Course Title: Elements of Chemical Engineering Laboratory		**Semester**	1/2
Course Code	1BECHEL107/207	**CIE Marks**	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	**SEE Marks**	100
Total Hours of Pedagogy	24 h	**Total Marks**	100
Credits	01	**Exam Hours**	3
Examination type (SEE)	**Practical**		

Course Outcomes (Course Skill Set)

After completing the course, the students will be able to ....

1. Perform various experiments using the available instruments and lab equipment.

2. Calibrate various measuring devices to achieve accuracy of measurement.

3. understand the importance of regression analysis for calibration of instrument .

4. Determine the properties and characteristics of fuels and oils.

5. Determine the hardness of water.

Note:

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 6 conventional experiments, PART-B has 6 typical open-ended experiments. The maximum marks for the laboratory course are 100.

2. Both PART-A and PART-B are considered for CIE and SEE.

3. Students have answer 1(one) question from PART-A and 1(one) question from PART-B.

   a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for 70 marks out of the maximum 100 marks.

   b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for 30 marks.

4. For continuous internal evaluation, during the semester, classwork, the typical open-ended questions shall be from PART-B, and any other similar questions to enhance the skill of the students.

<div align="center">PART – A CONVENTIONAL EXPERIMENTS</div>

1. Determination of viscosity coefficient of lubricant using redwood viscometer

2. Estimation of total hardness of water by EDTA method

3. Determination of alkalinity of water using standard NaOH solution

4. Measurement of density and specific gravity of a fluid.

5. Presentation of experimental data using MS Excel

6. Determination of viscosity coefficient of lubricant using Ostwald's viscometer

<div align="center">PART – B TYPICAL OPEN-ENDED EXPERIMENTS</div>

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.

1. Comparative study of flash point and fire point of various fuels / oils using the open cup method
2. Calibration of the Rotameter for Newtonian fluids.
3. Curve fitting using linear regression analysis (analytical)
4. Curve fitting using non-linear regression analysis (analytical)
5. Calibration of color concentration using colorimeter.
6. Determination of the color concentration using colorimeter.

Suggested Learning Resources: (Textbook/Reference Book):

Textbooks:

1. Pushpavanam S, Introduction to Chemical Engineering, PHI Learning Private Limited, New Delhi, 2010.
2. Morton Denn, Chemical Engineering: An Introduction, Cambridge University Press, 2011.

Reference books:

1. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, New York, 2021.
2. Walter L. Badger, Julius T. Banchero , Julius T. Bancheo, Introduction To Chemical Engineering, Tata McGraw-Hill, 1955.
3. Richard M. Felder and Ronald W. Rousseau, Elementary Principles of Chemical Processes, John Wiley & Sons, 3 rd Edition, 2005.
4. Himmelblau, D.M., Basic Principles and Calculations in Chemical Engineering, 6 th Edition, Prentice Hall of India, New Delhi, 1997.
5. Uche, N. Introduction to Chemical Engineering. Scrivener Publishing, Wiley, 2019
6. Ghoshal, S.K., Sanjal, S.K. and Datta, S. Introduction to Chemical Engineering. Tata McGraw-Hill Publication, 2017.
7. Introduction to Sustainable Engineering, Rag. R.L. and Ramesh Lakshmi Dinachandran, PHILearning Pvt. Ltd., 2ndEdn, 2016

Web links and Video Lectures (e-Resources):
1. https://nptel.ac.in/courses/103108097
2. https://onlinecourses.nptel.ac.in/noc25_ch07/preview
3. https://www.youtube.com/watch?v=SdP3BbCt4Ak

Teaching-Learning Process (Innovative Delivery Methods):

Teaching-Learning Process (Innovative Delivery Methods): The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

- Flipped Classroom
- Simulation and Virtual Labs
- Video demonstration

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying 50% weightage (i.e., 50 marks each). The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 20 marks. For both CIE and SEE, the student is required to conduct one experiment each from both Part A and Part B.

Rubrics for CIE – Continuous Assessment: 30 marks					
Performance Indicators	**Excellent**	**Good**	**Satisfactory**	**Needs Improvement**	**Poor**
Technical Skills & Procedure (PO1 & PO5) (10)	Performs operations flawlessly, correct sequence, excellent tool use. (9-10)	Minor errors, generally correct sequence and tool use. (7-8)	Performs task with some errors; needs occasional help. (5-6)	Many errors, requires frequent guidance. (3-4)	Cannot perform task without continuous supervision. (0-2)
Safety Compliance (PO6) (5)	Strictly follows all safety protocols, proper PPE usage at all times. (5)	Follows safety rules, occasional minor lapses. (4)	Mostly safe, some reminders needed. (3)	Frequent safety violations. (2)	Unsafe behavior, ignores safety rules. (0-1)
Interaction with the Group (PO8) (5)	Naturally leads, encourages, and includes all group members. Facilitates communication and ensures tasks are distributed fairly. Respects all opinions. (5)	Cooperates well with group members. Communicates clearly, shares the workload, and is a reliable and positive team member. (4)	Works alongside others but with limited communication or collaboration. Tends to work in isolation or contributes unevenly to the group effort. (3)	Fails to cooperate with the group. Is dismissive of others' ideas or causes friction and disagreement within the team. (2)	Refuses to work with the group or actively disrupts the group's ability to complete the experiment. (1)
Lab Report (PO9) (10)	Report is exceptionally well-organized, detailed, and insightful. All data and analysis are accurate. Submitted on time. (9-10)	Report is complete, well-organized, and accurate. All required sections are present and data is correctly reported. Submitted on time. (7-8)	Report has minor errors in data or analysis, or is missing some minor components. Organization could be clearer. (5-6)	Report is incomplete, contains significant errors, is poorly organized, or is submitted late without a valid reason. (3-4)	Fails to submit a report, or the submitted work is of completely unacceptable quality and lacks critical information. (0-2)

Rubrics for SEE / CIE Test:
 (CIE test -To be conducted for 100 marks and the marks obtained shall be reduced to 20)
 (SEE-To be conducted for 100 marks)

Performance Indicators	Excellent	Good	Satisfactory	Needs Improvement	Poor
Execution (PO3 & PO5) **(8)/ (40)**	Executes operations accurately with correct parameters; smooth, safe handling of equipment. **(7-8) / (33-40)**	Minor execution errors; mostly correct handling of tools/ machines. **(5-6) / (25-32)**	Acceptable performance with some parameter or handling errors. **(3-4) / (17-24)**	Multiple execution errors; needs frequent correction. **(2) / (9-16)**	Unable to perform operation independently. **(0-1)/ (0-8)**
Result and Discussion (PO4) **(7)/ (40)**	Presents accurate results; clearly compares with standards; insightful discussion of deviations and causes. **(7-8) / (33-40)**	Accurate results; some useful discussion. **5-6) / (25-32)**	Results mostly correct; discussion basic. **(3-4) / (17-24)**	Results incomplete or partially wrong; weak discussion. **(2) / (9-16)**	Presents accurate results; clearly compares with standards; insightful discussion of deviations and causes. **(0-1)/ (0-8)**
Viva Voce (PO9) **(5)/ (20)**	Answers all questions confidently, showing deep conceptual and practical understanding. **(5) / (17-20)**	Answers most correctly; minor conceptual gaps. **(4) / (13-16)**	Answers some but lacks depth. **(3) / (9-12)**	Gives vague or incomplete answers. **(2) / (5-8)**	Unable to answer. **(1) / (0-4)**

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks.**