Class Hours: 3.0  Credit Hours: 4.0
Laboratory Hours: 3.0  Date Revised: Fall 01

NOTE: This course is not designed for transfer credit.

Catalog Course Description:

Unit operations of chemical engineering, including evaporation, absorption, distillation, ion exchange, extraction, and drying. Problems of scale-up will be discussed. The laboratory will consist of experiments demonstrating principles. Emphasis will be placed on assembly and proper operation of the equipment. Detailed reports of experiments will be prepared.

Entry Level Standards:

Entering students should have familiarity with fluid flow and heat transfer.

Prerequisites:

CHT 2450

Textbook(s) and Other Reference Materials Basic to the Course:


I. Week/Unit/Topic Basis:

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heat exchanger</td>
</tr>
<tr>
<td>2</td>
<td>Heat exchangers</td>
</tr>
<tr>
<td>3</td>
<td>Evaporation</td>
</tr>
<tr>
<td>4</td>
<td>Vapor-liquid equilibria</td>
</tr>
<tr>
<td>5</td>
<td>Introduction to distillation</td>
</tr>
<tr>
<td>6</td>
<td>Batch distillation</td>
</tr>
<tr>
<td>7</td>
<td>Graphical methods for binary distillation</td>
</tr>
<tr>
<td>8</td>
<td>Distillation calculations using the computer</td>
</tr>
<tr>
<td>9</td>
<td>Packed distillation towers</td>
</tr>
<tr>
<td>10</td>
<td>Absorption</td>
</tr>
<tr>
<td>11</td>
<td>Extraction</td>
</tr>
<tr>
<td>12</td>
<td>Drying</td>
</tr>
<tr>
<td>13</td>
<td>Filtration</td>
</tr>
<tr>
<td>14</td>
<td>Ion exchange</td>
</tr>
<tr>
<td>15</td>
<td>Other unit operations</td>
</tr>
<tr>
<td>16</td>
<td>Final Exam</td>
</tr>
</tbody>
</table>

II. Course Objectives*:

A. Make rating calculations for heat exchangers.  I, II, III

B. Demonstrate an understanding of the principles involved in single or multiple stage evaporation.  I, IV, V

C. Demonstrate an understanding of the principles and function of batch and continuous binary distillation.  I, IV, V

D. Make calculations of theoretical stages for binary distillation systems.  I, II, III

E. Demonstrate an understanding of the principles of absorption, leaching and extraction.  I, IV, V

F. Demonstrate an understanding of the principles of solids drying.  I, IV, V

G. Demonstrate an understanding of the principles of filtration.  I, IV, V

H. Demonstrate an understanding of the principles of ion exchange and adsorption.  I, IV, V

I. Demonstrate familiarity with the principles and nomenclature of solids conveying, solids screening, solids mixing, thermal diffusion, and reverse osmosis.  I, IV, V

J. Demonstrate the ability to maintain and compile documentation and records of experimental work.  I, II, III, IV, V

K. Demonstrate the ability to compile information and prepare a formal report.  I, II, III, IV, V

*Roman numerals after course objectives reference goals of the CHT program.

III. Instructional Processes*:

Students will:

1. Attend lectures and discuss concepts.  Communication Outcome, Problem Solving and Decision Making Outcome, Information Literacy Outcome, Active Learning Strategy

2. Solve assigned problems out of class and be prepared to discuss the problem solutions.  Communication Outcome, Problem Solving and Decision Making Outcome, Numerical Literacy Outcome, Information Literacy Outcome, Active Learning Strategy
3. Participate in laboratory experiments which are direct applications of the concepts studied. *Communication Outcome, Problem Solving and Decision Making Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning Strategy, Transitional Strategy*

4. Work as part of a group to perform laboratory experiments and collect data. *Communication Outcome, Personal Development Outcome, Problem Solving and Decision Making Outcome, Cultural Diversity and Social Adaptation Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning Strategy*

5. Maintain a research style lab notebook. *Communication Outcome, Information Literacy Outcome, Active Learning Strategy*

6. Prepare formal written reports will be prepared comparing the students' experimental results for a heat exchange experiment and a distillation experiment and the results expected from the published correlations. *Communication Outcome, Information Literacy Outcome, Active Learning Strategy*

7. Make an oral report on a heat exchanger type that is not covered in the lecture and will obtain information for the report from the library, manufacturers catalogs and the Internet. *Communication Outcome, Technological Literacy Outcome, Information Literacy Outcome, Active Learning*

*Strategies and outcomes listed after instructional processes reference Pellissippi State’s goals for strengthening general education knowledge and skills, connecting coursework to experiences beyond the classroom, and encouraging students to take active and responsible roles in the educational process.*

**IV. Expectations for Student Performance***:

Upon successful completion of this course, the student should be able to:

1. Make rating calculations on heat exchangers. A

2. Use Raoult's Law to calculate boiling point and vapor pressures in evaporators. B

3. Describe a multiple effect evaporator. B

4. Explain the operation and what limits the number of stages in multiple stage evaporation. B

5. Describe the equipment used for continuous distillation. C

6. Calculate the number of theoretical stages required for a separation. C

7. Explain the concept of a theoretical stage. C

8. Explain the concept of relative volatility. C

9. Demonstrate the use of the McCabe Thiele method for binary distillation. D

10. Demonstrate the use of the Ponchon Savarit method for binary distillation. D

11. Explain the concept of minimum reflux ratio. D

12. Calculate the external reflux ratio for a distillation column. D

13. Describe the effect of variations in reflux ratio. D
14. Explain the concept of infinite reflux ratio. D
15. Draw a vapor-liquid equilibrium diagram using Raoult's Law. C
16. Show how temperature effects the operation of a distillation column. D
17. Show how to determine the pressures in a distillation column. D
18. Describe flooding in a distillation column. D
19. Explain entrainment and its effect in distillation. D
20. Describe the concept of a mass transfer film coefficient. D
21. Describe the differences between batch and continuous distillation. D
22. Demonstrate the use of Henry's Law. C
23. Calculate the number of theoretical stages needed in an absorption column. E
24. Show how to use absorption coefficients. E
25. Show how to obtain the height of a transfer unit from experimental data. E
26. Show how to use partition coefficients in liquid-liquid extraction. E
27. Explain why multiple extractions with small quantities of extractant is more effective than fewer extractions with large amounts of extractant. E
28. Describe the major type of dryers and explain the advantages of each. F
29. Make dryer sizing calculations from experimental data. F
30. Describe the major types of filtration equipment and explain the advantages of each. G
31. Make filtration calculations for non-compressible filter cakes. G
32. List the major uses for ion exchange separation. H
33. Calculate the capacity for a batch ion exchanger. H
34. Calculate the break thru point for an ion exchanger. H
35. Show familiarity with the major manufacturers of ion exchange resins. H
36. Be familiar with the basic principles, some nomenclature, and some important uses of solids conveying. I
37. Be familiar with the basic principles, some nomenclature, and some important uses of solids screening and separating. I
38. Be familiar with the basic principles, some nomenclature, and some important uses of solids mixing. I
39. Be familiar with the basic principles, some nomenclature, and some important uses of carbon adsorption. I
40. Be familiar with the basic principles, some nomenclature, and some important uses of leaching.
41. Be familiar with the basic principles, some nomenclature, and some important uses of thermal diffusion.
42. Be familiar with the basic principles, some nomenclature, and some important uses of reverse osmosis.
43. Maintain a laboratory notebook during laboratory experimental work.
44. Document laboratory preparation and data collection in a systematic manner.
45. Organize experimental data and perform relevant calculations.
46. Prepare a formal report in which the results of an experiment are presented.
47. Make an oral report describing a process or equipment item.

*Letters after performance expectations reference the course objectives listed above.

V. Evaluation:

A. Testing Procedures: 35% of grade

The student's progress will be evaluated by three exams and an additional comprehensive final exam.

B. Laboratory Expectations: 25% of grade

The laboratory work will comprise 25% of the course grade and the grade will be based on the laboratory notebook. Each student will keep a laboratory notebook and write up each experiment in the notebook. The notebook will be kept in a manner similar to an industrial notebook for patent purposes. Laboratory experiments may vary depending on equipment availability and maintenance. All experiments will require some student assembly of equipment.

1. Heat transfer
   Experiments in convective heat transfer will be conducted using heat exchange equipment to compare theory and experiment. Using brass shell and tube heat exchanger, Pyrex shell and tube heat exchanger and air cooled heat exchanger.

2. Distillation
   Experiments in distillation of mixtures will be performed to compare theoretical calculations and experimental results. Using a Pyrex 3” Oldershaw column. A gas chromatography and/or FAIR will be used for sample analysis.

3. Absorption
   Experiments in absorption of carbon dioxide will be performed using a 6” glass column. A gas chromatography will be used for analysis of samples.

4. Filtration
   Filtration experiments will be performed using pilot scale mixing and filtration equipment.

5. Crushing and screening
Crushing experiments will be performed using laboratory scale crushing and screening equipment.

C. Field Work: 45% of grade

Outside readings and library research will be required in this course. A formal written report will count 35% of the grade. Students will make a short oral presentation on their assigned heat exchanger and this will count as an exam. Homework assignments are an important part of this course and all homework assignments completed and submitted will be graded "A" and will comprise up to 10% of the course grade (as calculated below).

D. Other Evaluation Methods:

N/A

E. Grading Scale:

The course numerical grade will be calculated using the formula below:

\[
G = 10 * \frac{H}{HM} + .35 * \frac{(T(1) + T(2) + \ldots + T(N))}{N} + .3 * F + .25 * L) / (.9 + .1 H/HM)
\]

where

- \( G \) = the numerical grade
- \( H \) = the homework grade
- \( HM \) = the maximum homework grade attainable
- \( T(i) \) = the grade on exam number \( i \) (Research papers and the oral report are included in this category.)
- \( N \) = number of exams and research papers and oral report (excluding the final exam)
- \( F \) = the grade on the final exam
- \( L \) = the laboratory grade.

Letter grades will be awarded based on the following schedule:

- 90 – 100  A
- 87 – 89   B+
- 80 – 86   B
- 77 – 79   C+
- 70 – 76   C
- 60 – 70   D
- below 60   F

VI. Policies:

A. Attendance Policy:

Pellissippi State Technical Community College expects students to attend all scheduled instructional activities. As a minimum, students in all courses must be present for at least 75 percent of their scheduled class and laboratory meetings in order to receive credit for the course (Pellissippi State Catalog). Individual departments/programs/disciplines, with the approval of the vice president of Academic and Student Affairs, may have requirements that are more stringent.

Chemical/Environmental Engineering Technology Program:

Regular attendance in this course is required. Students who miss the equivalent of 10% of
either classroom hours or laboratory may, at the discretion of the instructor, have their course grade dropped by one letter. Students who arrive late for a class after the roll as been called have the responsibility of seeing the instructor after class the change their status from A (absent) to T (tardy).

B. Academic Dishonesty:

In keeping with college-wide policies, the student is expected to adhere to the general rules and regulations relevant to academic and classroom misconduct as outline in the catalog.