

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

EFD 48-10

DEPARTMENT Chemical Engineering EFFECTIVE SESSION Fall 2011

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

- | | |
|---|--|
| <input type="checkbox"/> 1. New course with supporting documents | <input type="checkbox"/> 7. Change in course attributes (department head signature only) |
| <input type="checkbox"/> 2. Add existing course offered at another campus | <input checked="" type="checkbox"/> 8. Change in instructional hours |
| <input type="checkbox"/> 3. Expiration of a course | <input checked="" type="checkbox"/> 9. Change in course description |
| <input type="checkbox"/> 4. Change in course number | <input checked="" type="checkbox"/> 10. Change in course requisites |
| <input checked="" type="checkbox"/> 5. Change in course title | <input checked="" type="checkbox"/> 11. Change in semesters offered (department head signature only) |
| <input checked="" type="checkbox"/> 6. Change in course credit/type | <input type="checkbox"/> 12. Transfer from one department to another |

PROPOSED:

Subject Abbreviation

Course Number

Long Title Chemical Engineering Laboratory

Short Title Chemical Engineering Lab

Abbreviated title will be entered by the Office of the Registrar if omitted (30 CHARACTERS ONLY)

EXISTING:

Subject Abbreviation CHE

Course Number 43500

TERMS OFFERED

Check All That Apply:

Summer Fall Spring

CAMPUS(ES) INVOLVED

- | | |
|---------------------------------------|--|
| <input type="checkbox"/> Calumet | <input type="checkbox"/> N. Central |
| <input type="checkbox"/> Cont Ed | <input checked="" type="checkbox"/> Tech Statewide |
| <input type="checkbox"/> Ft. Wayne | <input checked="" type="checkbox"/> W. Lafayette |
| <input type="checkbox"/> Indianapolis | |

CREDIT TYPE:

1. Fixed Credit: Cr. Hrs. 4
2. Variable Credit Range:
Minimum Cr. Hrs.
(Check One) To Or
Maximum Cr. Hrs.
3. Equivalent Credit: Yes No

COURSE ATTRIBUTES: Check All That Apply

1. Pass/Not Pass Only
2. Satisfactory/Unsatisfactory Only
3. Repeatable
Maximum Repeatable Credit:
4. Credit by Examination
5. Special Fees
6. Registration Approval Type
Department Instructor
7. Variable Title
8. Honors
9. Full Time Privilege
10. Off Campus Experience

| Schedule Type | Minutes Per Mtg | Meetings Per Week | Weeks Offered | % of Credit Allocated |
|----------------------|-----------------|-------------------|---------------|-----------------------|
| Lecture | 50 | 1 | 16 | |
| Recitation | | | | |
| Presentation | | | | |
| Laboratory | 170 | 2 | 16 | |
| Lab Prep | 50 | 1 | 16 | |
| Studio | | | | |
| Distance | | | | |
| Clinic | | | | |
| Experiential | | | | |
| Research (no. study) | | | | |
| Practicum | 50 | 1 | 16 | |

Cross-Listed Courses

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):

Credit Hours: 4.00. Quantitative experimental study of projects involving problems in fluid mechanics and heat and mass transfer or operation and evaluation of equipment; projects include analysis and data-based design of operations involving mass transfer such as distillation, absorption, extraction, drying, humidification, etc; study of rates and equilibria in simple chemical reaction systems; study of chemical processes; application of methods of data analysis in practice; some library work; emphasis on group work, report writing, and oral communication. Usually offered fall and spring.

Level: Undergraduate

Schedule Types: Laboratory, Practice Study Observation

Restrictions:

Must be enrolled in one of the following Colleges:

School of Chemical Engineering

Prerequisites: Minimum Grade of D-; CHE 32000 Minimum Grade of D-; CHE 34800 Minimum Grade of D-; CHE 37800 Minimum Grade of D-; CHE 30600 Minimum Grade of D-

Concurrent Prerequisites: ~~CHE 44900~~ *WFS*

remove

COURSE LEARNING OUTCOMES

- Obtain experimental data and calculate physical quantities from these data (1, 2).
- Understand experimental error, estimate it, and infer its significance in the experimental results (2).
- Design statistically sound experiments, conduct these experiments, and analyze the results (1, 2, 3).
- Effectively report results in written form and be able to communicate the results orally (7).
- Understand different personality types, how these types respond, and how they can function effectively together as a team (4).
- Develop an understanding of the professional responsibilities of the engineer as a member of a team (4, 6).
- Practice safety as an integral part of laboratory work (8).

Calumet Department Head _____ Date _____ Calumet School Dean _____ Date _____

7/29/10

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

EFD 48-10

DEPARTMENT Chemical Engineering EFFECTIVE SESSION Fall 2011

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

- | | |
|---|--|
| <input type="checkbox"/> 1. New course with supporting documents | <input type="checkbox"/> 7. Change in course attributes (department head signature only) |
| <input type="checkbox"/> 2. Add existing course offered at another campus | <input checked="" type="checkbox"/> 8. Change in instructional hours |
| <input type="checkbox"/> 3. Expiration of a course | <input checked="" type="checkbox"/> 9. Change in course description |
| <input type="checkbox"/> 4. Change in course number | <input checked="" type="checkbox"/> 10. Change in course requisites |
| <input checked="" type="checkbox"/> 5. Change in course title | <input checked="" type="checkbox"/> 11. Change in semesters offered (department head signature only) |
| <input checked="" type="checkbox"/> 6. Change in course credit/type | <input type="checkbox"/> 12. Transfer from one department to another |

PROPOSED:

Subject Abbreviation _____

Course Number _____

Long Title Chemical Engineering Laboratory

Short Title Chemical Engineering Lab

Abbreviated title will be entered by the Office of the Registrar if omitted (30 CHARACTERS ONLY)

EXISTING:

Subject Abbreviation CHE

Course Number 43500

TERMS OFFERED

Check All That Apply:

- Summer Fall Spring

CAMPUS(ES) INVOLVED

- Calumet N. Central
 Cont Ed Tech Statewide
 Ft. Wayne W. Lafayette
 Indianapolis

CREDIT TYPE

1. Fixed Credit: Cr. Hrs. 4
2. Variable Credit Range: _____
 Minimum Cr. Hrs. _____
 (Check One) To Or
 Maximum Cr. Hrs. _____
3. Equivalent Credit: Yes No

COURSE ATTRIBUTES: Check All That Apply

1. Pass/Not Pass Only
2. Satisfactory/Unsatisfactory Only
3. Repeatable
- Maximum Repeatable Credit: _____
4. Credit by Examination
5. Special Fees
6. Registration Approval Type
- Department Instructor
7. Variable Title
8. Honors
9. Full Time Privilege
10. Off Campus Experience

| Schedule Type | Minutes Per Mtg | Meetings Per Week | Weeks Offered | % of Credit Allocated |
|---------------|-----------------|-------------------|---------------|-----------------------|
| Lecture | <u>1</u> | <u>50</u> | | |
| Recitation | | | | |
| Presentation | | | | |
| Laboratory | <u>170</u> | <u>2</u> | <u>16</u> | |
| Prep | | | | |
| io | | | | |
| ance | | | | |
| Clinic | | | | |
| Experiential | | | | |
| Research | | | | |
| ind. Study | | | | |
| Pract/Observ | <u>50</u> | <u>1</u> | <u>16</u> | |

| Cross-Listed Courses |
|----------------------|
| |
| |
| |
| |

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):

Credit Hours: 4.00. Quantitative experimental study of projects involving problems in fluid mechanics and heat and mass transfer or operation and evaluation of equipment; projects include analysis and data-based design of operations involving mass transfer such as distillation, absorption, extraction, drying, humidification, etc; study of rates and equilibria in simple chemical reaction systems; study of chemical processes; application of methods of data analysis in practice; some library work; emphasis on group work, report writing, and oral communication. Usually offered fall and spring.

Level: Undergraduate
 Schedule Types: Laboratory, Practice Study Observation

Restrictions:
 Must be enrolled in one of the following Colleges:
 School of Chemical Engineering

Prerequisites: Minimum Grade of D-; CHE 32000 Minimum Grade of D-; CHE 34800 Minimum Grade of D-; CHE 37800 Minimum Grade of D-; CHE 30600 Minimum Grade of D-

Concurrent Prerequisites: CHE 44900

***COURSE LEARNING OUTCOMES**

- Obtain experimental data and calculate physical quantities from these data (1, 2).
- Understand experimental error, estimate it, and infer its significance in the experimental results (2).
- Design statistically sound experiments, conduct these experiments, and analyze the results (1, 2, 3).
Effectively report results in written form and be able to communicate the results orally (7).
- Understand different personality types, how these types respond, and how they can function effectively together as a team (4).
- Develop an understanding of the professional responsibilities of the engineer as a member of a team (4, 6).
- Practice safety as an integral part of laboratory work (8).

Calumet Department Head _____ Date _____ Calumet School Dean _____ Date _____

7/29/10
8

| | | | |
|--------------------------------|------|--|------|
| Fort Wayne Department Head | Date | Fort Wayne School Dean | Date |
| Indianapolis Department Head | Date | Indianapolis School Dean | Date |
| North Central School Dean | Date | North Central Vice Chancellor for Academic Affairs | Date |
| West Lafayette Department Head | Date | West Lafayette College/School Dean | Date |
| West Lafayette Registrar | Date | | |

Alvarado *12-2-09* *[Signature]* *5/24/00* *[Signature]* *7/29/10*

OFFICE OF THE REGISTRAR

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF AN UNDERGRADUATE COURSE
(10000-40000 LEVEL)

EFD 48-10

DEPARTMENT Chemical Engineering EFFECTIVE SESSION Fall 2011

- INSTRUCTIONS:** Please check the items below which describe the purpose of this request.
- | | |
|---|--|
| <input type="checkbox"/> 1. New course with supporting documents | <input type="checkbox"/> 7. Change in course attributes (department head signature only) |
| <input type="checkbox"/> 2. Add existing course offered at another campus | <input type="checkbox"/> 8. Change in instructional hours |
| <input type="checkbox"/> 3. Expiration of a course | <input type="checkbox"/> 9. Change in course description |
| <input type="checkbox"/> 4. Change in course number | <input checked="" type="checkbox"/> 10. Change in course requisites |
| <input checked="" type="checkbox"/> 5. Change in course title | <input checked="" type="checkbox"/> 11. Change in semesters offered (department head signature only) |
| <input checked="" type="checkbox"/> 6. Change in course credit/type | <input type="checkbox"/> 12. Transfer from one department to another |

| | | | | | | |
|---|--|---------------------------------------|--------------|---|--|--|
| PROPOSED: | | EXISTING: | | TERMS OFFERED Check All That Apply: | | |
| Subject Abbreviation | <input type="text"/> | Subject Abbreviation | <u>CHE</u> | <input type="checkbox"/> Summer | <input checked="" type="checkbox"/> Fall | <input checked="" type="checkbox"/> Spring |
| Course Number | <input type="text"/> | Course Number | <u>43500</u> | CAMPUS(ES) INVOLVED | | |
| Long Title | <u>Chemical Engineering Laboratory</u> | | | <input type="checkbox"/> Calumet | <input type="checkbox"/> N. Central | |
| Short Title | <input type="text"/> | | | <input type="checkbox"/> Cont Ed | <input type="checkbox"/> Tech Statewide | |
| Abbreviated title will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY) | | | | | | |
| <input type="checkbox"/> Indianapolis | <input type="checkbox"/> Ft. Wayne | <input type="checkbox"/> W. Lafayette | | | | |

| | | | | | |
|--|----------------------|--|--------------------------|------------------------------|--------------------------|
| CREDIT TYPE | | COURSE ATTRIBUTES: Check All That Apply | | | |
| 1. Fixed Credit: Cr. Hrs. | <u>4</u> | 1. Pass/Not Pass Only | <input type="checkbox"/> | 6 Registration Approval Type | <input type="checkbox"/> |
| 2. Variable Credit Range: | <input type="text"/> | 2. Satisfactory/Unsatisfactory Only | <input type="checkbox"/> | Department | <input type="checkbox"/> |
| Minimum Cr. Hrs | <input type="text"/> | 3. Repeatable | <input type="checkbox"/> | 7 Variable Title | <input type="checkbox"/> |
| (Check One) To <input type="checkbox"/> Or <input type="checkbox"/> | | Maximum Repeatable Credit: | <input type="text"/> | 8 Honors | <input type="checkbox"/> |
| Maximum Cr. Hrs | <input type="text"/> | 4. Credit by Examination | <input type="checkbox"/> | 9 Full Time Privilege | <input type="checkbox"/> |
| 3. Equivalent Credit: Yes <input type="checkbox"/> No <input type="checkbox"/> | | 5. Special Fees | <input type="checkbox"/> | 10 Off Campus Experience | <input type="checkbox"/> |

| Schedule Type | Minutes Per Mtg | Meetings Per Week | Weeks Offered | % of Credit Allocated | Cross-Listed Courses |
|---------------|-----------------|-------------------|---------------|-----------------------|----------------------|
| Lecture | | | | | |
| Recitation | | | | | |
| Presentation | | | | | |
| Laboratory | <u>170</u> | <u>2</u> | <u>16</u> | | |
| Lab Prep | | | | | |
| Studio | | | | | |
| Distance | | | | | |
| Online | | | | | |
| Experiential | | | | | |
| Research | | | | | |
| Ind. Study | | | | | |
| Pract/Observ | <u>50</u> | <u>1</u> | <u>16</u> | | |

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):

Credit Hours: 4.00. Quantitative experimental study of projects involving problems in fluid mechanics and heat and mass transfer or operation and evaluation of equipment; projects include analysis and data-based design of operations involving mass transfer such as distillation, absorption, extraction, drying, humidification, etc; study of rates and equilibria in simple chemical reaction systems; study of chemical processes; application of methods of data analysis in practice; some library work; emphasis on group work, report writing, and oral communication. Usually offered fall and spring.

Level: Undergraduate
Schedule Types: Laboratory, Practice Study Observation

Restrictions:
Must be enrolled in one of the following Colleges:
School of Chemical Engineering

Prerequisites: Minimum Grade of D-; CHE 32000 Minimum Grade of D-; CHE 34800 Minimum Grade of D-; CHE 37800 Minimum Grade of D-; CHE 30600 Minimum Grade of D-

Concurrent Prerequisites: CHE 44900

- COURSE LEARNING OUTCOMES**
- Obtain experimental data and calculate physical quantities from these data (1, 2).
 - Understand experimental error, estimate it, and infer its significance in the experimental results (2).
 - Design statistically sound experiments, conduct these experiments, and analyze the results (1, 2, 3).
Effectively report results in written form and be able to communicate the results orally (7).
Understand different personality types, how these types respond, and how they can function effectively together as a team (4).
 - Develop an understanding of the professional responsibilities of the engineer as a member of a team (4, 6).
 - Practice safety as an integral part of laboratory work (8).

Fort Wayne Department Head Date Fort Wayne School Dean Date

Indianapolis Department Head Date Indianapolis School Dean Date

North Central School Dean Date North Central Vice Chancellor for Academic Affairs Date

Alkerup *12-2-09* *[Signature]* *5/24/200*
West Lafayette Department Head Date West Lafayette College/School Dean Date West Lafayette Registrar Date

OFFICE OF THE REGISTRAR

To: The Faculty of the College of Engineering

From: The Faculty of the School of Chemical Engineering

Re: Change of existing CHE 43500 from 3 credit hours to 4 credit hours resulting in a change in title, description and requisites.

The faculty of the School of Chemical Engineering has approved the following change and submits it for your approval.

From:

CHE 43500 - Chemical Engineering Laboratory II
Sem 2, Lab 6, Cr. 3

Restrictions: Must be enrolled in the School of Chemical Engineering

Prerequisites:

CHE 30600, 34800, and 43400

Continuation of CHE 43400 covering operations involving mass transfer such as distillation, absorption, extraction, drying, humidification, etc.; study of rates and equilibria in simple chemical and reaction systems; study of chemical processes; library work and report writing. Typically offered Spring.

To:

CHE 43500 - Chemical Engineering Laboratory
Sem 1 and 2, Class 1, Lab 6, Cr. 4

Restrictions: Must be enrolled in the School of Chemical Engineering

Prerequisites: CHE 32000, 30600, 34800, 37800

Concurrent Prerequisites: CHE 44900

Quantitative experimental study of projects involving problems in fluid mechanics and heat and mass transfer or operation and evaluation of equipment; projects include analysis and data-based design of operations involving mass transfer such as distillation, absorption, extraction, drying, humidification, etc; study of rates and equilibria in simple chemical reaction systems; study of chemical processes; application of methods of data analysis in practice; some library work; emphasis on group work, report writing, and oral communication. Usually offered fall and spring.

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE

ECC Minutes

#19

Date

3/9/2010

Chairman ECC

R. Cipro

Reason: In the current curriculum, the students take two laboratory courses, in which in addition to the technical content they receive training in working in groups with different roles, and in oral and written communication skills. The students in the new curriculum will receive technical laboratory training as a part of three other courses, CHE 37700, CHE 37800, and CHE 34800. One credit has been added in each of these courses already. These three credits, have already been approved for the curriculum, and are called the "fundamental labs." To avoid duplication between the junior fundamental lab courses and the senior lab courses, and to avoid increasing the number of the total credits, the faculty voted and approved the above proposed change of removing CHE 43400 from the curriculum. Moreover, to avoid losing the written and oral communication parts of CHE 43400, which are not covered in the fundamental labs, the faculty proposes to increase the number of credits of CHE 43500 by 1 credit. The extra credit will cover lectures on oral and written communication and will be scheduled for one hour per week.

A. Varma

A. Varma, Head
School of Chemical Engineering
11/5/09

ChE 43400 Chemical Engineering Laboratory I (current)

A. Instructors: Vary/TBD

B. Catalog Description: Quantitative experimental study of thermodynamics, fluid mechanics, and heat and mass transfer; operation and evaluation of equipment; application of methods of data analysis in practice; use of computers in controlling and simulating experiments; strong emphasis on report writing and oral communication.

C. Prerequisites: CHE 32000, CHE 34800, CHE 37800

D. Textbooks: *Unit Operations of Chemical Engineering* (7th ed.), W. L. McCabe, J. C. Smith & P. Harriott, McGraw-Hill, 2005. *The Who/What/When/Where of CHE 434/435*, Chemical Engineering Laboratory, Purdue University, 2006.

E. Course Objective

Apply the engineering fundamentals and concepts developed in the chemical engineering core courses to design and conduct experiments, analyze the results, and present the results to a group of peers.

F. Course Outcomes (numbers in parentheses refer to related program educational objective)

1. Obtain experimental data and calculate physical quantities from these data (1, 2).
2. Understand experimental error, estimate it, and infer its significance in the experimental results (2).
3. Design statistically sound experiments, conduct these experiments, and analyze the results (1, 2, 3).
4. Effectively report results in written form and be able to communicate the results orally (7).
5. Understand different personality types, how these types respond, and how they can function effectively together as a team (4).
6. Develop an understanding of the professional responsibilities of the engineer as a member of a team (4, 6).
7. Practice safety as an integral part of laboratory work (8).

G. Course Topics: Flow measurement, rotameters, temperature measurement, electronic thermometers, analytical chemistry measurements, gas chromatography, CSTRs, bioreactors, agitation, natural convection evaporator, liquid/liquid extraction, concentric tube heat exchangers, RO water purification, fixed and fluidized beds, water pumping.

H. Assessment of Course Outcomes

Laboratory reports; Peer evaluation; Oral communication rubric.

ChE 43500 Chemical Engineering Laboratory II (current)

A. Instructors: Vary/TBD

B. Catalog Description: Continuation of CHE 43400 covering operations involving mass transfer such as distillation, absorption, extraction, drying, humidification, etc.; study of rates and equilibria in simple chemical and reaction systems; study of chemical processes; library work and report writing.

C. Prerequisites: CHE 43400

D. Textbook: *Unit Operations of Chemical Engineering* (7th ed.), W. L. McCabe, J. C. Smith & P. Harriott, McGraw-Hill, 2005. *The Who/What/When/Where of CHE 434/435*, Chemical Engineering Laboratory, Purdue University, 2006.

E. Course Objectives

Apply chemical engineering fundamentals to design, conduct, and analyze the results of experiments constructed to obtain intrinsic performance data required to complete design projects.

F. Course Outcomes (numbers in parentheses refer to related program educational objective)

1. Determine the intrinsic performance data required to complete the design, process, or process equipment (1, 2, 3).
2. Design and conduct an experimental program to determine the required performance data (1, 2, 3).
3. Use the requisite performance data to obtain a technically feasible and economical design to meet desired needs (1, 2, 3, 8).
4. Effectively report results in written form and be able to communicate these results in an oral presentation (7).
5. Understand different personality types, how these types respond, and how they can function effectively together as a team (4).
6. Develop the ability to identify, formulate, and solve engineering problems (1).
7. Develop the capability of independent and lifelong learning (9).
8. Develop knowledge of contemporary issues and understand the impact of engineering solutions in a global and societal context (8).
9. Develop ability to use modern techniques and engineering tools (5).
10. Develop an understanding of the professional and ethical responsibilities as a member of an engineering team (4).
11. Understand and practice appropriate safety measures (8).

G. Course Topics: Bioreactor and enzymatic reactor design and scale-up; distillation in a packed column and in a sieve-tray column; gas absorption in a packed column; gas separation by membrane permeation; gas-phase dehydrogenation; liquid-liquid extraction; ion exchange; food-grade solution production.

H. Assessment of Course Outcomes

Laboratory reports; Oral communication rubric; Peer evaluation.

ChE 435 Chemical Engineering Laboratory (proposed)**A. Instructors: Vary/TBD**

B. Catalog Description: Credit Hours: 4.00. Quantitative experimental study of projects involving problems in fluid mechanics and heat and mass transfer or operation and evaluation of equipment; projects include analysis and data-based design of operations involving mass transfer such as distillation, absorption, extraction, drying, humidification, etc; study of rates and equilibria in simple chemical reaction systems; study of chemical processes; application of methods of data analysis in practice; some library work; emphasis on group work, report writing, and oral communication. May be offered Fall or Spring, or both semesters, in cases of large enrollments.

C. Prerequisites: CHE 37700 Minimum Grade of D-; CHE 32000 Minimum Grade of D-; CHE 34800 Minimum Grade of D-; CHE 37800 Minimum Grade of D-; CHE 30600 Minimum Grade of D-
Concurrent Pre-requisite: CHE 44900

D. Textbook: *Unit Operations of Chemical Engineering* (7th ed.), W. L. McCabe, J. C. Smith & P. Harriott, McGraw-Hill, 2005. Also a set of notes and instructions, prepared by the instructors, is used on laboratory procedures, written reports, and oral reports, "*The Who/What/When/Where of CHE 435*," Chemical Engineering Laboratory, Purdue University, 2009.

E. Course Objectives

Apply chemical engineering fundamentals to design and conduct experiments; analyze and interpret the results of experiments to obtain intrinsic engineering parameters or equipment performance data needed in design projects; and propose and evaluate a specific process or equipment design.

F. Course Outcomes (numbers in parentheses refer to related program educational objective)

1. Obtain experimental data and calculate physical quantities from these data (1, 2).
2. Understand experimental error, estimate it, and infer its significance in the experimental results (2).
3. Design statistically sound experiments, conduct these experiments, and analyze the results (1, 2, 3).
4. Determine the intrinsic performance data required to complete the design, process, or process equipment (1, 2, 3).
5. Design and conduct an experimental program to determine the required performance data (1, 2, 3).
6. Use the requisite performance data to obtain a technically feasible and economical design to meet desired needs (1, 2, 3, 8).
7. Effectively report results in written form and be able to communicate these results in an oral presentation (7).
8. Understand different personality types, how these types respond, and how they can function effectively together as a team (4).

9. Develop the ability to identify, formulate, and solve engineering problems (1).
10. Develop the capability of independent and lifelong learning (9).
11. Develop knowledge of contemporary issues and understand the impact of engineering solutions in a global and societal context (8).
12. Develop ability to use modern techniques and engineering tools (5).

13. Develop an understanding of the professional and ethical responsibilities as a member of an engineering team (4).
14. Understand and practice appropriate safety measures (8).

G. Course Topics: CSTRs, bioreactors, agitation, natural convection evaporator, liquid/liquid extraction, concentric tube heat exchangers, RO water purification, fixed and fluidized beds, water pumping. Bioreactor and enzymatic reactor design and scale-up; distillation in a packed column and in a sieve-tray column; gas absorption in a packed column; gas separation by membrane permeation; gas-phase dehydrogenation; liquid-liquid extraction; ion exchange; food-grade solution production.

H. Assessment of Course Outcomes

Laboratory reports; Peer evaluation; Oral communication rubric; Written report rubric.

