ECH 4644
Process Design

Academic Term: Spring 2020

Course Section(s):
Find your section and make sure to take note of your class time and location.

Class #	Meeting Info	
12967	M,W,F | Period 6 (12:50 PM - 1:40 PM)	LAR 0330
12968	M,W,F | Period 7 (1:55 PM – 2:45 PM)	LAR 0330

Instructor:
Sindia M. Rivera-Jiménez, Ph.D. (Call me Dr. Rivera or Prof. Rivera)
Lecturer, Department of Engineering Education
Affiliate Faculty Chemical Engineering Department

- Pronouns: she, her, hers
- Office Location: Black Hall 320
- Telephone: 352-846-1974
- Email: rivera.jimenez@eng.ufl.edu .
    - **You MUST use ECH4644 in the subject heading to receive an answer.** It makes it more efficient for all.
    - Expect 24 hrs. response time from M-F and 48 hrs. for weekends.
- Office hours: To be announced on Canvas within the first week of class. You can email to make an appointment with your instructor. Also, I am available immediately after class. This has worked very well for students in the past. On certain weeks, I will post EXTRA office hours as well.

Teaching Assistant/Peer Mentor/Supervised Teaching Student: None

Course Description
Credits: 3. *Description:* Preliminary design of convention chemical processes, including process specifications, sitting and layout, equipment sizing, utility and manpower needs, safety and hazard analysis, environmental considerations and economic evaluation. Planning techniques for detailed engineering, construction and startup.

Course Pre-Requisites / Co-Requisites
Prereq: Synthesis and Specification of Economic Production (ECH 4604)
Coreq: Materials of Chemical Engineering, Process Control Theory (ECH 4824, ECH 4323)

Inclusion Statement

It is my intention that students from all backgrounds and perspectives will be well served by this course, and that the diversity that students bring to this class will be viewed as an asset. I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, socioeconomic background, family education level, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. Your suggestions are encouraged and appreciated.

Lived Name/Pronoun Statement

I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

Course Learning Objectives (CLO)

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

CLO 1. To instill an ability to analyze comprehensive situations and masses of data and facts in order to define key problems and variables.

CLO 2. Learn systematic methodologies for designing components, units and processes that meet performance specifications.

CLO 3. Learn how to search the literature for possible solutions to various aspects of the problems.

CLO 4. Develop techniques for checking individual work for accuracy and learn to work together as part of a team to review and help each other avoid mistakes.

CLO 5. Become power users of available computer aided engineering tools.

Materials and Supply Fees: None

Professional Component (ABET):

(ABET) Skills acquired during course: (1) Engineering problem solving and critical thinking that includes basics of Chemical Engineering.

Relation to Program Outcomes (ABET):

Outcome	Coverage[*]
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	High
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	High
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	Medium
4. An ability to communicate effectively with a range of audiences	High
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	High
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.	High
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty	High

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course. Shadowed box indicate that outcome is assessed in this course.

The ABET objectives are supported as follows:

a) Students develop the ability to apply knowledge of mathematics, science and engineering in context of a professional process design project. Students must seek out the information (knowledge) needed for developing the design solution in appropriate references or other repositories of knowledge.

b) The prime objective of the course is to teach students a systematic methodology for designing components, units and processes that meet performance specifications. Students develop an ability to apply knowledge from prerequisite courses to the solution of problems and sizing of equipment.

c) Students are assigned in teams so as to mix personalities and abilities and work on a semester-long team design project. The required team work develops abilities that are needed for effective function on multi-disciplinary teams.

d) Students are required to project needs into engineering requirements, synthesize process design concepts and prepare preliminary designs – thus identifying, formulating and solving engineering problems.

e) Oral and written communications are practiced through weekly team project review meetings and with the course instructor and through weekly written progress reports. These interim reports are revised and become part of the final design report. Formal team presentations of the project are made at the end of the project.

f) An ability to engage in lifelong learning is fostered through the project activities. Students are expected to research beyond the class and course materials for possible ideas and solutions to the problems, which arise in the development of valid design solutions.

g) Through several class tutorials students become power users of the design software UniSim and acquainted with Aspen Plus. They acquire further skills by using these software packages to produce simulations of the processes they are designing.

h) Lectures review safety concepts like flammability and toxicity. Information gathering includes obtaining MSDS sheets for all components involved in the design, as well as flammability limits. Safety and environmental impact are factors that students consider when selecting design.

Required Textbooks and Software

A. Main course text (required)
   i. Title – Product & Process Design Principles – Synthesis, Analysis and Evaluation.
   ii. Author – Seider, Seader, and Lewin,
   iii. Publication date and edition – Any edition will work (I will have 4th Ed, 2017). First edition is great.
   iv. ISBN number 9781119282631 (4th edition)

B. Required Software: Microsoft Office, access to a scanner, and access to Internet for Canvas LMS. Also UniSim, HYSYS and ASPEN (Go to Canvas for instruction for installation). A Windows laptop is required. Emulators will not work.

C. Computer requirements:

- All students must have a computer for this class. Make sure that your computer meets the minimum requirements established by the College of engineering: https://www.eng.ufl.edu/students/resources/computer-requirements/
- If your computer is almost full or lack memory, ChemE IT personnel have some recommendations for you (Find it on Canvas).
- A Windows laptop is required. Emulators will not work. For Mac users, ChemE IT personnel have some recommendations for you (Find it on Canvas).

Recommended Materials

- Online Resources: Learn ChemE , Educational Resources from ChemE from University of Colorado Boulder. Available at: http://www.learncheme.com/screencasts/mass-energy-balances

Course Schedule
Note: the detailed schedule below may change according to needs and circumstances. Any revisions will be announced in class and will be posted on canvas.

- Course logistics/structure:
  o The first 60% of the course will be face to face lecture 3 days per week (except holidays) and for the rest of the course we will meet for project support.
  o UniSim/Aspen Video tutorials: average time per homework should be ideally 1-2 hour/week. Student must submit homework in Canvas.
  o For the entire course: One weekly team project review meeting in which the teams make PowerPoint presentations.
- Topics covered in class:

o Overview of the design process	o Heat and power integration
o Assessing the problem	o Economic evaluation of designs
o Surveying literature	o Separation of azeotropes
o Database creation & property estimation	o Heat and power integration

- o Safety & environmental impact analysis
- o Professional ethics
- o Preliminary process synthesis
- o Selection of base case - Concept screening & scoring matrices
- o Heuristics for process synthesis
- o Reactor design & reactor network synthesis
- o Synthesis of separation trains
- o Separation of azeotropes

- o Economic evaluation of designs
- o Thermodynamic property estimation using UniSim/HYSYS and Aspen Plus
- o Steady state simulation of reactors using UniSim/HYSYS
- o Steady state simulation of separation processes using UniSim/HYSYS
- o Steady state simulation of entire plants (including integration) using UniSim
- o Pump sizing & selection

- **THE DETAILED SCHEDULE BELOW MAY CHANGE ACCORDING TO NEEDS AND CIRCUMSTANCES.** Any revisions will be announced in class and will be posted on Canvas

UNIT 1: EARLY STAGES IN DESIGNING AND RETROFITTING CHEMICAL PROCESSES	
Introduction to Product and Chemical Process Design Overview of the Process Synthesis Steps Topic 1. Problem assessment Topic 2: Surveying literature Topic 3: Preliminary Data base creation: property estimation: experiments; physical, environmental and safety data; chemical prices Topic 4. Preliminary Data base creation: collecting information about processing: raw materials, reaction pathways, product, by products	Deliverables 1,2, 3 ~ 4 weeks
UNIT #2: PRELIMINARY PROCESS SYNTHESIS FOR CONCEPT SCREENING AND SELECTION	
Topic 5 Preliminary Process Synthesis: Process Mode, ID Raw materials and Rxtn Pathways and Possible Flow Streams Process operations. Concept Screening and Selection (Decision Matrices) Topic 6. Preliminary Process Synthesis: Selecting promising Base-case flowsheet. Topic 7: Performing Mass Balances on the flowsheet	Deliverables 4, 5, 6,7,8 ~ 5 weeks
UNIT #3: CONCEPTUALIZATION OF THE POSSIBLE PROCESS FLOW DIAGRAMS	
Topic 8: Heuristics for process synthesis: deciding on process stream conditions Topic 9: Perform material and energy balances on the flowsheet Topic 10: Replace simple process unit models, with more rigorous models Topic 11: Perform economic evaluation for the process (profitability analysis) Topic 12: Seek opportunities for heat and mass integration	Deliverables 8,9, 10, 11 ~ 4 weeks
Unit #4: EVALUATION AND OPTIMIZATION OF THE POSSIBLE PROCESS	
Topic 13: Perform environmental impact and sustainability calculations. Check process safety risks and provide recommendations. Topic 14: Seek to improve the design using process optimization. Topic 15: Perform economic evaluation for the optimized process (profitability analysis) Topic 16: Final Design Report and oral presentation	Deliverables 11, 12, 13 ~ 4 weeks

Attendance Policy, Expectations, and Make-Up Policy

a) Attendance
- Regular attendance expected in addition to class discussions and satisfactory performance on class activities.
- Attendance will be taken in class periodically. Make sure to be in class or send and excuse to your instructor.
    - o Signing an attendance on behalf of an absent or tardy student is in violation of the academic honesty policy and will result in disciplinary action. A first violation will result in a letter grade reduction for all involved parties. A second violation will result in course failure for all involved parties.

- <mark>HOW TO SEND AN EXCUSE</mark>:
    - Email Dr. Rivera at rivera.jimenez@eng.ufl.edu
    - Use the Following Subject line: ECH 4644: Absence Excuse
    - What constitute a valid excuse? Excused absences are consistent with university policies in the undergraduate catalog and require appropriate documentation. Absences will be excused under the following conditions:
        - 24 hours ahead of time that you have a legitimate, unavoidable absence (such as an exam conflict for a higher-numbered academic course)
        - A verifiable medical or family emergency
        - Travel for a student conference—provided all excuse request prior to travel
        - Need to come to class late or leave early for a legitimate reason
    - Email instructor at least 24 hours before missing class due to interview confirmation email; conference email; UF official sporting event.

b) Basic Responsibilities Expected of You:
- Attendance is critical! The material you will learn is invaluable. In case of absence, you can ask a class mate for lecture material, use your book, and access supporting slides on Canvas. Note: supporting slides are NOT the complete lecture material, these are diagrams and pictures that I use to support the lecture.
- Don't be afraid to ask for help during class or office hours.
- Be an active learner - ask yourself questions during lectures, as you read, and as you attempt problems.
- Study in advance and go to office hours. Don't wait until the day before the exam, homework, or report to get clarification on the material.
- Check Canvas for class updates, assignments, announcements, lessons, calendar, and resources.
  If using a laptop and other devices in class, you shouldn't be on Facebook, Netflix, Hulu, etc. or do other things that are not class-related. When instructor asks you to put your device away, please do so.
- Recording the lecture is not allowed using any type of media. If you need special accommodations, please contact your instructor.
- You need to notify your instructor if your need accommodation from the Disability Resource Center. I would love to help you out.

c) Expectation from team and individual son each team: Conflict Resolution
- **Be Aware That Conflict Occurs**-Knowing that conflict may and will occur is the first step to resolving it, especially if you know that certain team members may disagree with each other.
- **Set the Ground Rules**-At the beginning of your project set some ground rules in your first meeting. Be sure to address what process will be taken to address conflicts, as they are bound to rise and will need to be taken care of before they spiral out of control. Remember that everyone's ideas for the project are valid and that they shouldn't be dismissed, even if you do not agree with them.
- **Document Team Dynamics**- teams must submit a weekly summary of each team member technical contributions, distribution of tasks, accomplishment of tasks, attendance to group meetings (besides inductor's meetings), and overall project status.
- **Stop Conflict When It Happens**-Conflict should be addressed immediately before it can grow. If a discussion grows heated during a meeting, do not wait until the next meeting to address the issue. Instead, discuss the issue while in the meeting; even if members disagree, they are still able to see each other's points of view. Your instructor can serve as a moderat0r for these discussions.
- **Discuss Both Sides of a Perspective**-Even if you are inclined to agree with one side of the conflict, do not make a final judgment until each person has had their say. Ending a discussion without hearing each person out can escalate the problem. Explain the pros and cons of both ideas, so that both people can consider the opposing view.
- **Make Compromise a Goal**-Compromising between parties is helpful, as it can allow for both conflicting parties the ability to use their ideas. Most times, points can be combined in order to make a better idea or solution.
- **Avoid Falling into Groupthink**-Groupthink is when a group suppresses the opposing views of members in order to create harmony. While it is always good to maintain harmony within a group while working on a project, this

idea of keeping opposing viewpoints at bay because they will disrupt the norm will end up doing more harm than good. To avoid this, make sure that there is one or two members that bring up constructive criticism to ideas.

- **Don't Try to Change a Team Member**-This final tip might be the most important. Just as in any type of relationship, do not try to change a member of your team. They are an individual person with unique ideas and forms of expression. Trying to change their feelings or viewpoints will only lead to resentment. You can propose to them alternatives, or list benefits of other ideas, but in the end you may just have to accept that they will disagree with an outcome.

d) Handling problems between a team member and the rest of the team
   1. Team must create and submit a team charter appended to their second deliverable. At the beginning of your project set some ground rules in your first meeting. Be sure to address what process will be taken to address conflicts, as they are bound to rise and will need to be taken care of before they spiral out of control. A template will be provided in class to facilitate the charter creation.
   2. In all weekly reports, teams must submit a weekly summary of each individual member's technical contributions, distribution of tasks, the accomplishment of tasks, attendance to group meetings (besides instructor's meetings), overall project status. Every team member must sign the report. This will allow your team to document relevant information in case we need it for a conflict resolution meeting.
   3. The team leader or any other member are welcome to discuss any concerns with your instructor by appointment or during the weekly meetings with your instructor. Your instructor will ask about team dynamics on every meeting.
   4. Each team member must complete all 3 peer evaluations that will be available on Canvas. This will allow each team member to have the opportunity to evaluate their peers and themselves. All information obtained from peer-evaluation will be used by your instructor to provide performance reviews to each team member. Only the last peer-evaluation will be used for the final grade adjustment.
   5. Team dissolution or changing individuals to another team are highly discouraged. The main goal of this class is that each student learns how to manage conflict to increase team performance towards an engineering goal. In case that a dispute between an individual cannot be resolved, this student will not be moved to another group. The student must have a formal meeting with the undergraduate coordinator and the faculty to establish a plan for assessment without significant changes in the overall project objectives.

e) Emails, Announcements, Feedback, and Communications
   - Announcements will be shared periodically during class and on Canvas. Is your responsibility to attend to class and read the emails/announcements from Canvas.
   - After each assignment is graded, you are responsible for reviewing your instructor's feedback.
   - Emails, announcements, and feedback may occur outside business hours.
   - Your instructor should respond within 24 hrs during workdays (M-F). There is not guarantee of response during weekends. Plan accordingly.

Grading Policy:

- **Evaluation of Grades:**

Assignment	Percentage of Final Grade
Homework	20 % (Individual)
UniSim exam	20 % (Individual)
Class & workshop participation	5 % (Individual)
Final oral presentation	5 % (Individual)
Project grade	50 % (Individual)***

- Project grade:
  - Based on the following:

Assignment	Percentage of Final Grade
Project progress reports (approximately one per week)	25%
Final design report	25%

- o ***The individual team members' grade is adjusted according to peer evaluations as follows:
    - Individual grade = team grade * (0.5+0.5*Individual Ratio)
    - Individual Ratio= average of student's evaluation excluding max and min)/(team average)
    - Note: For a student that is removed from a team, deliverables completed as part of the team will be adjusted as described above using the latest peer-evaluation. Then the rest of the deliverables will not include the Individual Ratio.
- **Grading Scale:** The students are sorted in the order of decreasing overall points. Grades are then decided as follows:

Division between A and A-	Largest gap between two students with 90 >= overall points > 85
Division between A- and B+	Largest gap between two students with 85 >= overall points > 80
Division between B+ and B	Largest gap between two students with 80 >= overall points > 75
Division between B and B-	Largest gap between two students with 75 >= overall points > 70
Division between B- and C+	Largest gap between two students with 70 >= overall points > 65
Division between C+ and C	Largest gap between two students with 65 >= overall points > 55
Division between C and C-	Largest gap between two students with 55 >= overall points > 45
Division between C- and D+	Largest gap between two students with 45 >= overall points > 30
Division between D+ and D	Largest gap between two students with 30 >= overall points > 10
Division between D and D-	Largest gap between two students with 10 >= overall points >= 0
E	Given to students for honesty violations.

More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Institutional Policies:
Students Requiring Accommodations
Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.
Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.
University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.
Commitment to a Safe and Inclusive Learning Environment
The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Program Coordinator
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: http://www.distance.ufl.edu/student-complaint-process.