall heat transfer coefficient, Temperature distribution with and without energy sources
3. Determine velocity profile and shear stress profiles in different flow situations
4. Derive molar flux for stagnant gas, liquid films, homogeneous and heterogenous reactions and applications to falling film forced convection mass transfer
5. Determine HT & MT coefficient using various analogies
6. Derive and apply equation of continuity, equation of motion, Navier's stokes equation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Transport Phenomena, Bird, Stewart and Lightfoot, Academic Press, 1994.

2. Momentum Heat and Mass Transport, Welty, Wikes and Watson, 4th edn., John Wiley, 2000.
3. Principles of Unit Operations in Chemical engineering, Foust et al., 2nd edn, John Wiley, 1990.
4. Transport Phenomena - A Unified Approach, Robert S. BrodKey and Henry C. Hershley, Vol.2, Brodkey Publishing, 2003

Pulp and Paper Technology			
Course Code	**21CH733**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To introduce students to the basic pulp and papermaking processes from virgin and recycled raw materials.
- Acquaint students with raw material characteristics, physical and mechanical concepts, nomenclature and procedures related to evaluating paper and paper board product properties
- To provide an understanding of the conversion of wood to mechanical and chemical pulps (Kraft, sulphite, and semi-pulping processes). Chemical recovery systems and bleaching of mechanical pulps.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Wood Chemistry: Chemical composition- cellulose, hemi cellulose, lignin, wood extractives, raw material. Quality parameters under evaluation. Yield of raw material.

Pulping: General principle of pulping. Types of pulping processes: mechanical, chemical, semichemical, sulphate process, Kraft process. Process calculations. Raw material utility requirements. Process flow sheet and description. Washing and bleaching. Common unit operation. Wood treatment, digestion, evaporation, drying with equipment used.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Treatment of Pulp: Screening, washing, refining, thickening of pulp. Bleaching- conventional and non-conventional bleaching techniques.

Paper Making: Preliminary operations on pulp. Beating and refining of pulp. Non-fibrous materials. Fillers and loading material. Internal sizing. Wet and additive surface treatment. Paper colouring. Surface sizing.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Paper Drying and Finishing: Types of dryers. Calendaring. Reeling and winding. Paper machine drives, cutting, winding and rewinding. Conversion of papers.

Paper Quality of Grades: Different grades of paper quality. Parameters and their evaluation. Saturation of paper. Special grade papers. Recycling of waste papers.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Supportive Operations: Chemical recovery – water balance, oxidation, evaporation of black liquor, lime recovery. Quality control and safety aspects.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5	
Environmental Aspects: Effluent characteristics of pulp and paper industries. Treatment methods.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Provide fundamental knowledge necessary to maximize bleach plant performance while extending the life span of pulp/bleaching equipment.
2. Optimize pulping operations to achieve maximum pulp bleachability and strength properties
3. Apply the fundamental chemical principles of making pulp and paper in the industry.
4. Advise pulp and paper makers on how to control environmental pollution.
5. Identify requirements for process control and quality assurance in pulp and paper manufacturing processes.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 Marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Pulp and Paper Chemistry and Technology, Casey, J.P., 2nd Edition, Inter Science, 1960.
2. Handbook of Pulp and Paper Technology, Britt K.W., Reinhold Publication Corp., 1964.
3. Pulp and Paper Science and Technology, Libby C.E. Vol 1 to 3, McGraw Hill, 1962.

Pilot Plant and Scale Up Studies			
Course Code	**21CH734**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:
To understand the importance of process equipment geometry and to provide concepts, methods and analysis to translate various chemical processes from laboratory scale to plant scale.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Pilot Plants: Evolution of process system. Need of pilot plants. Concept of prototypes, models, scale ratios, element. Principles of similarity: Geometric similarity, Distorted similarity, Static, dynamic, kinematic, thermal and chemical similarity with examples.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Dimensional Analysis: (Review of Rayleigh's, Buckingham-∏methods), Differential equation for static systems, flow systems, thermal systems, mass transfer processes, chemical processes-homogeneous and heterogeneous.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Regime Concept: Static regime. Dynamic regime. Mixed regime concepts. Criteria to decide the regimes Equations for scale criteria of static, dynamic processes, Extrapolation. Boundary effects.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Scale up of mixing process: Agitated vessel, Scale up of chemical reactor systems-Homogeneous reaction systems. Reactor for fluid phase processes catalysed by solids. Fluid-fluid reactors.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Stage wise mass transfer processes: Continuous mass transfer processes. Scale up of momentum and heat transfer systems. Environmental challenges of scale up.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Scale-up the fluid phase and fluid-fluid reactor.
2. Scale-up the mixing units and separation units.
3. Scale-up for mass transfer processes.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module Marks scored out of 100 shall be reduced proportionally to 50 marks. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. M. Zlokarnik, Scale-up in Chemical Engineering, Wiley-VCH (2006).
2. R.E. Johnstone and M.W. Thring, Pilot Plants, Models and Scale-up Methods in Chemical Engineering, McGraw-Hill (1957).
3. 1. C. Divall, and S. Johnston, Scaling up: the Institution of Chemical Engineers and the Rise of a New Profession, Springer (2000).
4. A. Bisio, and R.L. Kabel, Scale-up of Chemical Processes, John Wiley (1985).

Process and Industrial Safety			
Course Code	**21CH735**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To know about Industrial safety programs and toxicology, Industrial laws, regulations and source models
- To understand about fire and explosion, preventive methods, relief and its sizing methods
- To analyse industrial hazards and its risk assessment.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, Nature of the Accident Process, Inherent Safety, Seven Significant Disasters.

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.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

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.

Source Models: Introduction to Source Models, Flow of Liquid through Holes, and Pipes, Flow of Gases or Vapours through Holes and Pipes, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

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.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

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 vapour or Gas Services, Rupture Disc Reliefs in Liquid in vapour or Gas Services, Two-Phase Flow during Runaway Reaction Relief , Pilot-

Operated and Bucking-Pin Reliefs, Deflagration Venting for Dust and Vapour Explosions, Venting for Fires External to Process Vessels, Reliefs for Thermal Expansion of Process Fluids.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Hazards Identification: Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews, Other Methods,
Risk Assessment: Review of Probability Theory, Event Trees, Fault Trees, QRA and LOP

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Analyse the effect of release of toxic substances
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the relief and its sizing methods.
5. Understand the methods of hazard identification and preventive measures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011.
2. R.K. Sinnott, Coulson & Richardson's, Chemical Engineering, Vol. 6, Elsevier India, 2006.
3. Fawcett H.H. and W.S.Wood, Safety and accident prevention in Chemical operations 2nd edition John Wiley and Sons Inc. (1982).

Energy Technology			
Course Code	**21CH741**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- To facilitate the students to achieve a clear conceptual understanding of technical and commercial aspects of Wind and Alternative Sources of Energy.
- To enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding Wind and Alternative Sources of Energy.
- Understand the difference between renewable and non-renewable energy resources.
- Demonstrate understanding of the different types of renewable energy technologies that arecurrently available, and how they are used to provide energy.
- Identify strengths and limitations associated with the different renewable energy technologies.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction To Energy Sources: Conventional energy sources; non-conventional energy sources; advantages; limitations.

Solar Energy: Solar radiation and its measurement – solar constant, solar radiation at earths surface, solar radiation geometry, solar radiation measurement. Introduction to solar energy. Applications – solar water heating, space heating, space cooling, solar thermal electric conversion. Agriculture and industrial process heating, solar distillation, solar pumping, solar cooking.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Energy from Biomass (Bio-Energy): Introduction. Biomass conversion Technologies. Wet processes. Dry processes. Biogas generation. Factors affecting bio digestion or generation of gas. Classification of biogas plants. Advantages and disadvantages of floating drum plant. Advantages and disadvantages of fixed dome type plant. Types of biogas plants (KVIC model & Janata model). Selection of site for biogas plant.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Bio-Energy (Thermal Conversion): Methods of obtaining energy from biomass. Biodiesel, Thermal gasification of biomass. Classification of biomass gasifiers. Chemistry of gasification process. Applications of the gasifiers.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Wind Energy: Introduction. Basic components of WECS (wind energy conversion system). Classification of WECS. Types of wind machines- horizontal axis machines, vertical axis machines. Applications of wind energy.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Energy Form The Oceans: Introduction. Ocean thermal electric conversion (OTEC). Methods of ocean thermal electric power generation. Open cycle OTEC system. Closed or Anderson OTEC cycle, hybrid cycle. Application of energy from oceans.

Energy From Tides: Basic principles of tidal power. Components of tidal power plants Operation methods of utilization of tidal energy. Advantages and limitations of tidal power generation. Applications of tidal energy.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend the uses of conventional and non-conventional sources of energies and their limitations and explain the classification of fuels
2. Explain the measurements of solar radiation, solar collectors, and their applications
3. Discuss the generation of the biogas and different types of biogas plants
4. Comprehend the different types of gassifiers and the chemistry involved in the process
5. Explain the basic components of WECS, types of wind machines, and classification and characteristics of fuels
6. Discuss the methods of OTEC and the operation of tidal power plants

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Non-Conventional Energy Sources, G.D. Rai, 4th Edition, Khanna Publications, Second Reprint, 1997.
2. Engineering Chemistry, P.C. Jain & M. Jain, 10th Edition, Dhanpat Rai & Sons, 3rd Reprint, 1995.
3. Solar Energy, Second Edition, S.P. Sukhatme, 3rd Reprint, Tata McGraw Hill, New Delhi, 1998.
4. Solar Energy Utilization, G.D. Rai, 4th Edition, Khanna Publications,2006.

Risk Management			
Course Code	**21CH742**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Provide students with the knowledge and skills appropriate to the practice of risk management.
- Provide students with a framework, process, skills and tools for the critical analysis of issues relating to a risk management.
- Explain how an organization applies risk management.
- Demonstrate risk assessment and risk response methods and techniques

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Introduction, quantitative risk assessment, rapid risk analysis, comprehensive risk analysis, emission and dispersion, leak rate calculation, single and two, phase flow dispersion model for dense gas, flash fire, plume dispersion, toxic dispersion model and evaluation of risk.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Fire and Explosions: Radiation tank on fire flame length, radiation intensity calculation and its effect on plant, people and property, radiation VCVCE, explosion due to over pressure, effects of explosion, risk contour, effects, explosion, BLEVE, jet fire, fire ball.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Risk Analysis: Overall risk analysis, generation of meteorological data, ignition data, population data, consequence analysis and total risk analysis, overall risk analysis, overall risk contours for different failure scenarios, disaster management plan, emergency planning, onsite and off, site emergency planning, risk management, ISO 14000, EMS models, case studies, marketing terminal, gas processing complex, refinery.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Hazard identification & safety audits: Checklist, 'what if' analysis, vulnerability models event tree analysis, fault tree analysis, hazard past accident analysis, Fixborough, Mexico, Madras, Vizag, Bhopal analysis, hazop guidewords, parameters, derivation, cause, consequences, recommendation, coarse hazop study, case studies, pumping system, reactor, mass transfer system.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Process Safety: Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire, Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.

Safety Devices: Pressure relief valves. Rupture discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices. Process Safety Analysis: HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Acquire knowledge to ensure safety and manage risk in chemical industries.
2. Understand the risk analysis, targets and contingencies, and risk mitigation strategies.
3. Ability to Identify hazards and affects in chemical industries
4. Develop skills to estimate risks and apply a control measure hierarchy to control risks
5. Know about the Safe Working Procedures
6. Able to Conduct assessment and produce Safe operational Working Procedure in industries and research laboratories

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. K.V. Raghavan and A.A. Khan, Methodologies in Hazard identification and assessment, Manual, CLRI publication 1990.
2. V.C. Marcel, Major Chemical Hazard, Ellis Hawood Ltd., Chi Chester, UK, 1987.

3. B. Skeleton, Process Safety Analysis, Institution of Chemical Engineers, U.K., 1997.
4. Daniel A. Crowl and J.F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall, NJ 1990.

Material Science & Technology			
Course Code	**21CH743**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Use the fundamental science and engineering principles relevant to materials that include the relationships between nano/microstructure, characterization, properties, processing, performance and design of materials.
- Use their knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.
- Use the technical and communication skills developed in the program as a foundation for careers in engineering, research and development, the pursuit of advanced education and other professional careers.
- Use lifelong learning skills to develop knowledge and skills, to pursue new areas of expertise and careers, and to take advantage of professional development opportunities.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Introduction to material science, classification of engineering materials, Level of structure, Structure property relationships in materials.

Crystal Geometry and Structure: Determination Geometry of crystals-the Bravais lattices, Crystal directions and planes-the miller indices, Structure determination-X-Ray diffractionBragg law, The powder method, Scanning electron microscope.

Atomic Structure, Chemical Bonding And Structure Of Solids: Structure of atom, Periodic table, Ionization potential, Electron affinity and electro-negativity, Primary and secondary bonds, Variation of bonding character and properties, Covalent solids, Metals and alloys, Ionic solids, Structure of silica and silicates, Polymers.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Phase Diagram and Phase Transformations: Phase rule, Single component systems, Binary phase diagrams, Lever rule, Typical phase diagrams for Magnesia-Alumina, Copper-Zinc, Iron – Carbon systems, Nucleation and growth, solidification, Allotropic transformation, Cooling curve for pure iron, Iron-carbon equilibrium diagram, Isothermal transformations (TTT Curves), Eutectic, Eutectoid, Peritectic, Peritectoid reactions.

Crystal Imperfections: Point imperfections, Line imperfections-edge and screw dislocations, Surface imperfections.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Deformation of Materials and Fracture: Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture.

Heat Treatment: Annealing Normalizing, Hardening, Martempering, Austempering, Hardenability,

Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-4	
Corrosion and its Prevention: Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, Factor influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings, glass lining, lead lining, FRP lining.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-5	
Typical Engineering Materials: Ferrous metals, Nonferrous metals and alloys – Aluminium and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Mechanical, electrical and thermal properties of ceramic phase.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Capable of applying core concepts in Materials Science to solve Engineering problems.
2. Comprehend Importance of ceramics, polymers and composites, its types and applications and
3. study crystal imperfections, its characteristics and corrosion prevention methods.
4. Identify the phase transformation due to temperature in alloys and properties of metals and non-metals.
5. Apply the knowledge of visco-elastic behaviour in material science and engineering.
6. Categorize various heat treatment methods employed in the industry and its effect on the mechanical properties.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Materials Science and Engineering – A First Course, Raghavan V, 3rdEdn., Prentice Hall of India Pvt. Ltd., New Delhi, 1996.
2. Material Science and Processes, Hajra Choudhury S.K., 2ndEdition, Indian Book Distributing Co., 1982.
3. Elements of Material Science, Van Valck H.L., 2ndEdn., Addision – Wesly Publishing Company, New York, 1964.

Plant Utilities and Safety			
Course Code	**21CH744**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Calculate the requirements of water and air and their applications as utilities.
- Calculate the steam requirement and its applications as utility.
- Evaluate and apply the various risk assessment methods in industries.
- Do the hazard analysis for different industries using HAZOP.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities.

Water: Water resources. Water treatment processes for drinking, process and boiler feed. Storage and handling of water.

Steam And Power: Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, green fuels. Calorific value. Proximate and ultimate analysis.Cogeneration power plants. CHPs and Boiler performance. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Refrigeration: Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effects. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Insulation: Insulation Materials & Selection- Economics of insulation. Insulating factors. Properties & Classification. Cold insulation and cryogenic insulation.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Introduction To Process Safety: Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire, Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.

Process Safety Analysis: HAZAN and HAZOP comparison.. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-5

Safety Devices: Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Comprehend Intrinsic and Extrinsic Safety and different hazards
2. Discuss HAZOP & HAZAN as applied to process industries
3. Comprehend Safety and personal safety devices used in process industry
4. Identify applications of insulation and evaluate strategies to minimize heat losses
5. Assess different factors affecting refrigeration and air conditioning requirements and comprehend properties of refrigerants
6. Comprehend importance of process utilities - Air, Water and Steam and Refrigerants.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Power Plant Engineering, P.K. Nag, 2nd Edition,Tata Mc Graw Hill, 1998.
2. Water and Wastewater engineering- Vol 2, Gordon M Fair, John C. Geyer and Daniel A Okun, Jhon Hutey,1996.
3. Water and wastewater Technology, Mark J. Hammer Jr.,4th Edition, Prentice Hall, 1997.
4. Chemical Engineers Handbook, Perry, 8th Edition, 2007.

5. Loss prevention in chemical process industries, Vol. 1,2,3, Frank P Lees, ButterworthHeiremann,1980. Elements of Material Science, Van Valck H.L., 2nd Edn., Addision – Wesly Publishing Company, New York, 1964.

Food Technology			
Course Code	**21CH745**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Basic terms used in study of food and nutrition
- Methods of assessment of nutritional status
- Functions of food-physiological, psychological and social
- Understanding relationship between food, nutrition and health
- To understand the chemistry of foods - composition of food, role of each component and their interaction.
- To understand the functional aspects of food components and to study their role in food processing.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- An appeal is made to the teachers to use alternative effective teaching methodology to inculcate an interest in the subject and its applications to solve societal & industrial problems.
- Efforts may be made to use MOOC's, videos, recorded contents, presentations to induce curiosity, better understanding and also higher levels of learning.
- Activities to promote interest may be incorporated wherever possible

Module-1

Introduction and Quality Attributes of Food: Function of foods. Food in relation to health. Aim of food science and technology. Quality attributes – Appearance factors, Textural factors, Flavour factors. Visual and objectively measurable attributes. Aroma of foods – introductory ideas, formation, chemistry and analysis. **Taste** – introductory ideas, formation and chemistry. Additional quality; quality standards, quality control. Introduction to sensory evaluation of foods and beverages.

Modern Trends In Food Science: Biotechnology in food. Bio fortification, Nutraceuticals. Organic foods. Low cost nutrient supplements. Packaging of foods and nutrition labelling. Careers in food science and food industries.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-2

Formation and Chemistry of Food: Carbohydrates. Proteins. Lipids. Vitamins. Minerals. Water. Biotin. Choline. Phytochemicals. Food Processing and Preservation: Food deterioration – Causes. Aims and objectives of preservation and processing. Unit operations in processing. Different methods of food preservation – low temperature, high temperature, preservatives, osmotic pressure, dehydrations. food irradiation; processing and preservations of milk and dairy, vegetables and fruits, cereals, legumes and nut, meat and meat products, fats and oils, beverages, sugars, sweeteners, honey and confectionary, salt and spices.

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-3

Enzymatic and Non-Enzymatic ReactionsDuring Storages: Introduction to enzymes. Nature and function of enzymes. Classification of enzymes. Hydrolases – Esterace, amylases, pectic enzymes. Proteases.Oxidoreductases – phenolases, glucose oxidase, catalose, peroxidase, lipoxygenase, xantine oxidase. Immobilized enzymes. Uses and suggested uses of enzyme in food processing. Non-enzymatic reactions

Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Module-4

Food Additives: Introduction and need for food additives. Types of additives – antioxidants, chelating agents, colouring agents, curing agents, emulsions, flavours and flavour enhancers, flavour improvers, humectants and anti-choking agents, leavening agents, nutrient supplements, non- nutritive sweeteners, pH control agents. **Preservatives** – types and applications. Stabilizers and thickeners, other additives. Additives and food safety. Food Contamination and Adulteration: Types of adulterants and contaminants. Intentional adulterants. Metallic contamination. Incidental adulterants. Nature and effects. Food laws and standards.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.
Module-5	
Environmental Concerns and Food Safety: Water in food production. Properties and requirements of processing water. Environmental concerns – solid waste disposal, wastewater properties, wastewater treatment. Safety hazards and risks. Food related hazards. Processing and handling. Cleaning and sanitizing.	
Teaching-Learning Process	The teaching learning process along with the conventional teaching methodology may involve activities for the whole-class, or structured group work, or guided learning and individual activity.

Course outcomes (Course Skill Set)

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

1. Apply knowledge gained in food chemistry, microbiology, engineering, and sensory evaluation to the development, processing, and preservation of safe, nutritious, and high-quality food products.
2. Utilize advanced instruments and technologies to process and analysei food products and to solve food safety problems.
3. Design food products that meet the various food regulations and laws.
4. Critically assess and analyse food science information available in the public domain in an innovative and ethical way.
5. Communicate technical and other relevant information effectively in both oral and written format to a diverse audience including supervisors, colleagues, and consumers.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

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3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks.

Suggested Learning Resources:

Books

1. Food Science, B. Srilakshmi, 4thedn, New Age International, 2007.
2. Foods: Facts and Principles, N. Shakuntala Manay and M. Shadaksharamurthy, New Age Publishers, 2005.
3. Introduction to Food Science, Rick Parker, ThomsanDetmer, 2001.
4. Food Processing and Preservation, G. Subbulakshmi and Shobha A. Udupi, New Age International, 2001.
5. Food Science, Norman N. Potter and Joseph H. Hotchkin, 1stedn, Avi Publishing Co, 1968.
6. Principles of Food Chemistry, John M DeMan, 3rdedn, Springer,1999

Project work			
Course Code	**21CHP75**	CIE Marks	100
Contact Hours/Week	2	SEE Marks	100
Total Hours of Pedagogy	25	Total Marks	200
Credits	10	Exam Hours	3

PROJECT WORK: The objective of the Project work is

1. To encourage independent learning and the innovative attitude of the students.
2. To develop interactive attitude, communication skills, organization, time management, and presentation skills.
3. To impart flexibility and adaptability.
4. To inspire team working.
5. To expand intellectual capacity, credibility, judgment and intuition.
6. To adhere to punctuality, setting and meeting deadlines.
7. To instil responsibilities to oneself and others.
8. To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concernedDepartment and two senior faculty members of the Department, one of whom shall be the Guide.The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the samefor all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

Course outcomes (Course Skill Set)

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

1. Apply fundamentals of science and engineering to identify, formulate and solve chemical engineering problems
2. Conduct experimental investigation, data interpretation and develop solutions for chemical engineering problems.
3. Analyse and design solutions for chemical engineering problems using modern engineering and IT tools.
4. Assess the impact of chemical engineering solutions on the society and industry and demonstrate the need for sustainable development.
5. Develop the ability to communicate effectively in verbal and written forms and prepare project reports and presentations.
6. Apply the principles of management in chemical engineering and function effectively as member or leader of a team.

VIII Semester

Technical Seminar			
Course Code	**21CH81**	CIE Marks	100
Contact Hours/Week	1	SEE Marks	-
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	-

TECHNICAL SEMINAR: The objective of the seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas. Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the programme of Specialization.

1. Carry out literature survey, systematically organize the content.
2. Prepare the report with own sentences, avoiding a cut and paste act.
3. Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
4. Present the seminar topic orally and/or through PowerPoint slides.
5. Answer the queries and involve in debate/discussion.
6. Submit a typed report with a list of references.

The participants shall take part in the discussion to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Evaluation Procedure:

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question-and-answer session, and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three teachers from the department with the senior-most acting as the Chairman.

Marks distribution for CIE of the course:

Seminar Report:50 marks
Presentation skill:25 marks
Question and Answer: 25 marks

No SEE component for Technical Seminar

Course outcomes (Course Skill Set)

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

1. Develop presentation and communication skills both in verbal and written forms.
2. Review information about recent developments in Chemical engineering.
3. Compare alternate technologies and propose solutions
4. Identify new technologies which are feasible and beneficial to society.
5. Realise potential technologies to identified problems in Chemical engineering.
6. Gain in-depth knowledge in Chemical engineering topics and inculcate a sense of lifelong learning.