INDUSTRIAL PROCESS MANAGEMENT		Semester	05
Course Code	**BCH501**	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 hrs
Examination type (SEE)	Theory		

Course objectives:

- Understand the roles of managers and historical evolution of various approaches to the study of management.
- Demonstrate the process of planning which can be used as a tool for decision-making in organizations.
- Create logical relationships between various organizational structures and designs.
- Implement leadership practices towards the management and development of people within organizations.

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Organization and Management: Forms of Business Organization, Basic concepts of management classification, characteristics, objectives, Functions of management-planning, organizing, staffing, directing, Organization Structure-linear, functional, line and staff, staff and functional, Management by objectives, Management information system.

Module-2

Personnel (Human Resource) Management: Acquisition of manpower-functions and objectives of personnel management, manpower planning, Job analysis and evaluation, Induction, Orientation, Training and development, Maintenance of human resource. Industrial relations, Trade Unionism.

Module-3

Entrepreneurship and Project Management: Entrepreneurship- Types, Growth, functions, qualities, Project Planning-project implementation, monitoring and control, evaluation strategies, Gantt charts, Critical path method, Performance evaluation and review technique, application of network techniques.

Module-4

Operation Research: Introduction, phases, scope, methodology, O R Models, techniques, applications of O R, Linear Programming, graphic method, simplex method, waiting line theory, game theory, Monte Carlo technique. Dynamic programming.

Module-5

Materials Management: Purchasing, make or buy decision, stores management, inventory control, spare parts management, value engineering.

Marketing: Marketing research, marketing management, consumer behaviour and market promotion

Course outcome (Course Skill Set)

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

1. Discuss the principles of management theory & recognize the characteristics of an organization.
2. Explain the roles of management in acquisition, planning and maintenance of human resource
3. Discuss the types, growth, functions, qualities of entrepreneurship and project management
4. Differentiate the phases, scope, methodology and models of operation research
5. Design appropriate organizational structures for material management and marketing
6. Demonstrate leadership practices in organizations that would enable systems orientation.

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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. T R Banga, S C Sharma, "Industrial Organization and Engineering Economics", Khanna Publications 24th Edition ISBN No. 81-7409-078-9
2. Dr. Vilas Kulkarni & Hardik Bavishi, Engineering Economics & Management: Vikas Publishing.
3. Stephen Robbins, Mary Coulter &Neharika Vohra, Management, Pearson Education Publications, 10th edn, ISBN: 978-81-317-2720-1.
4. James Stoner, Edward Freeman & Daniel Gilbert Jr, "Management", PHI, 6th Edition, ISBN: 81-

203-0981-2.

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CHEMICAL REACTION ENGINEERING		Semester	05
Course Code	**BCH502**	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	3 Hours
Examination nature (SEE)	Theory		

Course objectives:

The students will be able to:

- Analyze and interpret the data to determine rate equation and estimate the performance equation of ideal systems.
- Formulate and analyze the rate equations for various reactions using suitable mechanisms.

Teaching-Learning Process (General Instructions)

These are sample strategies which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

MODULE-1

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

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

MODULE-2

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

MODULE-3

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

Multiple Reactor Systems: Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series.

MODULE-4

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

MODULE-5

Catalysis: Introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, inhibitors etc, Mechanism of catalysis. Rate equations for different rate controlling step.

Deactivation: Deactivating catalyst. Mechanism, rate & performance equation.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Batch Reactor
2	Isothermal plug flow reactor
3	Mixed flow reactor
4	Semi batch reactor
5	RTD Studies in mixed flow reactor
6	RTD Studies in tubular Reactor
7	Study of catalyst properties
8	Effect of temperature on rate of reaction
	Demonstration Experiments (For CIE)
9	Adiabatic reactor
10	Packed bed reactor
11	CSTR in series
12	Biochemical Reaction (Batch)

Course outcomes (Course Skill Set):

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

The IPCC means the 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**.

CIE for the theory component of the IPCC

- 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 time table, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. 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.

- The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 sub-questions are to be set from the practical component of IPCC; the total marks of all questions should not be more than 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.
- 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.

Suggested Learning Resources:

Books:

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

Web links and Video Lectures (e-Resources):

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

MASS TRANSFER OPERATIONS-I		Semester	05
Course Code	**BCH503**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible.

Module-1

Introduction: Types of diffusion in fluids. Types of diffusion in solids. Measurement and calculations of diffusivities. Mass transfer coefficients and their correlations. Theories of mass transfer. Interphase mass transfer. Material balance for co-current, cross-current and counter-current operations. Concept of stages, Cascade operations, NTU and HTU concepts.

Module-2

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

Module-3

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

Module-4

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

Module-5

Crystallization: Factors governing nucleation and crystal growth rates. Controlled growth of Crystals. Incorporation of principles into design of equipment. Different types of crystallizer equipment.
Introduction to Novel Separations: Ion exchange, Membrane Processes-Reverse Osmosis, Dialysis, Ultra and Micro-filtrations, Super-critical fluid extraction (Working principle and operations only)

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

1. Mass Transfer in Chemical Engineering Processes, by Jozef Markoš http://www.e-booksdirectory.com/details.php?ebook=6659
2. Ion Exchange: Studies and Applications, Ayben Kilislioglu, http://www.e-booksdirectory.com/details.php?ebook=10637
3. Transport Processes and Unit Operations by Geankoplis http://chembookneed.blogspot.in/2010/08/transport-processes-and-unit operations.html

MOOC's:

1. Mass transfer operations 1 https://www.coursebuffet.com/sub/chemical engineering/480/mass-transfer-operations-i
2. Mechanical heat and mass transfer https://www.springboard.com/udemy/mechanical-heat-and-mass-transfer/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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MASS TRANSFER OPERATIONS LAB-1		Semester	05
Course Code	**BCHL504**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2:0	SEE Marks	50
Credits	01	Total SEE+CIE	100
Examination type (SEE)	Practical	Exam Hours	3 Hours

Course Objectives:

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

Sl.N	Experiments
1	Diffusion of organic vapors in air
2	Surface evaporation
3	Tray dryer
4	Adsorption studies
5	Rotary/ vacuum dryers
6	Solid Dissolution
7	Ion Exchange
8	Wetted wall column
9	Absorption in packed columns.
10	Absorption with chemical reaction.

Course Outcomes (Course Skill Set):

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

1. Experimentally verify the mass transfer concepts studied in theory.
2. Conduct experiment and make observations for mass transfer equipment.
3. Discuss the effect of mass transfer coefficients in design of equipment.
4. Explain the handling of Mass transfer operations.
5. Apply theoretical knowledge of mass transfer equipment.
6. Acquire practical knowledge of mass transfer equipment.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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).

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- 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 schedules 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:

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POLYMER SCIENCE & ENGINEERING		Semester	05
Course Code	**BCH515A**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

The students will be:

1. Able to understand broad and fundamental knowledge of the polymers and their chemical, physical and mechanical behavior.
2. Able to emphasize the processing techniques, along with the production of polymers and correlate structure, processing properties relationships for polymers and blends.

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible.

Module-1

Principles of Processing of Polymers: Melt processing of thermoplastics. Classification of processes. Thermoset plastics processing, crystallization,

Orientation & shrinkage, copolymers blending, compounding for engineering application, stress–strain behaviour, WLF equation, practical assessment for long term behaviour.

Module-2

Polymer Extrusion: Requirements of polymer for extrusion. Single screw and double screw plasticating extruder zones in extrusion, breaker plates, extruder screw, power calculation. PVC extruder. Die and calibration equipment prime mover for extrusion, co extrusion, extrusion coating, extrusion film blowing.

Reactive extrusion. Extrusion blow moulding for PET bottles, wire drawing-PVC, spinning–various types and applications. Application of various extruded products. Rheological aspects of extrusion and extrusion defects. Operational and maintenance of extrusion equipment, pultrusion.

Module-3

Injection Moulding: Polymer characteristics for injection moulding. Reciprocating screw injection moulding. Single impression mould. Multi impression moulds. Cooling requirements in moulds. Hot runner moulds, gate, mould clamping force calculations. Control of pressure, temperature and time of injection thermostat and fiber reinforced polymer injection moulding, sandwich moulding and injection blow moulding. Rheological aspects and defects of injection. Comparison of injection moulding and extrusion of injection. Operational and maintenance of injection moulding equipment. Reaction injection moulding, Applications.

Module-4

Compression Moulding: Applications. Principles. Comparison with other processing methods. Derivation of compression mould thickness or compaction force. Transfer moulding.

Calendering: Characteristics of polymer for calendering. Principles and operation of calendering. Derivation of film thickness and pressure required for rollers. Gauge control during calendering. Application of PVC calendered products.

Module-5

Thermoforming:

Basic principles, Vacuum forming, Pressure forming, Description of operations, Product design, Applications. Derivation of thermoformed product thickness.

Rotational Moulding: Principles. Operation & applications. Thickness. Cooling calculations. Testing of Plastics: Thermal, electrical, optical, mechanical properties testing.

Course Outcomes (Course Skill Set)

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

1. Apply principles of melt processing for thermoplastics and thermoset plastics.
2. Differentiate between various polymer processing techniques.
3. Evaluate mechanical behavior of polymers for long-term performance.
4. Optimize polymer extrusion processes and address common defects.
5. Implement effective injection moulding strategies and maintenance.
6. Conduct comprehensive testing of polymer properties for quality assurance.

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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Principles of Polymer Processing, Morton Johnes Chapman, Hall 1989.

2. Plastic Engineering, R.J. Crawford, 3rd edn, Research Studies, 1996.

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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INDUSTRIAL POLLUTION CONTROL		Semester	05
Course Code	**BCH515B**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

The student will be able to:

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

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

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

Module-2

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

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

Module-3

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

Module-4

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

Module-5

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

Noise Control: Sources and definitions. Determination of noise levels. Noise control criteria and noise

exposure index. Acoustic absorptive materials.

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Air Pollution, H.C. Perkins, McGraw Hill, 1974.
2. Environmental Engineering, G.N. Pandey and G.C. Carney, Tata McGraw Hill, 11th Reprint, 2002.
3. Environmental Pollution Control Engg, C.S. Rao, 2nd edn, New Age International Reprint, 2002.

4. Industrial Pollution Control Handbook, Lund, H.F., 6th edn, Vol.1, McGraw Hill, 1971.
5. Integrated Solid Waste Management, George Tchobanoglous et al, 2nd edn, McGraw Hill & Co, 1993.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Site Visit.
- Quiz.

MATERIAL SCIENCE AND ENGINEERING		Semester	05
Course Code	**BCH515C**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible.

Module-1

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

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

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

Module-2

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

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

Module-3

Deformation of Materials and Fracture: Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture.

Heat Treatment: Annealing, Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.

Module-4

Corrosion and its Prevention: Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, Factor influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings, glass lining, lead lining, FRP lining.

Module-5

Typical Engineering Materials: Ferrous metals, Nonferrous metals and alloys – Aluminium and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Mechanical, electrical and thermal properties of ceramic phase.

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/113/102/113102080/
- https://archive.nptel.ac.in/courses/112/108/112108150/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CHEMICAL EQUIPMENT DESIGN		Semester	05
Course Code	**BCH515D**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

A student will be able to:

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible.

Module-1

Introduction: Basic considerations in design. General design procedure. Equipment classification. Various components of process equipment. Design parameters. Design Considerations: Material selection. Factors affecting design. Stresses due to static and dynamic loads (Internal & External).

Design of Pressure Vessels: Design parameters, conditions & stresses. Design of shell, and other vessel components. Vessel at low & high operating temperatures. Design problems using given process parameters.

Module-2

Vessel Component Design: Design of supports for vessels- Bracket, Leg, Saddle and Skirt supports. Classification of flanges. Flange thickness calculation, Gasket selection, Bolt selection, Nozzle Selection.

Design of vessel closures - Flat plates, Formed heads, Elliptical & Hemispherical heads. .

Module-3

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

Module-4

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

Module-5

Tall Vertical Vessels: Vessels subjected to various loads, Multi shell constructions. Determination of shell thickness. Supports for columns.

Pipe Line Design: Pipe line sizing, Condensate and steam pipe design.

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (**duration 03 hours).**

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

Suggested Learning Resources:

Books

1. Process Equipment Design - M. V. Joshi, 3rd edn., Macmillan & Co. India, Delhi, 1998.
2. Process Equipment Design - Vessel Design, Brownell & Young, John Wiley, 1959.
3. Process Design of Equipment - Vol 1, S. D. Dawande, 3rd edn, Central Techno Publications. 2003
4. Chemical Engineers Handbook, Perry & Green, 7th edn, McGraw Hill, 1997
5. Pressure Vessel Code - IS 2825, IS Code, B.I.S., New Delhi, 1969
6. Flow of Fluids through Valves, Fittings & Pipes, Crane Amazon, 2006

Web links and Video Lectures (e-Resources): Joshi's Process equipment design https://books.google.co.in/books/about/Joshi_s_Process_Equipment_Design.html?id=UTC1bc3PCNcC&redir_esc=y
MOOC's: [1] http://nptel.ac.in/courses/103103027/28 [2] http://nptel.ac.in/courses/103103027/8
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning •

MINI PROJECT		Semester	05
Course Code	**BCH586**	CIE Marks	100
Teaching Hours/Week (L:T:P:S)	0:0:4:0	SEE Marks	-
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03 Hours
Examination type (SEE)	Practical		

Mini Project work:

Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multi disciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini Project:

Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini project, shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini Project.

Course outcomes (Course Skill Set)

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

1. Apply fundamentals of science and engineering to identify, formulate and solve chemical engineering problems.
2. Conduct experimental investigation, data interpretation and develop solutions for chemical engineering problems.
3. Analyse and design solutions for chemical engineering problems using modern engineering and IT tools.
4. Assess the impact of chemical engineering solutions on the society and industry and demonstrate the need for sustainable development.
5. Develop the ability to communicate effectively in verbal and written forms and prepare project reports and presentations.
6. Apply the principles of management in chemical engineering and function effectively as member or leader of a team.

PROCESS EQUIPMENT DESIGN & DRAWING		Semester	06
Course Code	**BCH601**	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	3 Hours
Examination nature (SEE)	Theory		

Course objectives:

The students will be able to:

- Understand advances and types in the design of heat and mass transfer equipment and its accessories.
- Develop modifications based on design.

Note:

Detailed chemical engineering process design of the following equipment should be studied. Standard code books are to be used. The detailed proportionate drawings shall include sectional front view, full top/ side view depending on equipment and major components.

Class work: Students are to design the equipment. They shall also be trained to draw free hand proportionate sketches.

Final Examination: Students have to answer any one of the two questions given in the examination. After completing the design, free hand proportionate sketches are to be drawn as required.

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible.

CONTENTS

1. Double Pipe Heat Exchanger.
2. Shell and Tube Heat exchanger
3. Condenser–Vertical
4. Evaporator–Single effect
5. Sieve Tray Distillation Column
6. Packed Bed Absorption Column
7. Rotary Drier

Course outcomes (Course Skill Set):
At the end of the course, the student will be able to:

1. To identify proper engineering design problem
2. To collect physicochemical and thermodynamic data for given problem.
3. To calculate heat transfer area and size for the given equipment using appropriate equations.
4. To determine mechanical design parameters for equipment.
5. To draw proportionate drawings.

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 total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

The IPCC means the 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**.

CIE for the theory component of the IPCC

- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 03-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 drawing and preparation of drawing record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every drawing/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 drawing report. Each drawing report can be evaluated for 10 marks. Marks of all drawings are added and scaled down to **15 marks**.
- The drawing test **(duration 02/03 hours)** after completion of all the drawings shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of drawing evaluations and tests added will be CIE marks for the drawing lab component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the drawing lab 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**)

1. The question paper will have two questions. Each question is set for 100 marks.
2. The students have to answer any one full question.
3. 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 drawing lab portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the drawing lab component.

- The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the drawing lab component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the drawing lab component shall be included**.** The maximum of 04/05 sub-questions are to be set from the practical component of IPCC, the total marks of all questions should not be more than 30 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify for the SEE. Marks secured will be scaled down to 50.
- 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.

Suggested Learning Resources:

Books

1.Process Equipment Design - M. V. Joshi, 3rd edn., Macmillan & Co. India, Delhi, 1998.
2. Process Equipment Design - Vessel Design, Brownell & Young, John Wiley, 1959.
3. Process Design of Equipment - Vol 1, S. D. Dawande, 3rd edn, Central Techno Publications. 2003.
4. Chemical Engineers Handbook, Perry & Green, 8th edn, McGraw Hill, 1997.
5. Pressure Vessel Code - IS 2825, 4503, IS Code, B.I.S., New Delhi, 1969.
6. Flow of Fluids through Valves, Fittings & Pipes, Crane Amazon, 2006.

Web links and Video Lectures (e-Resources):

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

MASS TRANSFER OPERATIONS-II		Semester	06
Course Code	**BCH602**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	03 Hours
Examination type (SEE)	Theory		

Course objectives:

- This course aims at providing students with an understanding of principles of advanced separation processes.
- To learn conceptual design of separation processes and design of equipment involved.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Gas liquid contacting systems: Types, construction and working of plate and packed columns. Types and properties of industrial packing, plate efficiencies. HTU and NTU concepts, HETP.
Packed tower absorption: Liquid phase holdup and pressure drop in absorption towers. Design of packed towers-height and diameter, minimum solvent rates, Problems encountered in packed towers

Module-2

Distillation: Introduction, vapor liquid equilibria, relative volatility, prediction of VLE from vapor pressure data using Raoult's law, VLE for multi-component systems, Non-ideal systems, Azeotropes, Immiscible systems, Flash distillation.

Module-3

Distillation: Multi-stage rectification column. Design using McCabe Thiele method for binary mixtures. Side stream in distillation columns, Multiple feed to distillation columns. Plate to plate calculations-Lewis Sorel Method. Ponchon-Savarit method. Extractive, azeotropic distillations. Molecular, vacuum distillations.

Module-4

Liquid-liquid Extraction: Ternary equilibrium, solvent selection, single stage, multistage cross current, counter current extraction. Equipment for liquid-liquid extraction. Numerical problems on miscible and immiscible systems of extraction.

Module-5

Leaching operation: Equipment for leaching, preparation of solids for leaching, equilibrium and phase diagrams. Calculations for single stage and multistage leaching operations. Numerical problems

Course outcome (Course Skill Set)

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

1. Comprehend the gas – liquid operation and apply the knowledge of gas-liquid operations in absorption
2. Study the absorption processes and apply to a wide variety of process such as recovery of vapours from dilute mixture with gases, solute recovery
3. Apply the knowledge of distillation in separation of liquid mixtures
4. Study the extraction process and able to design suitable separation process using extraction
5. Solve problems associated with leaching and extraction operations

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (duration 03 hours).

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

Suggested Learning Resources:

Books

1. Mass Transfer Operations, Robert E Treybal, 3rd Edition, McGraw Hill, 1981, ISBN:978007065760.
2. Unit Operations in Chemical Engineering, McCabe & Smith, 6th Edition, McGraw Hill, 2001. ISBN:9780072848236.
3. Coulson and Richardson, "Chemical Engineering Volume 1 and Volume 2", 4th Edition, Pergamon Press, 1998. ISBN: 0750644451.
4. Badger and Banchero, "Introduction to Chemical Engineering", Edition 1997, Tata McGraw Hill. ISBN:9780070850279.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=PsTHlSpr9us&list=PLkntubLGPn4mjMJBDHys95hb-XASxDZSJ.
- https://youtu.be/8SyDfGJV8kA?si=YYq5GVIOA970dgjW

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CHEMICAL PROCESS INDUSTRIES		Semester	06
Course Code	**BCH613A**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Sulphur: Elemental Sulphur mining, Sulphur from ores, Oxides of Sulphur (SO_2, SO_3).

Industrial Gases: CO_2, H_2, O_2, N_2, Water gas and Shift gas.

Module-2

Acids: Sulphuric, Nitric, Hydrochloric, phosphoric acid.

Chlor-Alkali Industries: Sodium chloride, Soda ash, Caustic soda, Chlorine, Bleaching powder.

Module-3

Fertilizers: Ammonia, Urea, Ammonium chloride, Ammonium nitrate, Ammonium phosphate, Ammonium sulphate, DAP, Bio fertilizers.

Phosphorous Industries: Manufacture of white and Red Phosphorus, Pentoxide, Phosphoric Fertilizers, Super Phosphate and Triple Super Phosphate.

Module-4

Fermentation Industries: Production of alcohol, acetic acid and citric acid, penicillin.

Petroleum Industries: Constituents of crude petroleum refining and processing. Production of Ethylene, Propylene.

Module-5

Polymers and Rubber: Polymerization, PVC, LDPE, Polyproylene, cross linked polymers, natural rubber, synthetic rubber and rubber compounding.

Miscellaneous Industries: Paints, Pigments, Varnishes, Enamel, Lacquers, Hydrogen peroxide (H_2O_2), Silicon carbide (SiC), Glass.

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (duration 03 hours).

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

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

- .https://nptel.ac.in/courses/103107082

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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APPLIED MATHEMATICS IN CHEMICAL ENGINEERING		Semester	06
Course Code	**BCH613B**	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 Hours
Examination nature (SEE)	Theory		

Course objectives:

The students will be able to

- To impart the knowledge of mathematics for solving various mathematical equations that need to be solved in several chemical engineering courses such as heat and mass transfer, momentum transfer, reaction engineering, separation processes, thermodynamics, etc.

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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Mathematical Formulation of the Physical Problems: Applications of laws of conservation of mass, energy. Statement of the problem. Modeling. Examples and problems.

Module-2

Ordinary Differential Equations: Formulations of ordinary differential equations involving chemical engineering problems. Solutions- Equations of first order and first degree. Equations of first order and second degree. Bernoulli equation. Euler equation. Simultaneous linear differential equations.

Module-3

Partial Differential Equations: Formulations of partial differential equations involving chemical engineering problems. Solutions. Fourier series.

Module-4

Numerical Methods: Solutions of ordinary differential equations for chemical engineering problems. Solutions of partial differential equations for chemical engineering problems.

Module-5

Difference operator, linear difference equations, analysis of stage wise processes. Laplace transforms and their applications to chemical engineering.

Course outcome (Course Skill Set)

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

1. Understand the basic algorithms for solution of and be able to solve linear and non-linear equations.
2. Be proficient in manipulation of logarithmic, exponential, and other non-linear functions in order to linearize and to regression non-linear expressions.
3. Understand the basic algorithms for solution.
4. Solve numerical integration and ordinary differential equations.
5. Familiar with a variety of numerical methods for solving partial differential equations.
6. Apply the techniques learnt in this subject to the solution of comprehensive design problems in chemical engineering.

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 time table, with common question papers for the course (duration 03 hours).

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

Suggested Learning Resources:

Books

1. Applied Mathematics in Chemical Engineering, H.S. Mickley, T.K.Sherwood and C.E. Reed, 3rd edn ,Tata McGraw Hill, 1999.
2. Mathematical Methods in Chemical Engineering, G.Jenson & G.V. Jeffreys, Academic Press, London, 1977.
3. Mathematical Methods in Chemical Engineering ,S .Pushpavanam, Eastern Economy Edition, 2004.

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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CHEMICAL PROCESS INTEGRATION		Semester	06
Course Code	**BCH613C**	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 Hours
Examination nature (SEE)	Theory		

Course objectives:

- To understand the energy and mass targets in design of processes.
- To learn the concept of Process Intensification.
- To apply the techniques of intensification to arrange of chemical processes and process equipment

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Introduction to Process Integration: Graphical Techniques. Overall mass targeting, Synthesis of Mass Exchange Network: Graphical approach. Direct recycle strategies.

Module-2

Visualization strategies: for development of mass integrated system: Algebraic approach to targeting direct recycle

Module-3

Algebraic Approach to targeting mass exchange, networking. Recycle strategies using property integration.

Module-4

Heat Integration: Combined heat and power integration. Optimization: Mathematical approach to direct recycle, Graphical method, simplex method, single variable optimization, multivariable optimization

Module-5

Mathematical Techniques: Synthesis of mass & heat exchange excluding Lingo optimization techniques for mass integration. Initiatives and applications. Case studies.

Course outcome (Course Skill Set)

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

1. Understand of the fundamentals of process integration.
2. Perform pinch analysis.
3. Analyse and design heat exchanger networks.
4. Minimize the water consumption and waste generation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 time table, with common question papers for the course (duration 03 hours).

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

Suggested Learning Resources:

Books

Books

1. Process Integration- Mahmoud M, EL-Hawalgi Vol 17, Academic press 2006.
2. Linnhoff, D.W., User Guide on Process Integration for the Efficient Use of Energy Institution of Chemical Engineers (1994).
3. Smith, R., Chemical Process Design and Integration, John Wiley & Sons (2005).
4. Shenoy, V. U., Heat Exchanger network Synthesis, Gulf Publishing (1995).
5. Kumar, A., Chemical Process Synthesis and Engineering Design, Tata McGraw Hill (1977).

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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PETROLEUM REFINERY ENGINEERING		Semester	06
Course Code	**BCH613D**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

- Understand history, classification of petroleum crudes.
- Understand the extraction and production of oil and gas to meet energy needs, as well as refining of crude oil for a wide spectrum of useful products such as petrochemicals, Chemicals, Plastics.

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

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

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

Product Properties and Test Methods: Gas. Various types of gas and LPG. Reid vapor pressure analysis. Gasoline and naptha. Octane number. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities etc, Diesel, octane testing, viscosity etc. Grades of diesels e.g. HSD, LDO. Diesel additives. Lube oils: Types, tests-carbon residue and viscosity index.

Module-2

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

Module-3

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

Treatment of lubes: sulphuric acid, clay treatment, solvent treatment- phenol, furfural.

Module-4

Thermal Processes: Thermal cracking reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. Visbreaking, Dubbs two coil cracking process.

Catalytic Reforming: Theory of reforming. Factors influencing reforming, reforming catalysts, feed stock requirements. Plat-forming, flexi forming etc.

Module-5

Catalytic Cracking: Comparison of thermal and catalytic cracking. Carbonium ion chemistry. Feedstock requirements. Cracking conditions. Commercial cracking analysis. Various catalytic cracking processes. Fixed bed crackers. Moving bed crackers. Fluid catalytic cracking-flexi cracking-ortho-flow reactor. Theory of coking: various types of coking processes. Delayed coking, fluid coking, contact coking, flexi coking. Naptha cracking, naptha cracking for ethylene as feed selection and gas yield. Hydro cracking. Theory of hydro cracking. Catalysts for hydro cracking.

Course outcome (Course Skill Set)

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

1. Outline markets, prospects and classification of petroleum crudes.
2. Explain the refining of crude oil for the production of wide spectrum of useful products.
3. Classify the various treatment techniques employed in petroleum refining.
4. Discuss various cracking and reforming methods employed in petroleum refining.
5. Discuss catalytic cracking methods employed in petroleum refining.
6. Identify suitable refining technology for maximizing the product yield.

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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (duration 03 hours).

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

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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NANO SCIENCE AND TECHNOLOGY		Semester	06
Course Code	**BCH654A**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

1. To provide students with a thorough understanding of the principles, properties, and behavior of materials at the nanoscale.
2. To equip students with practical knowledge and skills in the synthesis, fabrication, and characterization of nanomaterials.
3. To foster an understanding of the applications, ethical considerations, environmental impacts, and safety issues associated with nanotechnology.

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Introduction to Nanoscience and Nanotechnology

Fundamentals of Nano science: Definition and history, Nanoscale dimensions and their implications. Types: nanoparticles, nanowires, nanotubes, nanofilms, and nanocomposites. Synthesis methods**:** top down vs. bottom up approaches. Characterization Techniques: Electron microscopy (SEM, TEM), Atomic force microscopy (AFM), Spectroscopy methods (XPS, Raman, FTIR)

Module-2

Physical and Chemical Properties of Nanomaterials

Quantum Mechanics of Nanomaterials, Quantum confinement effects, Electronic properties, Optical Properties: Plasmonics, Fluorescence and phosphorescence Mechanical and Thermal Properties: Mechanical strength and flexibility, Thermal conductivity and heat capacity.

Module-3

Synthesis and Fabrication Techniques

Chemical Vapor Deposition (CVD) and Physical Vapor Deposition (PVD): Process and applications Sol Gel Process and Self Assembly: Techniques and applications Lithography Techniques: Photolithography, Electron beam lithography, Nano imprint lithography

Module-4

Applications of Nanotechnology

Nanoelectronics: Quantum dots and transistors, Nanosensors. Nanomedicine: Drug delivery systems, Diagnostic tools. Energy Applications: Solar cells, Batteries and supercapacitors. Environmental Applications: Water purification, Pollution control

Module-5

Ethical, Environmental, and Safety Aspects

Ethical Issues: Societal implications, Intellectual property. Environmental Impact: Environmental risks, Green nanotechnology. Safety and Regulations: Health risks, Regulatory frameworks and standards.

Course outcome (Course Skill Set)

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

1. Demonstrate a comprehensive understanding of fundamental principles of nanoscience and nanotechnology.
2. Identify and apply various characterization techniques for analyzing nanomaterials.
3. Gain proficiency in synthesis and fabrication methods of nanomaterials.
4. Understand and explain diverse applications of nanotechnology in various fields.
5. Develop an awareness of ethical, environmental, and safety considerations in nanotechnology.
6. Enhance critical thinking and problem solving skills related to challenges in nanoscience and nanotechnology.

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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (**duration 03 hours).**

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

Suggested Learning Resources:

Books:

1. Introduction to Nanotechnology by Charles P. Poole, Frank J. Owens, 2003, ISBN: 9780471079354, 0471079359, Wiley publishing
2. Nanomaterials-Synthesis, Properties and Applications by A.S Edelstein, R.C Cammaratra, 1998, ISBN: 9781482268591, 1482268590, CRC Press
3. Nanotechnology: Principles and Practices by Sulabha K. Kulkarni, 2014, ISBN: 9783319091716, 3319091719, Springer International Publishing.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/113/102/113102080/
- https://archive.nptel.ac.in/courses/112/108/112108150/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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PRINCIPLES OF DOWNSTREAM TECHNIQUES IN BIOPROCESS		Semester	06
Course Code	**BCH654B**	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. Understand the importance of purification technology for bio products in industrial scale
2. Comprehend various primary purification techniques for bio products
3. Learn purification Techniques for isolation of products from complex biological mixtures
4. Impart knowledge of conventional separation techniques of distillation, extraction, adsorption and drying for purification.
5. Apply the knowledge towards advanced techniques for purification of biological products

Teaching-Learning Process (General Instructions)

These are sample Strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Introduction to downstream techniques: strategies and steps involved in product purification, Costing, material and energy balances, Physical and chemical principles in Downstream, principles of centrifugation, centrifugation equipment. Methods of cell disruption.

Module-2

Solid Liquid Separation: Pre-treatment, theory of filtration, filtration equipment, Solid Liquid separation-problems.

Adsorptive Separations: Review of fundamentals. Mathematical modeling of column factors. Pressure swing & thermal swing adsorption. Counter current separations.

Module-3

Extraction: Batch extraction, staged extraction, differential extraction and fractional extraction. Reverse micellar and aqueous two phase extraction.

Module-4

Membrane separation Technology: Types of membranes, Reverse Osmosis, Ultra filtration, Micro filtration, Dialysis.

Chromatography: Chromatography fundamentals. Different types, Gradient & affinity chromatography, Design Calculations for chromatographic columns.

Module-5

Crystallisation: Mechanism of Crystallization, Mier's Super saturation theory, crystallization equipment.

Drying: Introduction, Equilibria, Drying rate curves. Mechanism of drying, types of dryers. Precipitation, Future trends.

Course outcome (Course Skill Set)

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

1. Recognize the need for separation techniques for crude product purification.
2. Understand the concepts separation processes and carryout material and energy balances.
3. Explain the principles of various separation techniques
4. Analyze the various separation techniques and select the best technique for the separation.
5. Understand the working principles of various separation equipment.
6. Design various separation equipment.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (duration 03 hours).

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

Suggested Learning Resources:

Books

1. Bioseparation: Downstream processing for Biotechnology, Belter, P.A. and Cussler, E.L. Hu,W.S (1988), Wiley, New York.
2. Bioseparation Engineering: Principles, Practice and Economics, Ladisch, M.R., (2001), Wiley, Interscience.

Web links and Video Lectures (e-Resources):

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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SOLID WASTE MANAGEMENT IN PROCESS INDUSTRIES		Semester	06
Course Code	**BCH654C**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

General Aspects: Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

Module-2

Engineered Systems: Typical generation rates. Estimation and factors affecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

Module-3

Processing Techniques: Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

Module-4

Material Recovery: Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

Energy Recovery: Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

Module-5

Hazardous Wastes: Classification. Origin and reduction at source. Collection and handling. Management issues and planning methods. Environmental Acts.

Case Studies: Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

Course outcome (Course Skill Set)

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

1. Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the SWM system.
2. Select appropriate engineered methods for handling, collection and transportation of solid waste.
3. Explain various processing techniques employed in SWM
4. Assess various material and energy recovery methods employed in SWM
5. Identify and discuss the different hazardous waste handling associated with solid waste
6. Justify solid waste management from an environmental, public health perspective.

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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (duration 03 hours).

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

Suggested Learning Resources:

Books

1. Integrated Solid Waste Management, George Tchobanoglous *et al*., 2nd edn, McGraw Hill & Co, 1993.
2. Industrial Solid Waste Management and Land Filling Practice, Dutta *et al*.,Narosa Publishing House, 1999.
3. Waste Treatment Plants, Sastry C.A. *et al*, Narosa Publishing House, 1995.
4. Hazardous Waste Management, Lagrega, McGraw Hill, 1994.

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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MATERIAL SCIENCE AND TECHNOLOGY		Semester	06
Course Code	**BCH654D**	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 Hours
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Introduction: Introduction to material science, classification of engineering materials, Level of structure, Structure property relationships in materials.Crystal Geometry and Structure: Determination Geometry of crystals-the Bravais lattices, Crystal directions and planes-the miller indices, Structure determination-X-Ray diffraction Bragg law, The powder method, Scanning electron microscope.

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

Module-2

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

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

Module-3

Deformation of Materials and Fracture: Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture.

Heat Treatment: Annealing, Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.

Module-4

Corrosion and its Prevention: Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, Factor influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings, glass lining, lead lining, FRP lining.

Module-5

Environmental and Sustainability Issues: Environmental Impact of Materials- Resource extraction and processing, Waste management and recycling, Green materials and eco-friendly alternatives, Lifecycle analysis and environmental footprint, Industry standards and regulations for material safety and quality, Compliance and certification processes

Case Studies and Real-World Applications- Case Studies and Real-World Applications, Successful implementation of sustainable practices

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 Evaluation:

- There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component.
- Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks
- 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks)
- The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s marks.

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 time table, with common question papers for the course (duration 03 hours).

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

Suggested Learning Resources:

Books

1. Materials Science and Engineering – A First Course, Raghavan V, 3rd Edn., Prentice Hall of India Pvt.

Ltd., New Delhi, 1996.
2. Material Science and Processes, Hajra Choudhury S.K., 2nd Edition, Indian Book Distributing Co., 1982.
3. Elements of Material Science, Van Vlack H.L., 2nd Edn., Addison – Wesley Publishing Company, New York, 1964.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/113/102/113102080/
- https://archive.nptel.ac.in/courses/112/108/112108150/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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PROJECT PHASE-1		Semester	06
Course Code	**BCH685**	CIE Marks	100
Teaching Hours/Week (L:T:P: S)	0:0:4:0	SEE Marks	-
Total Hours of Pedagogy	40	Total Marks	100
Credits	02	Exam Hours	3 Hours
Examination type (SEE)	Theory		

CIE procedure for Project Work Phase - 1: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for project work phase -1, shall be based on the evaluation of project work phase -1 Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

Project work:

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multi disciplinary project can be assigned to an individual student or to a group having not more than 4 students.

In extraordinary cases, like the funded projects requiring students from different disciplines, the project studentstrength can be 5 or 6.

CIE procedure for Project Work Phase - 1:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

Course Outcomes: After studying this course, students will be able to:

1. Apply fundamentals of science and engineering to identify, formulate and solve chemical engineering problems.
2. Conduct experimental investigation, data interpretation and develop solutions for chemical engineering problems.
3. Analyze and design solutions for chemical engineering problems through the use of modern engineering and IT tools.
4. Assess the impact of chemical engineering solutions on the society and industry and demonstrate the need for sustainable development.
5. Develop the ability to communicate effectively in verbal and written forms and prepare project reports and presentations.
6. Apply the principles of management in chemical engineering and function effectively as member or leader of a team. Prepare presentation and communicate findings to audience.

MASS TRANSFER OPERATIONS LAB -2		Semester	06
Course Code	**BCHL606**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2	SEE Marks	50
Credits	01	Total SEE+CIE	100
Examination type (SEE)	Practical	Exam Hours	3 Hours

Course Objectives:

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

Sl.NO	Experiments
1	Simple Distillation
2	Packed bed distillation.
3	Steam distillation
4	Single stage and Multi stage cross current leaching
5	Single stage and Multi stage counter current leaching
6	Liquid-liquid/Vapor –liquid equilibrium
7	Liquid extraction – (cross current: 1 and 2 or 3 stage)
8	Hold up studies in packed columns
9	Vapour Liquid Equilibrium Studies.
10	Gel- Electrophoresis

Course Outcomes (Course Skill Set):

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

1. Experimentally verify the mass transfer concepts studied in theory.
2. Conduct experiment and make observations for mass transfer equipment.
3. Discuss the effect of mass transfer coefficients in design of equipment.
4. Explain the handling of mass transfer operations.
5. Apply theoretical knowledge of mass transfer equipment.
6. Acquire practical knowledge of mass transfer equipment.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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).

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.
- 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:

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TECHNICAL REPORT WRITING AND PRESENTATION SKILLS		Semester	6
Course Code	**BCH657A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	2 Hours
Examination type (SEE)	**THEORY (general paper pattern)**		

Course objectives:

- Students will be able to create well-organized reports with clear sections, including a title, abstract, introduction, methodology, results, discussion, and conclusion, tailored to their intended audience.
- Students will be proficient in gathering credible data, evaluating research sources, and applying appropriate analytical methods to generate insightful and relevant findings for their reports.
- Students will develop the skills to design engaging presentations, use visual aids effectively, and deliver their content confidently, addressing questions and feedback professionally during their oral presentations.

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 Report Writing:

Importance of Report Writing, Types of Reports (Technical, Business, Academic), Understanding the Audience and Purpose, Structure of a Report (Title, Abstract, Introduction, Body, Conclusion, Recommendations, References)

Module-2

Research and Data Collection:

Conducting Research: Primary vs. Secondary Data, Evaluating Sources for Credibility and Relevance, Data Collection Methods, Ethical Considerations in Research

Module-3

Writing the Report:

Writing Clear and Concise Content, developing a Logical Flow and Coherence, Using Visuals (Charts, Graphs, Tables), Writing the Abstract and Executive Summary

Module-4

Presentation Skills:

Designing Effective Presentations, Visual Aids and Their Importance, Public Speaking Techniques, Handling Q&A Sessions

Module-5

Final Report and Presentation:

Compiling and Finalizing the Report, Rehearsing the Presentation, Tips for Professionalism in Delivery Evaluation Criteria for Reports and Presentations

Course outcome (Course Skill Set)

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

1. Write well-organized reports with clear sections.
2. Gather and evaluate credible sources.
3. Interpret and present research data clearly.
4. Develop impactful charts, graphs, and tables.
5. Present content confidently and handle questions.
6. Maintain high standards in written and oral communications.

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

1. The question paper will have ten questions. Each question is set for 10 marks.
2. 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).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

- **Technical Communication: Process and Product"** by Sharon J. Gerson and Steven M. Gerson
- **The Elements of Style"** by William Strunk Jr. and E.B. White
- **Presentation Zen: Simple Ideas on Presentation Design and Delivery"** by Garr Reynolds

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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INTRODUCTION TO START-UPS		Semester	6
Course Code	**BCH657B**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- Provide students with a comprehensive understanding of the startup ecosystem, including the roles and interactions with various stakeholders.
- Enable students to generate, validate, and refine startup ideas, develop business models and plans, and create strategies for securing funding and scaling operations.
- Cultivate an entrepreneurial mindset by encouraging innovative thinking, problem-solving, and resilience in the face of challenges commonly encountered in startup environments.

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 Startups:

Definition and Types of Startups, What constitutes a startup? Types of startups (tech, social, green, etc.) The Startup Ecosystem: Key players: entrepreneurs, investors, mentors, accelerators, incubators Ecosystem dynamics. Startup Trends and Case Studies: Current trends in the startup world, Successful and failed startup case studies

Module-2

Ideation and Market Research:

Generating Startup Ideas: Techniques for brainstorming and idea generation, Identifying problems worth solving. Market Research and Validation: Methods for conducting market research, Validating your idea with potential customers. Competitive Analysis: Identifying competitors, Analyzing competitive landscape

Module-3

Business Model and Planning :

Business Model Generation: Introduction to Business Model Canvas, Creating a business model for your startup. Building a Minimum Viable Product (MVP): Definition and importance of an MVP, Steps to create an MVP. Business Plan Development: Key components of a business plan, Writing an effective business plan

Module-4

Funding and Financials:

Sources of Startup Funding: Bootstrapping, angel investors, venture capital, crowd funding, Financial Planning and Projections: Basics of startup financials, Creating financial projections. Pitching to Investors: Crafting a compelling pitch, Dos and don'ts of pitching

Module-5

Growth and Scaling:

Growth Strategies: Customer acquisition strategies, Retention and growth hacking techniques, Building and Managing Teams, Hiring the right people, Building a strong company culture. Scaling Operations: Operational challenges in scaling, Tools and techniques for managing growth

Course outcome (Course Skill Set)

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

1. Describe key components and dynamics of the startup ecosystem.
2. Apply techniques to brainstorm and validate startup ideas.
3. Create viable business models and MVPs.
4. Develop comprehensive business plans with market strategy and financial projections.
5. Identify funding sources and craft effective investor pitches.
6. Develop and execute strategies for customer acquisition, team building, and scaling operations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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.

Suggested Learning Resources:

Books

1. **"Zero to One: Notes on Startups, or How to Build the Future"** By Blake Masters, Peter Thiel · 2014, ISBN: 9780753550304, 075355030X, Ebury Publishing,
2. **"The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company"** by Steve Blank, Bob Dorf, 2020, ISBN: 9781119690726, 1119690722, Wiley Publishing.

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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PROBLEM BASED LEARNING		Semester	6
Course Code	**BCH657C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 also higher levels of learning.
3. Activities to promote interest may be incorporated wherever possible

Module-1

Introduction to Problem Based Learning: Traditional vs. Cognitive Learning, Behavioral Learning, Cognitive Learning, Constructivist Learning.

Module-2

Improved Learning Strategies and Thinking Skills, Learning To Learn, Life Long Learning, Active Learning, Cooperative Learning

Module-3

PBL Applications and Research Trends: Case Study in Chemical Engineering, Case Study in Interdisciplinary domains. Assessment and Evaluation: Introduction to Assessment and Evaluation,

Module-4

Different forms of Assessment in PBL, Grading Criteria in PBL Developing Problems and Tutorial Process: Steps of Problem Design, PBL Tutorial Process, PBL Curriculum,

Module-5

Online PBL Changing Roles and need for increased participation, Role of Tutors & students.
Implementation Issues in Problem Based Learning:

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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.

Suggested Learning Resources:

Books:

1. "Problem-Based Learning: A Research Perspective on Learning Interactions" edited by Philip C. Abrami, Steven J. Schmid, and Tonia P. Borokhovski
2. "Problem-Based Learning: An Inquiry Approach" by John Barell, 2020, Publisher: Lawrence Erlbaum Associates
3. "The Essentials of Problem-Based Learning" by David Boud and Grahame Feletti

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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PROJECT MANAGEMENT		Semester	6
Course Code	**BCH657D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- Provide students with a comprehensive understanding of project management principles, methodologies, and best practices to effectively plan, execute, and close projects.
- Enhance students' ability to identify project risks, develop mitigation strategies, and solve complex project-related problems using analytical and decision-making skills.
- Train students to communicate project information clearly and effectively, manage stakeholder expectations, and lead project teams to achieve successful project outcomes.

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 Project Management

Basics of Project Management: Definition and Importance of Project Management, Project Life Cycle and Phases. Project Management Framework: Key Concepts and Terminologies, Project Management Process, Groups (Initiating, Planning, Executing, Monitoring & Controlling, Closing)

Role of the Project Manager: Skills and Competencies, Responsibilities and Challenges

Module-2

Project Planning and Scheduling

Project Scope Management: Defining Scope, Creating Work Breakdown Structure (WBS)

Project Time Management: Defining Activities and Sequencing, Estimating Activity Durations, Developing the Project Schedule (Gantt Charts, CPM, PERT)

Resource Planning and Management: Identifying and Allocating Resources, Resource Optimization Techniques

Module-3

Project Cost and Quality Management

Project Cost Management: Cost Estimating and Budgeting, Cost Control and Earned Value Management (EVM)

Project Quality Management: Quality Planning, Assurance, and Control Tools and Techniques for Quality Management

Risk Management in Projects: Identifying and Assessing Risks, Risk Mitigation and Management strategies

Module-4

Project Communication and Stakeholder Management

Project Communication Management: Communication Planning and Strategies, Tools and Techniques for Effective Communication

Stakeholder Management: Identifying Stakeholders, Stakeholder Analysis and Engagement

Leadership and Team Management: Building and Leading Project Teams, Conflict Resolution and Negotiation Skills

Module-5

Project Execution, Monitoring, and Closing

Project Execution: Directing and Managing Project Work, Deliverables and Performance Metrics
Monitoring and Controlling Projects: Tracking Progress and Performance, Change Management and Control
Project Closure: Closing Processes and Final Deliverables, Lessons Learned and Project Documentation

Course outcome (Course Skill Set)

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

1. Understand Project Management Fundamentals
2. Develop Project Planning and Scheduling Skills
3. Implement Cost and Quality Management Techniques
4. Manage Project Risks Effectively
5. Enhance Communication and Stakeholder Management
6. Execute, Monitor, and Close Projects Successfully

Assessment Details (both CIE and SEE)

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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.

Suggested Learning Resources:

Books

1. **"A Guide to the Project Management Body of Knowledge (PMBOK® Guide)"** by Project Management Institute (PMI), 2018, ISBN: 162825551X, 9781628255515, published by Project Management Institute.
2. **"Project Management: A Systems Approach to Planning, Scheduling, and Controlling"** by Harold Kerzner, 2009, ISBN: 9780470503836, 0470503831, Wiley publishing.

Web links and Video Lectures (e-Resources):

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