PROBABILITY AND STATISTICS		Semester	III
Course Code	BCH301	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. To study the basics of statistics, measure central tendency and dispersion.
2. Develop statistical methods for correlation, regression analysis and curve fitting.
3. Explore the principles of probability.
4. Understand the principles of probability distribution.
5. Explain the sampling theory, errors and chi distribution.

Teaching-Learning Process (General Instructions)

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

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments, quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution for some exercises (post-lecture activity).

Module-1

Basic Statistics: Measures of central tendency, measures of dispersion, range quartile deviation, mean deviation, standard deviation, coefficient of variation, Skewness and Kurtosis, problems.

Module-2

Statistical Methods: correlation and regression –Karl Pearson's coefficient of correlation and rank correlation problems, regression analysis-lines of regression, problems.

Curve fitting: curve fitting by the method of least square-fitting the curves of the form
$Y=ax+b$, $y=ab^x$, $y=ax^2+bx+c$

Module-3

Probability: Introduction, sample space and events, Axioms of probability, Addition and multiplication theorems, conditional probability, Bayes' Theorem, problems.

Module-4

Probability Distributions: Random variables (discrete and continuous), probability mass/density function, Binomial, Poisson, Exponential and normal distributions- problems (no derivations for mean and standard deviation)

Module-5

Sampling theory: Introduction to sampling distributions, standard error, type-I and type-II errors. Test of hypothesis of means, students' distribution, Chi-square distribution as a test of goodness of fit problems.

Course outcome (Course Skill Set)

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

- Elucidate the basic principles of statistics
- Apply the correlation and regression analysis to engineering problem
- Apply the principles of probability to thermodynamic problems
- Explain probability distribution and solve problems
- Explain the sampling, error and its applications

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. B. S. Grewal: "Higher Engineering Mathematics", Khanna publishers,44th Ed.2018.
2. Fundamentals of Mathematical Statistics by Guptha, S.C & Kapoor, V.K .
3. Introduction to Statistical Methods by Guptha ,C.B and Vijay Guptha (1988).

MOMENTUM TRANSFER		Semester	III
Course Code	**BCH302**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

1. 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.
2. Learn detailed explanation on types of fluids, stress and velocity relations, type of fluid flow and boundary layer relations.
3. Understand relationship between pressure energy, kinetic energy, and potential energy using Bernoulli's equation with application to industrial problems.
4. 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.
5. Study flow of compressible fluids, Dimensional analysis, Dimensional homogeneity and various dimensionless numbers and their applications.
6. 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; that teachers 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 of fluids 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, Eddy viscosity. Flow in boundary layers, Reynolds number, and Boundary layer separation and wake formation.

Module-2

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

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

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).

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.

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.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Friction in circular pipes.
2	Flow measurement using venturi /orifice meters (incompressible fluid).
3	Flow over notches.
4	Packed bed.
5	Fluidized bed.
6	Study of various pipe fittings and their equivalent lengths.
7	Unsteady flows-Emptying of Tank
8	Friction in helical/spiral coils.
9	Friction in non-circular pipes.
10	Bernoulli's Experiment.
11	Study of characteristics for centrifugal, Positive displacement pump
12	Reynolds apparatus

Course outcomes (Course Skill Set):

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

1. Recall the concepts of fluid statics and dynamics and able to measure pressure difference.
2. Explain the fundamental equations of fluid flow.
3. Compare the various equations for incompressible and compressible fluids in conduits.
4. Demonstrate the knowledge fluid flow principles in various types of flow measurements, transportation and metering equipment of fluids using experimental techniques and application to industry.
5. Develop functional relationships using dimensional analysis and similitude to solve technical problems.
6. Design appropriate flow systems and flow measuring instruments.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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 the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- 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)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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**)

- The question paper will have ten questions. Each question is set for 20 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.
- Marks scored by the student shall be proportionally scaled down to 50 Marks

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 may include questions from the practical component.

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, 5th edn., 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

UNIT PROCESS IN ORGANIC SYNTHESIS		Semester	III
Course Code	**BCH303**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

1. To understand the principles of nitrations, kinetics and mechanism of nitration.
2. To study the principles of amination
3. To study the principles and application of halogenation operation and applications
4. To understand principles of Sulfonation and sulfation
5. To study hydro formylation and esterification.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers 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

Nitration: Introduction, Nitrating Agents, Aromatic Nitration –Theory of aromatic nitration, Kinetics & Mechanism of Aromatic Nitration.

Module-2

Amination: Amination by reduction introduction, definition, methods of reduction, Reaction mechanism, synthesis of aniline by reduction, catalytic hydrogenation-production of Hydrogen by amination

Module-3

Halogenation: Introduction, Chlorination, Iodination, fluorination, chlorination of ethane, propane. Design & construction of Halogenation, Photo halogenation.

Module-4

Sulfonation & sulfation: Introduction, Sulfonating & sulphating agents and their applications. Preparation of sulfonates and sulphates, transition from batch to continuous processing.

Module-5

Hydrocarbon & Hydro formylation: Introduction, Fischer-Tropsch process, catalysts, thermodynamics of Fisher Tropsch processes, processes related to fisher Tropsch processes.

Esterification: Introduction, Esterification of carboxylic acid derivatives, design & operation of esterification process.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Nitration of nitrobenzene to m-dinitrobenzene
2	Acetylation of aniline by acetic anhydride
3	Preparation of benzoic acid from benzaldehyde
4	Bromination of acetanilide to p-bromoacetanilide
5	Diazotization of aniline and coupling with phenol
6	Estimation of alcohol by acetylation
7	Estimation of amino group by acetylation
8	Estimation of phenol by bromination
9	Estimation of esters by hydrolysis
10	Estimation of carboxylic acid by iodometric titration
11	Analysis of oil i) Determination of acid value ii) Determination of Saponification value

Course outcomes (Course Skill Set):

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

1. Able to carry out nitration reactions, use nitrating agents calculate conversion yield
2. To carryout amination reaction, calculate % conversion and yield
3. Able to conduct chlorination reactions and report yield
4. Select sulphating agents carryout sulfonation and sulfation reactions
5. Design and operation of esterification

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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 the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- 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)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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**)

- The question paper will have ten questions. Each question is set for 20 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.
- Marks scored by the student shall be proportionally scaled down to 50 Marks

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 may include questions from the practical component.

Suggested Learning Resources:

Books

1. Unit Processes in organic synthesis by P. H. Groggins, McGraw Hill Education; 5th edition, 28 May 2001.
2. Organic Chemistry (7th Edition) by Paula Yurkanis Bruice, published by Pearson in 2014.

CHEMICAL PROCESS CALCULATIONS		Semester	III
Course Code	**BCH304**	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	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

1. Learn basic laws about the behaviour of gases, liquids and solids and some basic mathematical tools.
2. Understand systematic problem solving skills, enhance confidence, and generate careful work habits.
3. Learn what material balances are, how to formulate and apply them, how to solve them.
4. 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 teachers 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.

Module-2

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

Module-3

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

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.

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.

Course outcome (Course Skill Set)

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

1. Convert units from one system to others and to express composition of solids, liquids and gases.
2. Discuss material balance of steady state processes like distillation, absorption, extraction, crystallization.
3. Solve material balance problems like drying, mixing, evaporation, bypass, recycle and psychometry.
4. Discuss concepts of material balance problems with chemical reactions, combustions and air fuel calculation.
5. Explain the concepts of thermos physics and thermos chemistry and solve steady state enthalpy balance problems.
6. Develop mathematical solutions for mass and energy balance for any 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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

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.

COMPUTER AIDED DRAWING LAB		Semester	III
Course Code	**BCHL305**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03
Examination nature (SEE)	Practical		

Course objectives:

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

Sl.No	Experiments
1	**INTRODUCTION TO SECTIONAL VIEWS**: Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.
2	**PROPORTIONATE DRAWINGS:** Equipment and piping symbols
3	**VESSEL COMPONENTS:** Vessel openings, Manholes
4	Vessel enclosures, Vessel support, Jackets
5	Shell and tube heat exchanger, Reaction vessel
6	Different types of Evaporators. P & I Diagrams
7	**ASSEMBLY DRAWINGS:** Cotter joint with sleeve
8	Socket and Spigot joint
9	Flanged pipe joint
10	Union joint (Demonstration)
11	Stuffing box (Demonstration)
12	Expansion joint (Screw type or flanged type) (Demonstration)

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, jacketed vessels, evaporator, STHE and DPHE
4. Identify the parts of industrially 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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 03 hours

Suggested Learning Resources:

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

INDUSTRIAL BIOTECHNOLOGY		Semester	III
Course Code	BCH306A	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. Impart basic knowledge of biochemistry and chemicals of life
2. Understand microbes for environmental biotechnology, Bio remediation.
3. Explore microbial application for production of chemicals, antibiotics, fertilizers, pesticides. Etc.,
4. Understand the fermentation technology and processes
5. Apply the principles of unit operation for purification process.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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

Biochemistry: Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids. Vitamins, Biopolymers, Nucleic Acids: RNA, DNA and their derivatives (Structure, Biological function and Importance for life only to be studied). Enzymes and Proteins: 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, Briggs-Haldane approach. Derivation.

Module-2

Environmental Biotechnology

Microbes in waste water treatment, microbial ore leaching and mineral recovery, oil recovery, bioremediation/biodegradation of agro chemicals and other organic compounds. Role of GEMS in degradation of xenobiotics; Bioscrubbers – Biomining of metals - Biopulping.

Module-3

Industrial microbiology and Agricultural microbiology

Microbial Industrial production of chemicals: alcohol (ethanol), acids (citric, acetic and gluconic acid), antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine glutamic acid). SCP production- mushroom cultivation; Biofertilizers and bioinsecticides, Biopesticides, Silage production, Biofuel, Agro-wastes

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. Introduction to sterilization of bioprocess equipment. Growth Kinetics of Microorganisms: Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. Continuous culture: Optimum dilution rate and washout condition in Ideal Chemostat.

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.

Course outcome (Course Skill Set)

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

1. Apply the principles of biochemistry for production and purification of enzymes.
2. Able to use microbes for environmental treatment processes like bioremediation, ore leaching, oil recovery etc.,
3. Design chemicals, antibiotics, bio fertilizer units from industrial microbial application.
4. Apply principles of fermentation and design reactors.
5. Understand the separation process and application in bioprocess industries.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Biochemical Engineering Fundamentals, Bailey and Ollis, 2nd edn, McGraw Hill, 1976.
2. Bioprocess Engineering, Shuler M. L. and Kargi F., 2nd edn, Prentice Hall, 2002.
3. Biochemical Engineering, James Lee, Prentice Hall, 1992
4. Biochemical Reactors, Atkinson B, Pion Ltd., London, 1974.
5. Industrial Microbiology, Casida, Wiley, New York, 1968
6. Principles of Fermentation Technology, Stanbury and Whitekar, 2nd edn, Butterworth-Heinemann An Imprint of Elsevier

MATLAB FOR CHEMICAL ENGINEERS		Semester	III
Course Code	BCH306B	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. Understand the fundamentals of MATLAB.
2. Learn to write function files in MATLAB.
3. Learn numerical integration using MATLAB.
4. Study MATLAB to develop model equation.
5. Understand to write model equation for multivariable ODEs.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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 MATLAB, Introduction to Vectors and Matrix operations, Simple matrix operations and writing script files in MATLAB, Different plot options in MATLAB,

Module-2

Eigen values and Eigen vectors of Matrices, Writing function files in MATLAB and conducting matrix operations.

Module-3

Introduction to numerical integration:
Model equation: AX=b form: Solution of the linear algebraic equation of multivariable
MATLAB program for the solution of linear algebraic equations, i.e., Ax = b

Module-4

Model equation: Nonlinear Equation algebraic equation; Solution using N-R method, MATLAB program for the solution for the nonlinear algebraic equations, Introduction to Simulink-MATLAB, Simulink model development exercises

Module-5

Model equation of type single ODEs: Solution methods, Model equation of type multivariable ODEs: Solution methods, MATLAB program for the solution for the Single ODEs, MATLAB program for the solution for the multiple ODEs,

Course outcome (Course Skill Set)

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

1. Learn the basic concepts of MAT LAB
2. Learn to perform simple matrix operations and writing scripts in MATLAB
3. Solving Eigen values and Eigen vectors
4. Solving model equations using numerical methods
5. Developing MATLAB programs for solving non-linear algebraic equations
6. Developing MATLAB programs to solve single ODEs and multiple ODEs.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one

assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Pushpavanam S., *Mathematical methods in Chemical engineering,* (1e), PH Learning Pvt.Ltd.,2005.
2. Canale R.P. and Chapra S.C , *Numerical Methods for Engineers*, , (7e),McGraw Hill, 2015
3. Montgomery D.C., *Design and Analysis of Experiments*, (8e), Wiley, 2012.

CARBON SEQUESTRATION TECHNOLOGY		Semester	III
Course Code	BCH306C	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. Discuss carbon cycle, capture and storage
2. Understand physical and chemical absorption of carbon from industrial processes.
3. Discuss adsorption capture system and adsorption technology for carbon capture
4. Explain the concept and operation of cryogenic process.
5. Learn about geological and ocean storage methods.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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:

The Carbon cycle, Mitigating growth of the atmospheric carbon inventory, The process of technology innovation, overview of carbon capture and storage.

Module-2

Absorption capture systems:

Chemical and physical fundamentals, absorption applications in post combustion capture, absorption technology RD & D status. Carbon capture from industrial processes: cement production, steel production, oil refining, natural gas processing.

Module-3

Adsorption capture systems:

Physical and chemical fundamentals, adsorption process applications, adsorption technology RD & D status. References and resources.

Module-4

Cryogenic and distillation systems:

Physical fundamentals, Distillation column configuration and operation, Cryogenic oxygen production for oxy-fuel combustion, Ryan–Holmes process for CO_2 – CH_4 separation, RD & D in cryogenic and distillation technologies.

Module-5

Geological storage:

Introduction, Geological and engineering fundamentals, Enhanced oil recovery, Saline aquifer storage, Other geological storage options,

Ocean storage:

Introduction, Physical, chemical, and biological fundamentals, Direct CO_2 injection, Chemical sequestration, Biological sequestration.

Course outcome (Course Skill Set)

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

1. Explain carbon capture and overview of capture technologies.
2. Discuss the absorption capture system and absorption in chemical process industries.
3. Discuss physical and chemical adsorption systems and technology for carbon capture
4. Understand cryogenic principles, types of oxygen distillation techniques.
5. Explain geological and ocean storage of carbon.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Carbon Capture and Storage Stephen A. Rackley Elsevier, 2010
2. Introduction To Carbon Capture and Sequestration: 1 (The Berkeley Lectures on Energy)
3. Carbon Capture, Storage and, Utilization: A Possible Climate Change Solution for Energy Industry, 2014 by Malti Goel, M Sudhakar and R V Shashi

NANOTECHNOLOGY AND NANO SENSORS		Semester	III
Course Code	BCH306D	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. Understand the concepts of nanoscience and develop quantum structures.
2. Study types of nanomaterials.
3. Learn physical methods of synthesis of nanomaterials.
4. Understand synthesis of nanomaterials from chemical methods
5. Explain sustainable energy sources and technologies and synthesis of nano materials.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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 Nano science

Emergence of Nanoscience with special reference to Feynman and Drexler, Role of particle size, Spatial and temporal scale, Exciton, Concept of confinement, strong and weak confinement with suitable examples, Development of quantum structures, Basic concept of quantum well, quantum wire and quantum dot. Density of states of 1D, 2D & 3D structure, surface effect

Module-2

Types of Nanomaterials

Nano clusters, Solid solutions, Thin film, Nano composites (Metal oxide and polymer based), Core shell nanostructure, Buckyballs, Carbon nano tubes and, Zeolites minerals, Dendrimers, Micelles, Liposomes, Block Copolymers, Porous Materials, Metal Nanocrystals, Semiconductor nanomaterials.

Module-3

Synthesis of Nano Material:

Physical Methods: Physical vapour deposition (PVD), Inert gas condensation, Arc discharge, DC sputtering, Ion sputtering, RF & Magnetron sputtering ,Pulse Laser Deposition (PLD), Ball Milling, Molecular beam epitaxy, Electro-deposition,

Module-4

Synthesis of Nano Material:

Chemical Methods: Metal nanocrystals by reduction, Sol- gel, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Nanocrystals of semiconductors and other materials by arrested precipitation, Thermolysis routes, Liquid-liquid interface.

Module-5

Sustainable energy technologies: Solar energy, Hydrogen energy and Nano-materials, Carbon nanotube fuel cells, Hydrogen storage, Thermoelectricity, Re-chargeable batteries, Energy savings, Nano-lubricants, Nano-composites and Nano-catalysts.

Course outcome (Course Skill Set)

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

1. Explain the concepts of nanoscience and its applications.
2. Discuss the types of nanomaterials
3. Able to synthesize nanomaterials from physical methods
4. Able to synthesize nanomaterials from chemical methods
5. Understand the sustainable energy sources and synthesis of nanomaterials

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Introduction to Nanoscience and Nanotechnology, Charles P. Poole, Frank J. Owens 2020
2. G. Cao, Nanostructures and Nanomaterials – Synthesis, Properties and Applications, Imperial College Press 2006.
3. Nanostructured materials: Processing, Properties and Potential Applications, Edited by Carl. C. Koch, Noyes Publications, 2002.
4. Nanoscale Physics for Material Science, By Takaaki Tsurumi, Hiroyuki Hirayama, Martin Vacha, Tomoyasu Taniyama, CRC Press, 2009
5. Introductory Quantum Mechanics for Applied Nanotechnology by D. M. Kim, Wiley-VCH; 2015.

ADVANCED MS EXCEL FOR CHEMICAL ENGINEERS		Semester	III
Course Code	**BCHL358A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03
Examination nature (SEE)	Practical		

Course objectives:

1. Understand the basics of MS Excel.
2. Create open and save workbook.
3. Study entering and editing data.
4. Lear to use functions and formulas.
5. Understand to create and edit charts.

Sl.NO	Experiments
1	**Excel Basics**: Spread sheet concepts and exploring the Microsoft Office Excel environment.
2	**Creating Spread sheets:** Create, open and view a workbook. Save and print workbooks.
3	Enter and edit data. Modify a worksheet and workbook
4	Work with cell references.
5	Learn to use functions and formulas –Mathematical Calculations
6	Create and edit charts and graphics
7	Filter and sort table data.
8	Work with pivot tables and charts, Import and export data
	Demonstration Experiments (For CIE)
9	**Advanced topics**: Set up by formulas
10	Introduction to Logical functions,
11	One-way/two-way Data Table
12	Creating Material balance sheet with cell references.

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 work books.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.

- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 03 hours.

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.

PERSONALITY DEVELOPMENT SKILLS		Semester	III
Course Code	**BCH358B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Credits	01	Exam Hours	01
Examination nature (SEE)	Theory (MCQ type)		

Course objectives:

1. The course intends to develop talent, facilitate employability enabling the incumbent to excel and sustain in a highly competitive world.
2. 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.
3. 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 teachers 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 Personality Development

The concept of personality - Dimensions of personality – Theories of Freud & Erickson-Significance of personality development.

Module-2

Attitude & Motivation

Attitude - Concept - Significance - Factors affecting attitudes - Positive attitude – Advantages –Negative attitude- Disadvantages - Ways to develop positive attitude

Concept of motivation - Significance – Internal and external motives - Importance of self- motivation- Factors leading to de-motivation

Module-3

Self-esteem

Term self-esteem - Symptoms - Advantages - Do's and Dont's to develop positive self-esteem – Low self-esteem

Module-4

Other Aspects of Personality Development

Body language - Problem-solving - Conflict and Stress Management - Decision-making skills -

Leadership and qualities of a successful leader – Character building –Team work – Time management -Work ethics – Good manners and etiquette.

Module-5

Employability Quotient

Resume building- The art of participating in Group Discussion – Facing the Personal (HR & Technical) Interview -Frequently Asked Questions - Psychometric Analysis - Mock Interview Sessions.

Course outcome (Course Skill Set)

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

1. Understand, analyse develop and exhibit accurate sense of self.
2. Think critically.
3. Demonstrate knowledge of personal beliefs and values and a commitment to continuing personal reflection and reassessment.
4. Learn to balance confidence with humility and overcome problems associated with personality.
5. Discuss resume writing skills and face interviews confidently.

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures 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 Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.
- **The duration of the examinations shall be defined by the concerned board of studies**

Suggested Learning Resources:

Books

1. Hurlock, E.B (2006). Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill.
2. Stephen P. Robbins and Timothy A. Judge (2014), Organizational Behavior 16th Edition: Prentice Hall.

Reference Books:

1. Andrews, Sudhir. How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill 1988.
2. Heller, Robert. Effective leadership. Essential Manager series. Dk Publishing, 2002
3. Hindle, Tim. Reducing Stress. Essential Manager series. Dk Publishing, 2003
4. Lucas, Stephen. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill. 2001
5. Mile, D.J Power of positive thinking. Delhi. Rohan Book Company, (2004).
6. Pravesh Kumar. All about Self- Motivation. New Delhi. Goodwill Publishing House. 2005.
7. Smith B . Body Language. Delhi: Rohan Book Company. 2004

UNDERSTANDING EQUIPMENT DATA SHEET		Semester	III
Course Code	**BCH358C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination nature (SEE)	Theory (General question paper pattern)		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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 Flow Diagram, Basics of Data Sheets and Specifications

Module-2

Types of data sheets -process datasheet, instrument data sheet, piping and instrumentation diagram,

Module-3

Utility head diagram, product data sheet, material safety data sheet

Module-4

Exercises on data sheets to capture information pertaining to process, mechanical and electrical

Module-5

Exercises on data sheets to Control requirements for equipment and instruments.

Course outcome (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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures 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 Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 01 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.
- **The duration of the examinations shall be defined by the concerned board of studies**

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

CAREER OPTIONS AFTER ENGINEERING		Semester	III
Course Code	**BCH358D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination nature (SEE)	Theory (General question paper pattern)		

Course objectives:

1. The course aims at creating awareness of career opportunities in Chemical Engineering.
2. 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 teachers 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

- Biotechnologist
- Process and production engineer
- Colour technologist
- Energy Auditor

Module-2

• Energy Engineer
• Environmental engineer
• Material Scientist

Module-3

• Mining engineer
• Nuclear engineer
• Petroleum Engineer
• Product/process development Engineer

Module-4

• Production manager
• Quality control engineer
• R & D Engineer
• Safety Specialist

Module-5

• Waste management engineer
• Water and Effluent engineer
• Legal / Intellectual property specialist
• Future specialization studies

Course outcome (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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures 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 Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one

assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 01 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.
- **The duration of the examinations shall be defined by the concerned board of studies**

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

CHEMICAL ENGINEERING THERMODYNAMICS		Semester	IV
Course Code	**BCH401**	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	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

1. Learn fundamentals of thermodynamics such as types of properties, processes and laws of thermodynamics for flow and non-flow process.
2. Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility and problem solving skills.
3. Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.
4. Study the estimation of partial molar properties, property changes of mixing, and ideal and non-ideal solutions.
5. Learn the fundamentals of phase equilibrium, concept of chemical potential and generation and consistency check for VLE data.
6. 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; that teachers 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

BASIC CONCEPTS:
System, surrounding and processes, Closed and open systems, Intensive and extensive properties, 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.

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: vander Waals 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.

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 C_P & C_V, 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.

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.

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.

Course outcome (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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Smith J.M. and Vanness H.C., "Introduction to Chemical Engineering Thermodynamics", 5th edn., 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.

PROCESS HEAT TRANSFER		Semester	IV
Course Code	**BCH402**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

1. Study various modes of Heat transfer and their fundamental relations
2. Study conduction heat transfer and develop mathematical relations for various solid geometries.
3. Understand properties of insulation and critical thickness of insulation
4. Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
5. Study the Boiling phenomenon and to generate pool boiling curve
6. 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
7. Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers 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 layer slabs, cylinders, and spheres for constant and variable thermal conductivity.
INSULATION: Properties of insulation materials, Types of insulation, Critical and Optimum thickness.

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.

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 dropwise 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

Module-4

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

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.

PRACTICAL COMPONENT OF IPCC

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

Course outcomes (Course Skill Set):

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

1. Comprehend basic laws of heat transfer & 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, heat transfer 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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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 the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- 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)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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**)

- The question paper will have ten questions. Each question is set for 20 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.
- Marks scored by the student shall be proportionally scaled down to 50 Marks

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 may include questions from the practical component.

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", 5th edn., McGraw Hill, New York, 2000
3. Coulson J.M. and Richardson J.F., "Unit Operations of Chemical Engineering", Vol-I, 5th edn., Chemical Engg, Pergamon & ELBS, McGraw Hill, New York, 2000.
4. Rao Y.V.C., "Heat Transfer", 1st edn. Universities Press (India) Ltd., New Delhi, 2001.
5. Dutta, Binay K., "Heat Transfer: Principles and Applications", PHI Learning. 2000

MECHANICAL OPERATIONS		Semester	IV
Course Code	**BCH403**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

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; that teachers 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.

Module-2

SIZE REDUCTION: Introduction – types of forces used for comminution, Criteria for comminution, Characteristics of comminuted 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.

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.

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.

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.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Ball mill
2	Batch sedimentation
3	Free settling
4	Drop weight crusher
5	Screen effectiveness
6	Sieve analysis
7	Jaw crusher
8	Leaf filter
9	Air elutriation
10	Grindability index
11	Gyratory crusher
12	Froth floatation

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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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 the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- 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)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.

- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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**)

- The question paper will have ten questions. Each question is set for 20 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.
- Marks scored by the student shall be proportionally scaled down to 50 Marks

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 may include questions from the practical component.

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

POLLUTION CONTROL AND INSTRUMENTAL ANALYSIS LAB		Semester	IV
Course Code	**BCHL404**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

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

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	UV Spectrophotometer
5	Flame photometer
6	Turbidimeter
7	Potentiometer titration
8	Viscometer
9	Dissolved oxygen
	Demonstration Experiments (For CIE)
10	Bomb calorimeter
11	Measurement of particulate matter in Air
12	Measurement of SO_2 in air
13	KF Auto titrator
14	Orsat Apparatus

Course outcomes (Course Skill Set):

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

1. Experimentally verify the principles and working of instruments studied in theory.
2. Know the use of skills in handling various analytical instruments.
3. Study and use various analytical instruments for analysis of various parameters.
4. Evaluate the data and compare with reported literature.
5. Apply theoretical knowledge of various Analytical Instruments.
6. Acquire practical knowledge and able to handle analytical instruments to determine pollution parameters and thereby control of pollutants to help environment and society

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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):

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

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

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are 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 down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. **Air Pollution Engineering Manual**, Wayne T. Davis, John Wiley & Sons, Inc., 2000.
2. **Practical Waste Treatment and Disposal**, Dickinson, Applied Science publication, London.
3. **Pollution control in Process industries,** Mahajan, TMH, New Delhi.

STATISTICAL THERMODYNAMICS		Semester	IV
Course Code	BCH405A	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	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. Find the connection between statistics and thermodynamics.
2. Differentiate between different ensemble theories used to explain the behavior of the systems.
3. Describe the different ensembles
4. Apply Fermi-Dirac and Bose-Einstein statistics to solids

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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: The Statistical Foundation and Classification Scheme of Classical Thermodynamics. **Probability and Statistics:** Probability: Definitions and Basic Concepts. Permutations and Combinations. Probability Distributions: Discrete and Continuous. The Binomial Distribution. The Poisson distribution. The Gaussian distribution. Combinatorial Analysis for Statistical Thermodynamics

Module-2

The Statistics of Independent Particles

Essential Concepts from Quantum Mechanics. The Ensemble Method of Statistical Thermodynamics. The Two Basic Postulates of Statistical Thermodynamics. The Most Probable Macrostate. Bose–Einstein and Fermi–Dirac Statistics. Entropy and the Equilibrium Particle Distribution.

Module-3

Statistical Thermodynamics for Ideal Gas Mixtures

Equilibrium Particle Distribution for the Ideal Gas Mixture. Thermodynamic Properties of the Ideal Gas Mixture. The Reacting Ideal Gas Mixture. Equilibrium Constant: General Expression and Specific examples

Module-4

Thermodynamic Properties of the Ideal Gas

The monatomic gas: Translation Mode, Electronic Mode. The Diatomic Gas, Rigorous and Semi rigorous Models for the Diatomic Gas, the Polyatomic Gas: Rotational and Vibrational Contribution.

Module-5

Basics of Quantum Mechanics

Historical Survey of Quantum Mechanics, the Bohr Model for the Spectrum of Atomic Hydrogen. The de Broglie Hypothesis. A Heuristic Introduction to the Schrödinger Equation. The Postulates of Quantum Mechanics. The Uncertainty Principle. The Pauli Exclusion Principle

Course outcome (Course Skill Set)

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

1. Differentiate between classical statistics and quantum statistics.
2. Explain the statistical behavior of ideal Bose and Fermi systems
3. Contextualize the connection between quantum mechanics and thermodynamics
4. Derive and compute thermodynamic functions from partition functions
5. Derive the vibrational and translational partition function

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Reif, Frederick (1965). Fundamentals of Statistical and Thermal Physics. McGraw-Hill. ISBN 0-07-051800-9.
2. Sears, Francis W. (1975). Thermodynamics, Kinetic Theory, and Statistical Thermodynamics. Addison Wesley. ISBN 020106894X.
3. Kittel, Charles (1969). Thermal Physics. Chichester: Wiley. ISBN 0-471-49030-X. 2e Kittel, Charles; and Kroemer, Herbert (1980) New York: W.H. Freeman ISBN 0-7167-1088-9
4. Mandl, Franz (1971). Statistical physics. Chichester: Wiley. ISBN 0-471-56658-6. 2e (1988) Chichester: Wiley ISBN 0-471-91532-7, ISBN 0-471-91533-5.
5. Landsberg, P. T. (1978). Thermodynamics and statistical mechanics. Oxford University Press. ISBN 0-19-851142-6. (1990) New York: Dover ISBN 0-486-66493-7
6. Stowe, Keith (1983). Introduction to Statistical Mechanics and Thermodynamics (1st ed.). John Wiley & Sons. ISBN 0-471-87058-7
7. Waldram, J. R. (1985). The theory of thermodynamics. Cambridge: University Press. ISBN 0-521-28796-0.

ANSYS FOR CHEMICAL ENGINEERS		Semester	IV
Course Code	BCH405B	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives: Student will be able to

1. Understand the fundamentals of ANSYS.
2. Understand the concepts of Boolean operation, Meshing.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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 FEM/FEA concepts, Introduction to Ansys, Creating geometry, Generation of key points, lines, Areas and Volumes.

Module-2

Generation of Extruding areas, lines & key points. Work plane management, coordinate systems, Editing geometry, Performing Boolean operations (Add, subtract, intersect)

Module-3

Boolean operation- (divide, glue, partition, overlap), Move/modify, Copy and reflect geometries. Check geometric properties. Import geometry from other CAD software.

Module-4

Material Definition, Explaining about nodes & elements. Meshing. Types of mesh-free & mapped meshing. Explaining about mesh attributes. Size controls. Meshing key points, lines, areas & volumes.

Module-5

Mapped meshing, Mesh concatenation, Mesh extrusion, Mesh sweeping. Hexa –tetra conversion. Define loading & boundary conditions. Different types of loads. Different types of constraints

Course outcome (Course Skill Set)

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

1. Learn basic concepts of ANSYS
2. Learn about extruding areas, editing and creating geometry.
3. Perform Boolean operations
4. Move/modify, Copy & reflect geometries.
5. Import geometry from other CAD software
6. Learn about basics and types of Meshing

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. An Introduction to Ansys Fluent by Jhon E Matsoon Published June 26, 2023
2. Finite Element Simulation with ANSYS workbench by Huei-Huang Lee.

INTRODUCTION TO R LANGUAGE		Semester	IV
Course Code	BCH405C	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

The student will

1. learn the basics of R Language and its fundamental components
2. learn about statistical data analysis and building interactive applications

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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: R interpreter, Introduction to major R data structures like vectors, matrices, arrays, list and data frames, Control Structures, vectorized if and multiple selection, functions.

Module-2

Installing, loading and using packages: Read/write data from/in files, extracting data from web-sites, Clean data, Transform data by sorting, adding/removing new/existing columns, centring, scaling and normalizing the data values, converting types of values, using string in-built functions.

Module-3

Statistical analysis of data for summarizing and understanding data, Visualizing data using scatter plot, line plot, bar chart, histogram and box plot.

Module-4

Designing GUI: Building interactive application and connecting it with data base.

Module-5

Building Packages.

Course outcome (Course Skill Set)

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

1. Understand the fundamental concepts of R Language
2. Learn about the essential components of R Language
3. Understand about installing, loading and using packages.
4. Learn about statistical analysis of data using packages.
5. Understand the visualization of data using scatter plot, line plot, tools, etc.,
6. Build interactive application and connecting with database

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. R for Data Science by Hadley Wickham and Garrett Grolemund
2. The Book of R by Tilman M. Davies
3. Discovering Statistics using R by Andy Field, Jeremy Miles, and Zoe Field.
4. The Art of R Programming by Jared P. Lander

COMPUTATIONAL FLUID DYNAMICS		Semester	IV
Course Code	BCH405D	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

Students will be able to

1. Understand the concepts of different types of flow governing equations.
2. Understand the concepts of CFD modeling of Turbulence Flows and Multiphase Flows.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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

Governing Equations Fluid flow phenomena, flow terminologies, conservation principles, Reynolds Transport Theorem, Stokes Theorem, Integral and Differential approaches, Equation of continuity, Navier stokes equations, Energy Equation, equations in vector forms, Mathematical classification of governing equations, Boundary conditions, conservative and non-conservative forms.

Module-2

Solution Techniques for Governing Equations: FDM

Discretization of governing equations using FDM, FDM grid, forward differencing, backward differencing, FTCS, Explicit methods, Implicit Methods, Semi-implicit methods, solving of governing equations using Euler's, Jacobi, Crank Nicholson and ADI Methods, error analysis, stability criterion, Courant-Friedrichs-Levi condition, convergence and consistency

Module-3

Solution Techniques for Governing Equations: FVM

Finite volume concept, FVM mesh, discretization using FVM, solution of 1-D diffusion equation with and without sources, solution of 2-D diffusion steady and unsteady state, solution of convection-diffusion equation, Conservation, Accuracy, Convergence, Consistency, Stability, Transportive-ness, boundedness, upwind schemes, pressure-velocity coupling, SIMPLE, SIMPLEC and SIMPLER algorithms.

Module-4

CFD modeling of Turbulence Flows

Introduction to turbulent flows, characteristics, time averaging techniques, mean velocity, turbulent eddies and scales, RANS, Reynolds stresses, turbulent flow models, mixing length, energy dissipation, algebraic models, one equation models, Spalart-Allmaras Model, two equation models, k- ε and k- ω models, problem closure, Direct Numerical Solution, Large Eddy Simulation,

Module-5

CFD modeling of Multiphase Flows

Basic Physics of Multiphase flow, applications, classification of multiphase flows, flow patterns, dispersed phases, separated phases, bubbly, slug, annular, stratified, wavy flows for horizontal and vertical geometries, governing equations, Multiphase flow modeling, discrete phase modeling, continuous phase modeling, VOF, Euler-Euler, Euler-Lagrangean Models.

Course outcome (Course Skill Set)

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

1. Solve major governing equations.
2. Use Finite Difference and Finite Volume methods in CFD modeling
3. Generate and optimize the numerical mesh
4. Simulate simple CFD models for turbulence flows
5. Simulate simple CFD models for multiphase flows

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Anderson J. D. Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method (2nd Edition) by H. Versteeg W. Malalasekera
3. Computational Methods for Fluid Dynamics by Joel H. Ferziger & Milovan Perić (4th Edition)
4. Finite Volume Methods for Hyperbolic Problems by Randall J. Leveque (2002)
5. Computational Fluid Dynamics: A Practical Approach by Jiyuan Tu, Guan-Heng Yeoh & Dr. Chaoqun Liu

UPSTREAM OIL & GAS ENGINEERING WITH AI APPLICATIONS		Semester	IV
Course Code	BCH405E	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	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

Students will be able to

1. Understand the phenomenon of oil and gas formation and exploration methodologies including AI & ML and learn to estimate the physical properties of oil and gas.
2. Learn various systems for oil recovery and learn to analyze the enhanced oil recovery methods with modern techniques.
3. Learn to estimate transportation requirements of oil and gas and learn pipeline specifications, automation and storage.
4. Understand the plant layout of a gathering station and oil & gas production facility, learn to design phase separators and learn the application of AI & ML in upstream production.
5. Understand the practices and procedures adopted in gas collection and processing and learn to carry out gas processing calculations.
6. Understand safety, health and environmental aspects of upstream field operations of the oil and gas industry.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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

Oil & Gas Reserves, Properties and Exploration

Origin and Formation of Oil and Gas – Crude oil origin and reserves, formation and composition, geology and mineralogy, crude oil classification and overview of refining;

Impacts of AI & ML in O&G Industry including Stock Price Prediction, Geomodeling Process

Properties, Specifications and Terminology - Calculations on properties: estimation of density, specific gravity, mole fraction, viscosity, gas compressibility factor etc.

Exploration - Various methods of exploration including gravity, magnetic, seismic, electrical and electromagnetic as well as aerial surveys; exploration and related equipment

Seismic Data Processing Techniques (Salt body delineation) using AI & ML.

Module-2

Oil Production Methods and Systems

Equipment in Upstream Oil and Gas Production – Derricks, rigs, drill bits, stimulation, production, water injection systems, compression; offshore platforms, subsea fabrication & installation, modular erection

Drilling – Servicing structures, hoisting systems, rotary equipment, downhole motors, types and selection of drilling practices, well finishing and abatement, casing and tubing, mud hydraulics, wellhead, christmas tree, single and dual completion; AI & ML in reservoir rock classification; AI & ML in well bore testing

Oil Recovery Methods- conventional methods, tertiary methods using heat, steam, complex polymers, surfactants, and microbes to increase the recovery, offshore enhanced oil recovery

Module-3

Transportation and Production Processes

Transportation - Gathering station/ Process platform, flowlines and manifolds, measurements, pumps, beams, sub-surface, compressors, non-isothermal flow, pressure drop and pumping, corrosion monitoring and control, artificial lift methods, gathering stations and assembly

Separation Systems – Types of separators, sludge catcher, test separator, group separator, dehydration, two phase and three phase separation systems, sizing of separators;

Treatment of Recovered Oil – Heater treater, condensate processing - multi-stage flash, stabilization; heat requirements, de-salting and stabilization, produced water treatment Optimal Production Engineering in O&G Industry using AI & ML

Storage of crude oil - Floating Production Storage and Offloading (FPSO) construction, offshore platforms, subsea, tank farms, above ground and underground storage, vapor recovery

Advances in AI Technology for O&G Industry: Service Oriented Architecture (SOA) of Big Data for O&G Industry

Module-4

Gas Production, Processing and Transportation

Gas Production Engineering – Separation facility, gas compression, pressure vessels, separator design and construction, piping guidelines and safety, condensate stabilization, gas flow systems, gas lift, corrosion control, two stage separation

Gas Processing - Dehydration and acid gas removal, dew point control, sweetening processes, solvent processes, liquid recovery, gas compression, processes at floating liquefied natural gas (FLNG) facility, liquefaction, re-vaporization at receiving terminals

Gas Transportation – Technology selection, pipelines, head loss and safety, booster stations, liquefaction, gas to liquid, gas to wire, subsurface storage

Module-5

Safety & Environmental Impact Aspects of Oil & Gas Operations

Safety aspects: Basic safety considerations, HAZOP & HAZID analysis of Oil & Gas Upstream Operations both offshore and onshore

Pollution Control Technologies for Oil and Gas Operations – Identification and significance of pollutants in upstream operations both onshore and offshore and their effect on water and air quality, handling of hazardous chemicals in oil and gas, and waste treatment methods and environmental management plan.

Course outcome (Course Skill Set)

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

1. Explain the phenomenon of oil and gas formation and exploration methodologies including AI & ML and estimate the physical properties of oil and gas.
2. Select appropriate systems for oil recovery and analyze the enhanced oil recovery methods with modern techniques.
3. Estimate transportation requirements of oil and gas, explain pipeline specification, automation and storage.
4. Estimate transportation requirements of oil and gas, explain pipeline specification, automation and storage
5. Explain the practices and procedures adopted in gas collection and processing and carryout gas processing calculations
6. Explain safety, health and environmental aspects of upstream field operations of the oil and gas industry

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 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 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:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test 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 course (**duration 03 hours).**

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

Suggested Learning Resources:
Books

1. Surface Operations in Petroleum Production, Volume I. (1987) Book by George V. Chilingar, John O. Robertson, and Sanjay Kumar
2. Surface Production Operations: Vol 2 (3rd Edition, 2014): Design of Gas-Handling Systems and Facilities
3. Working Guide to Petroleum and Natural Gas Production Engineering, By William Lyons, Elsevier 2009
4. Handbook of Offshore Oil and Gas Operations by James G. Speight, Elsevier 2014

DATA ANALYTICS		Semester	IV
Course Code	**BCH456A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Credits	01	Exam Hours	01
Examination type (SEE)	Theory (MCQ type)		

Course objectives:

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

1. Chemical engineers to use data science tools and take advantage of the increasing amount of data available to them.
2. Data storage, analysis, and visualization.
3. Benefit in becoming a master in data analytics along with Excel, R and Python.
4. Develop interpersonal and aptitude skills.

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 data analytics, Data management tools such as Excel, Statistical learnings, SQL. Introduction to languages such as Python , R, Machin learnings, and SQL

Module 2

Methods to organize, sort and process datasets.

Module 3

Basics of real-time processing of data from sensors, instruments, and simulations.

Module 4

Data analysis software, Programming with R, Python, Statistics and computing, Machine learning.

Module 5

Data Visualization

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 and 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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures 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 Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only

one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 01 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.
- **The duration of the examinations shall be defined by the concerned board of studies**

Suggested Learning Resources:

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

ENTREPRENEURSHIP DEVELOPMENT		Semester	IV
Course Code	BCH456B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination type	Theory (General question paper pattern)		

Course objectives:

The objective of this course is to:

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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
Evolution of 'Technopreneur-ship' , Entrepreneurial Motivation in the current economic scenario
Module 2
Creativity and entrepreneurship, Innovation and inventions, & Legal Protection of innovation
Module 3
New Ventures - Industrial Parks, Special Economic Zone, Export oriented units, Incentives to entrepreneurs
Module 4
Organisational Assistance to an entrepreneur, Financial assistance by different agencies
Module 5
Rules And Legislation, Basics of Project Report

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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures 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 Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 01 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.
- **The duration of the examinations shall be defined by the concerned board of studies**

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.

BASICS OF ACCOUNTING AND TAXATION		Semester	IV
Course Code	BCH456C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination type (SEE)	Theory (General question paper pattern)		

Course objectives: Student will be able to

1. To provide an understanding of the principles of accounts and practice in recording transactions and interpreting individual as well as company accounts.
2. To develop an understanding of the form and classification of financial statements as a means of communicating financial information.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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 Accounting Concepts - Background of accounting and accountancy: knowledge and understanding of GAAP; accounts - types and classification; basic terms used in accounting, Accounting Standards and Accounting Equation.

Module-2

Journal and Ledger – Journal: recording of entries in journal with narration, Ledger, posting from journal to respective ledgers, Cash book (including petty cash book): single column; double column; triple column.

Module-3

Depreciation, Provisions and Reserves - Methods of charging depreciation (straight line and WDV method), problems with purchase and sale of assets, Provisions and Reserves.

Module-4

Taxation - Introduction to Income Tax, Basic definitions, Income Tax slabs, Income Tax calculation, Financial Year and Assessment Year

Module-5

Introduction to GST - Historical background of GST, Types of GST, Levy and Collection of GST, Exemption from GST

Course outcome (Course Skill Set)

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

1. Learn the background knowledge and requirement of accounting.
2. Learn basic terms used in accounting, accounting standards and accounting equations
3. Learn the concepts of journal, ledger and entries with narration.
4. Understand the concepts of Depreciation, Provisions and Reserves.
5. Understand the concepts of Taxation and its impact on economy.
6. Historical background of GST, Types of GST, Levy and Collection, Exemption from GST

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) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures 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 Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 01 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.
- **The duration of the examinations shall be defined by the concerned board of studies**

Suggested Learning Resources:

Books

0. Basic Accounting by K M. Bansal and Dr. Rithu Guptha Reprint 2022.
1. Principles and Practice of Accounting by D G. Sharma and Dr. S. K Agrawal, 3rd edition,
2. Principles of Taxation Laws with goods and services tax act, 2017(GST) by Prof. Ullas Kumar Saha

ENERGY AND ENVIRONMENTAL AUDITING		Semester	IV
Course Code	BCH456D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Credits	01	Exam Hours	01
Examination type (SEE)	Theory (MCQ type)		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers 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

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.

Module 2

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

Module 3

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

Module 4

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

Module 5

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

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 out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures 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 Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 01 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.
- **The duration of the examinations shall be defined by the concerned board of studies**

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.