PROCESS MODELING AND SIMULATION		Semester	07
Course Code	**BCH701**	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
Examination nature (SEE)	Theory		

Course objectives: The students will be able to

- Apply numerical techniques to solve chemical engineering problems
- Analyze chemical engineering system in terms of modeling principle
- Distinguish simulation from design of equipment
- Develop algorithm for modeling & solve the model
- Develop simple chemical engineering models

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

Modeling in Chemical Engineering: Introduction, Fundamental laws, scope of coverage, principles of formulation, modeling aspects, classification of models. Continuity equation, equations of motion, transport equations, equations of state, equilibrium, and chemical kinetics with examples.

MODULE-2

Models in Separation processes: Steady state single and multiple stage solvent extraction, unsteady state single stage solvent extraction, multistage gas absorption, single component vaporizer and ideal binary distillation column, batch distillation, multi-component flash drum.

MODULE-3

Models in reactors: Series of Isothermal, constant hold-up CSTRs, CSTRs with variable hold-ups, Non-isothermal CSTR, Batch reactor and reactor with mass transfer, gas phase pressurized CSTR.

MODULE-4

Models in heat transfer operation: Cooling of tanks, unsteady state heat transfer by conduction, unsteady state steam heating of Liquid.

Models in fluid flow operation: Fluid flow through packed bed column, flow of a film on the outside of a circular tube, Basic tank model –Level V/s time.

MODULE-5

Numerical analysis for simulation: Introduction to simulation, Role of computers and numerical methods in simulation, iterative convergence methods – interval halving, Newton-Raphson method, False-position, Wegstein and Muller methods, numerical integration of ODEs – Euler and Runge-Kutta.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	**Experiments**
1	Simulation of Shell and Tube Heat Exchanger
2	Simulation of Centrifugal Pump/Compressor
3	Simulation of Flash drum/Separator
4	Simulation of single stream gas heater/cooler
5	Simulation of CSTR
6	Simulation of Distillation Column
7	Simulation of Atmospheric distillation of crude oil
8	Simulation of aromatic stripper with recycling
9	Simulation of Benzene production
10	Simulation of methanol-water separation using RADFRAC
11	Simulation of various reactor types to model a single reaction
12	Simulation of cyclo hexane production

Course outcomes (Course Skill Set):

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

1. Recall the fundamental laws in modeling chemical engineering systems
2. Explain modeling and simulation of simple chemical engineering systems
3. Apply mathematical tools to solve model equations
4. Analyze chemical engineering systems for model development

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.

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 timetable, 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. Process Modeling, Simulation and Control for Chemical Engineers, William L. Luyben McGraw Hill 2nd Edition, 1999, ISBN: 978-0070391598.
2. Process Plant Simulation, B V Babu, 1st Edition, 2004, Oxford University Press, ISBN: 978-0-19-566805-6.
3. Elements of Chemical Reaction Engineering, H Scott Fogler, 3rd Edition, Prentice Hall of India, 2004, ISBN: 7502741003.
4. Process Heat Transfer, D.Q.Kern, 1st Edition, 2012, Tata McGraw Hill, ISBN: 007034190.

Web links and Video Lectures (e-Resources):

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

PROCESS CONTROL AND INDUSTRIAL IOT		Semester	07
Course Code	**BCH702**	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

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

Teaching-Learning Process (General Instructions)

These are sample strategies 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

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

MODULE-2

First Order Systems: Thermometer, level, mixing tank, STR, Linearization, I order systems in series. Response for various input forcing functions.
Second Order Systems: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case – Terms associated with it. Transportation lag.

MODULE-3

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

MODULE-4

Stability: Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams. Control System Design By Frequency Response: Bode criterion. Gain and Phase margins, Ziegler – Nichols controller tuning, Cohen-Coon controller tuning. Root Locus: Rules for plotting and problems.

MODULE-5

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

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.N	Experiments
1	Thermometer
2	Liquid Level System-Step Response
3	Non-Interacting Tanks -Step Response
4	Interacting Tanks -Step Response
5	Valve Characteristics
6	Valve Hysteresis
7	Valve Positioner
8	Mixing tank
9	Temperature Controller (Can be Demo experiments for CIE)
10	Pressure Controller (Can be Demo experiments for CIE)
11	Level/Flow/Pressure/pH/Temperature control–P controller, PI controller, PD controller, PID controller (Can be Demo experiments for CIE)
12	Flapper Nozzle System (Can be Demo experiments for CIE)

Course outcomes (Course Skill Set):

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

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

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.

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

Web links and Video Lectures (e-Resources):

1. http://www.ourmumbaicity.com/ebooks
2. http://www.leka.lt/sites/default/files/dokumentai/process-control.pdf

MOOC's &ONLINE COURSES:

1. https://nptel.ac.in/courses/103/106/103106148/
2. https://nptel.ac.in/courses/103/105/103105064/

3. https://www.mooc-list.com/ 4. http://elearning.vtu.ac.in/06IT64.html
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

PROCESS ENGINEERING ECONOMICS AND MANAGEMENT		Semester	7
Course Code	**BCH703**	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: The students will be able to

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

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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 maybe incorporated wherever possible

Module-1

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

Module-2

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

Module-3

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

Module-4

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

Module-5

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

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 & Engineering Economics 22nd edn. Khanna Publishers,1999.
2. Plant design and Economics for Chemical Engineers-Peters & Timmerhaus,4th edn McGraw Hill,1991
3. Engineering Economy, Thuesen, Fabrycky and Thuesen, 9th Edition, Prentice-Hall,2000.
4. Engineering Economics and Costing, Sasmita Mishra, PHI Learning Pvt. Ltd., 2nd Edition, 2011.
5.Principles of Engineering Economy; by Grant and Ireson, Ronald Press, 2019.

Web links and Video Lectures (e-Resources):

Engineering Economics, R Paneerselvam, ISBN: 978-81203-48370

MOOC's:

1. https://www.coursera.org/lecture/faecalsludge/4-7-engineering-economics-KoVa9
2. https://online.stanford.edu/courses/cee146s-engineering-economics-and-sustainability

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

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TRANSPORT PHENOMENA		Semester	7
Course Code	**BCH714A**	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:

- To be able to analyse various transport processes with understanding of solution approximation methods and their limitations.
- To introduce the students about basic laws of momentum, heat and mass transfer.
- To determine the heat transfer rate and temperature distribution for different heat transfer situations.
- To determine the mass transfer rate and concentration distribution for different mass transfer situations.
- To study the different analogies between mass, momentum and heat transfer

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 ismadetotheteacherstousealternativeeffectiveteachingmethodologyto 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 maybe incorporated wherever possible

Module-1

Momentum Energy and Mass Transport Newton's law of viscosity. Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction, Fick's law of diffusion, Effect of temperature and pressure on transport properties of fluids.

Module-2

Velocity Distribution in Laminar Flow: Different Flow situations, Steady state Shell momentum balances, Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flowthrough Annulus.

Steady State Shell Energy Balances: General Boundary conditions applicable to energy transport problems of chemical engineering. Heat conduction through compound walls. Overall heat transfer coefficient.

Module-3

Temperature Distribution in Solids and in Laminar Flow: Different situations of heat transfer: Heat conduction with internal generation by electrical and nuclear energy sources, Heat conduction in a cooling fin: Forced and free convection heat transfer.

Concentration Distributions in Laminar Flow: Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Equimolar counter diffusion. Numerical problems.

Module-4

Concentration Distributions in Laminar Flow: Diffusion through stagnant gas and liquid films, Diffusion with homogeneous reaction, Diffusion with heterogeneous reaction Diffusion into falling film–Forced convection mass transfer.

Module-5

Analogies between Momentum, Heat and Mass Transport: Reynold's, Prandtl's and Chilton & Colburn analogies.

Equations of Change: Equation of continuity, Equation of motion; Navier–Stokes equation.

Course outcome (Course Skill Set)

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

1. Explain types of fluids, comprehend effect of temperature and pressure on transport properties of fluids and apply transport laws to solve numerical problems.
2. Derive overall heat transfer coefficient, Temperature distribution with and without energy sources
3. Determine velocity profile and shear stress profiles in different flow situations
4. Derive molar flux for stagnant gas, liquid films, homogeneous and heterogenous reactions and applications to falling film forced convection mass transfer
5. Determine HT& MT coefficient using various analogies
6. Derive and apply equation of continuity, equation of motion, Navier-stokes equation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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. Transport Phenomena, Bird, Stewart and Lightfoot, Academic Press,1994.
2. Momentum Heat and Mass Transport, Welty, Wikes and Watson,4th edn.,John Wiley, 2000.
3. Principles of Unit Operations in Chemical engineering, Foust et al.,2nd edn ,John Wiley, 1990.
4. Transport Phenomena-A Unified Approach, Robert S. Brod Key and Henry C. Hershley, Vol.2, Brodkey Publishing, 2003.

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 SAFETY AND RISK MANAGEMENT		Semester	07
Course Code	**BCH714B**	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:

- Select appropriate risk assessment techniques.
- Analyze public and individual perception of risk.
- Relate safety, ergonomics and human factors.
- Carry out risk assessment in process 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

General: Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, Consequence analysis. Hazards in workplaces-nature and type of work place hazards.

Module-2

Techniques and Methods: General, risk adjusted discounted rate method, certainty equivalent coefficient method, quantitative analysis, probability distribution, coefficient of variation method, simulation method, Hiller's model, Hertz model.

Module-3

Risk Management: Emergency relief Systems, Diers program, bench scale experiments, emergency relief systems, internal emergency planning, risk management plan, risk management tools, risk management plans, Dowfire and explosion method, Mond index Method.

Module-4

Risk Assurance and Assessment: Property Insurance, transport insurance, liability insurance and risk Assessment, low probability high consequence events. Fault tree analysis, event tree analysis, zero Infinity dilemma.

Module-5

Risk Analysis in Chemical Industries: Handling and storage of chemicals, process plants, personnel protection equipments. Environmental risk analysis, international environmental management system.

Course outcome (Course Skill Set)

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

1. Understand hazard identification technologies.
2. Recall risk assessment techniques used in process industry.
3. Analyze risk management plans.
4. Interpret the various risk assessment tools.
5. Analyze tools and safety procedures for protection in process industries.
6. Understand risk assurance plans.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal 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. Functional Safety in the Process Industry : A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North carolina, Lulu publication, ISBN:1291187235
2. Safety Instrumented Systems Verification Practical probabilistic calculations, William M. Goble, 2005, Pennsylvania ISA publication, ISBN:155617909X
3. Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition 2003, The University of Alberta press, Canada, ISBN: 0888643942.
4. Environmental Engineering – A Design Approach, Sincero A P and Sincero G A, 1996, Prentice Hall of India, New Delhi, ISBN: 0024105643

Web links and Video Lectures (e-Resources):

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

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PHARMACEUTICAL TECHNOLOGY		Semester	7
Course Code	**BCH714C**	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:

- Learn formulations, tablet and capsule making.
- Learn product development, testing of cosmetics.
- Learn manufacturing technology.
- Learn patent intellectual property rights and regulatory affairs.

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

Electrophilic Substitution Reaction: Preparation of cyclo alkane. Bayer's strain theory and orbital picture of angle stream.

Electrophilic Substitution Reaction Mechanism & Application: Dehydrogenation of alkyl halides. 1-2 elimination kinetics: E2 and E1mechanisms. Isotope effect. Dehydration of alcohols. Ease of dehydration.

Module-2

Nucleophilic Addition Reaction: Mechanism. Important chemicals. Oxidation-Reduction reactions.
Rheology of Fluids in Mixing and Blending. Properties of fluids

Module-3

Preparation: Test for purity and medical uses of Chlorobutal, Dimercopral, Glycerol trinitrate and ethylene diamine dehydrate, saccharin and sodium.

Module-4

Preparation: Test for purity and medical uses of Urea, and vanillin.
Preparation: Test for purity and medical uses of lactic acid, citric acid, salicylic acid.

Module-5

Preparation: Test for purity and medical uses of Ethyl borate, dimethyl phthalate, paraldehyde and aspirin.

Course outcome (Course Skill Set)

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

1. Explain various formulations and formulate tablet and capsule.
2. Develop manufacturing technologies and apply for various cases.
3. Practice industrial safety and involve in patent intellectual property rights and regulatory affairs.
4. Understand the principles of Electrophilic substitution reaction in pharmaceutical formulations.
5. Learn purity tests and medical uses of various compounds.
6. Understand the rheological behaviour of fluids during mixing and blending.

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. The Theory and Practice of Industrial Pharmacy, Liberman, and Lachman, 3rd edn, Lea & Febiger, Philadelphia, 1986.
2. Pharmaceutical Product Development, Jain N.K, CBS Publications and Distributions, New Delhi, 2006.

Web links and Video Lectures (e-Resources):

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

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BIOCHEMICAL ENGINEERING		Semester	7
Course Code	**BCH714D**	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:

- To apply the chemical engineering principles in biological systems.
- Calculate the kinetic parameters of enzymatic reactions.
- Calculate and analyse the kinetic parameters for microbial growth.
- Analyse bioprocess design and operation.

Teaching-Learning Process (General Instructions)

These are sample strategies, which 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

Biochemistry: Role of a Chemical engineer in bioprocess industry, Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids. Vitamins, Biopolymers, Nucleic Acids: RNA, DNA and their derivatives (Structure, Biological function and Importance for life only to be studied).

Enzymes and Proteins: Detailed structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes.

Module-2

Kinetics of Enzyme Action: Kinetics and mechanism of Enzyme action: Michaelis–Menten and Briggs-Haldane approach. Derivation. Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Lineweaver–Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods).

Module-3

Enzyme Inhibition: Effect of Inhibitors (Competitive, non-competitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalysed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses. Methods of enzyme immobilization.

Module-4

Fermentation Technology: Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: Sources of nutrients. Alternate bioreactor configurations. Introduction to sterilization of bioprocess equipment.

Module-5

Downstream Processing: Strategies and Steps involved in product purification. Methods of Cell disruption, Filtration, Centrifugation, Sedimentation, Chromatography, Freeze drying / lyophilization.

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

Course outcome (Course Skill Set)

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

1. Explain the nomenclature, classification, production of enzymes; derive the rate equation by M-M and Brigs-Haldane approach
2. Derive rate equation for given enzyme mechanisms and estimate the kinetic rate parameters
3. Describe the effects of pH, temperature and inhibitors on enzyme catalysed reactions and explain the methods

of enzyme immobilization

4. Describe the growth cycle phases for batch cultivation and fed-batch reactors and, derive an expression to determine optimum dilution rate.
5. Explain medium formulation and sterilization of bioprocess equipment and steps involved in product purification

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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. Biochemical Engineering Fundamentals, Bailey and Ollis, 2nd edn, McGraw Hill, 1976.
2. Bioprocess Engineering, Shuler M. L. and Kargi F., 2nd edn, Prentice Hall, 2002.

Web links and Video Lectures (e-Resources):

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

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DISASTER MANAGEMENT		Semester	7
Course Code	**BCH755A**	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:

- Study the environmental impact of natural and manmade calamities
- Learn to analyze and assess risk involved due to disasters.
- Understand the role of public participation.
- Learn the management tools and mitigation techniques.

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

Natural disasters and Disaster management

Introduction to natural and Industrial Hazards- floods, landslides, earthquakes, volcanoes, avalanche, cyclones, drought, fire, release of effluents, harmful gases, Blast etc. Prediction and perception.

Environmental risk due to project activities. Preparation of on-site and off-site disaster management plans - Pre disaster, actual disaster, Post disaster plans. Relief camp organization. Role of voluntary organization and armed forces during disasters.

Module-2

Risk analysis and assessment

Basic concept. Purpose of risk analysis. Analytical techniques and tools of risk assessment. Toxicology. Significance of risk. Risk characterization. Risk communication and Management, AI in emergency responses

Module-3

Environmental Impact Assessment (EIA)

Definition, Basic concepts and principles of EIA. Regulatory framework in India. Environmental inventory. Base line studies. Overview of EIA studies.

Module-4

Assessment and Methodologies

Physical, Biological, Natural resources, Socio economic and cultural environmental assessment. EIA methodologies- Adhoc, Matrix, Checklist approaches. Economic evaluation of impacts- cost benefits of EIA. Public participation in environmental decision making. Procedures for reviewing EIA analysis and statement. Decision methods for evaluation of alternatives.

Module-5

Disaster Mitigation and Management

Introduction, types, modes of disaster management, tools and techniques, primary and secondary data. Natural disasters its causes and remedies-Earthquake hazards-Causes and remedies, Flood and Drought assessment, causes and remedies, Landslides-causes and remedies. Fire hazards in buildings, Fire hazard management, Traffic management, Cyclones and hurricanes, inter department cooperation. Regional and global disaster mitigation.

Course outcome (Course Skill Set)

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

1. Explain the different types of disasters and manage the pre and post disaster situation.
2. Estimate and communicate the risk by conducting the risk assessment and Environmental Impact Assessment
3. Identify the methods of disaster mitigation based on the basis of the risk assessment.
4. Analyze and evaluate the impact of measures adopted to mitigate the impacts
5. Analyze and evaluate the impact of measures adopted to manage the disaster
6. Understand the management tools and mitigation techniques.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). 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. Environmental Impact Analysis Hand Book, John G Rau and David C Wooten, Edition: 2013, ISBN: 978-0070512177.
2. Introduction to environmental Impact assessment, John Glasson, Riki Therivel, Andrew Chadwick, Edition: 2012, Research Press, ISBN:000-0415664705.2005, Reliance Publishing House, New Delhi.
3. Natural Disaster Reduction, Girish K Mishra, G C Mathew (eds), Edition, 2005, Reliance Publishing House, New Delhi,

4. Remote Sensing and Image Interpretation, Thomas M. Lillis and R.W. Keifer, 6th Edition,2002, John Wiley, ISBN:9780470052457.
Web links and Video Lectures (e-Resources):
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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning •

SUSTAINABLE TECHNOLOGY		Semester	07
Course Code	**BCH755B**	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 the fundamental concepts related to interaction of industrial and ecological systems.
- Understand the basic concepts of life cycle assessment.
- Demonstrate life cycle assessment methodology using appropriate case studies.
- Use concepts of systems-based, trans-disciplinary approach to sustainability.

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 sustainability: Introduction to Sustainability Concepts and Life Cycle Analysis, Material flow and waste management, Chemicals and Health Effects, Character of Environmental Problems

Module-2

Environmental Data Collection and LCA Methodology: Environmental Data Collection Issues, Statistical Analysis of Environmental Data, Common Analytical Instruments, Overview of LCA Methodology. – Goal, Definition.

Module-3

Life Cycle Assessment: Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Benefits and Drawbacks.
Wet Biomass Gasifiers: Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant, their advantages and disadvantages.

Module-4

Design for Sustainability: Green Sustainable Materials, Environmental Design for Sustainability.
Dry Biomass Gasifiers: Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems:

Module-5

Case Studies: Odor Removal for Organics Treatment Plant, Bio-methanation, Bioethanol production. Bio fuel from water hyacinth.

Course outcome (Course Skill Set)

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

1. Understand the sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society.
2. Identify problems in sustainability and formulate appropriate solutions based on scientific research, applied science, social and economic issues.
3. Apply scientific method to a systems-based, trans-disciplinary approach to sustainability
4. Formulate appropriate solutions based on scientific research, applied science, social and economic issues.
5. Understand the concepts of systems-based, trans-disciplinary approach to sustainability
6. Analyze life cycle assessment methodology using appropriate case studies.

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. Sustainable Engineering Principles and Practice, Bavik R Bhakshi, 2019, Cambridge University Press, ISBN - 9781108333726.
2. Environmental Life Cycle Assessment, Olivier Jolliet, Myriam Saade-Sbeih, Shanna Shaked, Alexandre Jolliet, Pierre Crettaz , 1st Edition, CRC Press, ISBN: 9781439887660 .
3. Sustainable Engineering: Drivers, Metrics, Tools, and Applications, Krishna R. Reddy, Claudio Cameselle, Jeffrey A. Adams, 2019, John Wiley & Sons, ISBN-9781119493938

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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AIR POLLUTION CONTROL TECHNIQUES		Semester	7
Course Code	**BCH755C**	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 the basic concepts of air pollution and its effects on human ecosystem and health
- Explore how atmospheric chemical composition both drives and responds to changes in the earth system, including climate change.
- Look at the major air pollutants, their sources, chemical transformations in the atmosphere and impacts.
- Know how to interpret meteorological data for atmospheric stability and air pollutant transport and dispersion.
- Get an insight into the fundamentals of some of the most widely used commercial and freely available air quality models.

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

Air Pollution – Definitions, Scope, Significance and Episodes, Air Pollutants –Classifications – Natural and Artificial – Primary and Secondary, point and Non-Point, Line and Arial Sources of air pollution- stationary and mobile sources.

Module-2

Effects of Air pollutants on man, material and vegetation; Global effects of air pollution – Green House effect, Heat Islands, Acid Rains, Ozone Holes etc.

Module-3

Thermodynamics and Kinetics of Air-pollution – Applications in the removal of gases like SOx; NOx; CO; HC etc., air-fuel ratio. Computation and Control of products of combustion. Meteorology and plume Dispersion; properties of atmosphere; Heat, Pressure, Wind forces, Moisture and relative Humidity; Influence of Meteorological phenomena on Air Quality, Wind rose diagrams.

Module-4

Lapse Rates, Winds and moisture Plume behaviour and Plume Rise Models; Gaussian Model for Plume Dispersion. Control of particulates – Control at Sources, Process Changes, Equipment modifications,

Design and operation of control.

Equipment – Settling Chambers, Centrifugal separators, filters, Dry and Wet scrubbers, Electrostatic precipitators.

Module-5

General Methods of Control of NOx and SOx emissions – In-plant Control Measures, process changes, dry and wet methods of removal and recycling.

Air Quality Management – Monitoring of SPM, SOx; NOx and CO Emission Standards.

Course outcome (Course Skill Set)

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

1. Have a firm foundation and knowledge of mathematics, science and engineering principles and the ability to apply the knowledge.
2. Define and reason about fundamental concepts of waste water treatment
3. Design and conduct experiments and the ability to analyse the data, interpret results and draw conclusions.
4. Design a component, system or process to meet desired needs and imposed constraints.
5. Think logically, critically and creatively.

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. Air pollution By M. N. Rao and H. V. N. Rao – Tata McGraw Hill Company.
2. Air pollution by Wark and Warner. - Harper & Row, New York.
3. Air pollution and control By K.V.S.G. Murali Krishna, Kaushal Publishers. Kakinada.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105104099/
- https://nptel.ac.in/courses/105104099/3

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

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PROTEIN CHEMISTRY		Semester	7
Course Code	**BCH755D**	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:

- To acquire basic knowledge related to structure and properties of proteins and their most important functions.
- To understand different analytical techniques used in protein chemistry.
- To study various protein interactions and catalytic activity of proteins.

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

Amino acids and the Peptide Bond, Protein Architect, Levels of Protein Synthesis-I, Levels of Protein Synthesis-II, Protein Folding and Denaturation-I, Protein Folding and Denaturation-II, Protein isolation and characterization-I, Protein isolation and characterization-II

Module-2

Protein isolation and characterization-III, Protein isolation and characterization-IV, Metalloproteins-I, Metalloproteins-II, Motor Proteins-I, Motor Proteins-II, Membrane Proteins-I, Membrane Proteins-II

Module-3

Families of enzymes, Enzyme substrate complexes, Enzyme kinetics and Enzyme inhibition-I, Enzyme kinetics and Enzyme inhibition-II, Enzyme mechanisms-I, Enzyme mechanisms-II, Cofactors & Coenzymes, Protein-Protein interactions-I

Module-4

Protein-Protein interactions-II, Protein-Protein interactions-III, Protein-ligand interactions-I, Protein-ligand interactions-II, Protein-ligand interactions-III, Protein aggregation-I, Protein aggregation-II, Electron Transfer in Proteins-I

Module-5

Electron Transfer in Proteins-II, Protein Structure analysis-I, Protein Structure analysis-II, Protein Simulations-I, Protein Simulations-II, Protein Simulations-III, Ribozymes: Catalytic mechanism & applications-I, Ribozymes: Catalytic mechanism & applications-II

Course outcome (Course Skill Set)

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

1. Understand the architecture of protein molecule.
2. Understand the protein synthesis, folding and denaturation.
3. Learn about protein isolation and characterization.
4. Understand the structure and working principle of enzymes.
5. Understand the protein interactions and protein aggregation.
6. Understand the catalytic mechanisms of ribozymes and their functions.

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 Protein Structure: Second Edition by Carl Branden and John Tooze
2. Proteins: Structures and Molecular Properties by Thomas E. Creighton
3. Physical Biochemistry by K.E.van Holde, C. Johnson, P. Shing. Ho
4. Protein-Ligand Interactions by S. E. Harding and B. Z. Chowdhry.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/content/syllabus_pdf/104105040.pdf

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

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MAJOR PROJECT PHASE-II		Semester	7
Course Code	**BCH786**	CIE Marks	100
Teaching Hours/Week (L:T:P: S)	0:0:12:0	SEE Marks	100
Total Hours of Pedagogy		Total Marks	200
Credits	06	Exam Hours	3 Hours
Examination type (SEE)	Theory		

Project Work

CIE procedure for Project Work Phase - II:

(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 -II, shall be based on the evaluation of project work phase -II 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.

ii) Interdisciplinary: Continuous Internal Evaluation shall be groupwise 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 -II, shall be based on the evaluation of project work phase -II 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 batchmates.

SEE for Project Work Phase - II:

1. **Single discipline:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.
2. **Interdisciplinary:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.

Course Outcomes: On successful completion of 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.

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