Overall Description:
A course on the theory and practice of various unit operations within process engineering, with emphasis on separations, including equilibrium staged and some rate-based separations.

Prerequisite Knowledge:
- Application of material and energy balances
- Phase equilibrium thermodynamics

Course Objectives:
- Understand the phase equilibrium principles that govern staged chemical separation processes.
- Develop the ability to model separation processes using material and energy balances combined with phase equilibrium expressions (equilibrium stage approach). Understand the advantages and limitations of this approach. Numerical solutions may be obtained by hand, by spreadsheet, and using steady-state simulators (e.g., ASPEN RADFRAC).
- Obtain a practical, working knowledge of common separation operations such as distillation, absorption/stripping, and liquid-liquid extraction.

Expected Outcomes: After completion of this course the typical student should be able to:
- Understand the physical principles and basic mechanical designs of fundamental separation operations (flashes, distillation, absorption-stripping, and liquid-liquid extraction).
- Develop an equilibrium stage model of a separation process from first principles (material and energy balances, combined with phase equilibrium calculations).
- Use various mathematical tools (hand calculations, graphical solutions, math software, and ASPEN software) to simultaneously solve the material balances, energy balances, and phase equilibrium expressions needed to model equilibrium-staged separations.
- Use equilibrium stage model solutions to design and troubleshoot separation operations.
- Combine equilibrium stage models with simple cost estimates to optimize separation designs from an economic standpoint.

Time/Place: S2 17/103, W (Mi) 8:00 – 9:30

Recitation: None

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WebPage: http://webpages.sdsmt.edu/~ddixon/UO_TUD.html
List of Potential Topics (subject to change as the course progresses):
- Single stage vapor-liquid equilibrium flash
- Cascade
- Basic principles of distillation
- McCabe-Theile diagrams
- Trayed tower design, including reboilers and condensers
- Tray efficiencies in distillation
- Shortcut methods for multicomponent distillation
- Rigorous distillation modeling using RADFRAC in AspenPlus
- Complex distillation
- Ternary diagrams for single stage liquid-liquid extraction
- Multistage countercurrent liquid-liquid extraction
- Membrane systems
- Drying
- Adsorption
- Absorption

Grading (for this course at TU-Darmstadt):
- Midterm written exam 50%
- Final written exam 50%
- Homework improvement 0.3 pt

Grading (SDSMT style of teaching; for example only):

<table>
<thead>
<tr>
<th>Item</th>
<th>Points</th>
<th>Points earned</th>
<th>Grade</th>
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<tr>
<td>Exams (3)</td>
<td>60</td>
<td>90</td>
<td>A</td>
</tr>
<tr>
<td>Final Exam*</td>
<td>(20)</td>
<td>80-89</td>
<td>B</td>
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<tr>
<td>Homework**</td>
<td>30</td>
<td>70-79</td>
<td>C</td>
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<tr>
<td>Project</td>
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<td>60-69</td>
<td>D</td>
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* The Final will be a 2-hour comprehensive exam. All exams will be open textbook and open notes. Of the four exams given, only the top three exam scores will be used in computing the total points and final grade.
** Homework turned in late will be subject to 10% deduction daily. Submitted homework must be clean, readable and logically sound.
*** The final grade will be reflective of a student's rank in the class as well as the cumulative points earned.