ECH 3264 Elementary Transport Phenomena (3 credits)

1. Catalog Description:
   Flux law and conservation equation of mass, energy, and momentum; steady and unsteady states as applied to physical and chemical processing; macroscopic and microscopic analysis.

2. Prerequisites and Corequisites:
   Prerequisites: ECH 3023 and MAP 2302
   Corequisites:

3. Course Objectives:
   Upon completion of this course, a student should be able to:
   1. Derive differential equations from basic conservation principles describing heat, mass, and momentum transport for Cartesian, cylindrical, and spherical coordinate systems.
   2. Define and utilize Fourier's Law and Fick's Law, the constitutive equations for heat and mass transfer.
   3. Define the characteristics of a Newtonian and non-Newtonian fluids, including Bingham and power law fluids, and use the corresponding constitutive relationships to solve problems of fluid flow.
   4. Define and explain the origin of friction factors, heat transfer coefficients, and mass transfer coefficients, and the associated boundary conditions in the solution of relevant problems.
   5. Use the equations of change to formulate differential equation along with the proper boundary conditions for real physical systems involving transport phenomena relevant to the practice of chemical engineering.
   6. Solve steady, one-dimensional transport problems involving composite systems and systems with source terms.
   7. Solve unsteady and multi-dimensional transport problems using separation of variables and/or similarity transforms.
   8. Work ethically with other students, engaging in discussions and working independently as appropriate.

4. Contribution of course to meeting the professional component (ABET only – undergraduate courses): This course contributes to the engineering topics.

5. Relationship of course to program outcomes: Skills student will develop in this course (ABET only undergraduate courses)

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to identify, formulate, and solve engineering problems
(c) an understanding of professional and ethical responsibility
(d) an ability to communicate effectively
(e) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(f) a knowledge of contemporary issues
(g) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Instructor: Anuj Chauhan
    a. Office location: Room 419, ChE Building
    b. Telephone: 352-392-2592
    c. E-mail address: chauhan@che.ufl.edu
    d. Class Web site: https://elearning2.courses.ufl.edu/portal/site/fffcb8fb-7d56-43bf-a246-0cf17170c6ae
    e. Office hours: Monday, Wednesday 3:00-4:00 PM

7. Teaching Assistant: Deepak Rangarajan
    a. Office location: CHE 216
    b. Telephone
    c. E-mail address: deepakrangarajan@ufl.edu
    d. Office hours: Tuesday and Friday 3:00-4:00 PM

8. Meeting Times: 9:35 AM M, W, F
9. Class/laboratory schedule, i.e., number of sessions each week and duration of each session: Twice a week, total hours = 3
10. Meeting Location: ChE 237
11. Material and Supply Fees: None
12. Textbooks and Software Required: None
13. Recommended Reading

R. B. Bird, W. E. Stewart, E. N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley, 2002.
R..W. Fahien, Fundamentals of Transport Phenomena, McGraw-Hill, NY, 1983.

14. Course Outline (provide topics covered by week or by class period)

0. Overview of Mathematical Topics (approximately 1 week)
    a. Selected types of ordinary differential equations (pages 852, 853, 856, 857)

1. Energy Transport without Convection (approximately 4 weeks)
    a. Thermal conductivity and Fourier's law (pages 266-270)
    b. Temperature distributions determined by shell balances (pages 291, 292)
    c. Examples of 1-dimensional energy transport (pages 292-298, 303-310)
    d. Equations of change for non-isothermal systems (pages 333-336, 342-352)
    e. Examples of unsteady and/or multi-dimensional energy transport solved by using equations of change (pages 374-379).

2. Momentum Transport (approximately 5 weeks)

    a. Vector analysis (pages 807-814, 819-822, 825-827)

b. Viscosity and Newton's law (pages 11-21). Introduction to tensor analysis (pages 815-818, 821)
c. Convective momentum transport (pages 34-37)
d. Velocity distributions determined by shell balances (pages 41, 42)
e. Examples of 1-dimensional momentum transport (pages 42-58)
f. General momentum and mass balances with examples (pages 77-80, 83-89, 97-98)
g. Convective effects in heat transfer (pages 339-343).
h. Heat conduction with a viscous heat source (pages 283-286, 298-300)
i. Non-Newtonian fluids (pages 240-243)

3. Mass Transport (approximately 3 weeks)
   a. Diffusivity and Fick's first law (pages 514-519)
   b. Transport by convection (pages 533-537)
   c. Concentration distributions determined by shell balances (pages 543-545)
   d. Examples of mass transport (pages 545-560)
   e. Fick's second law (p. 585)
   f. Generalized mass balance equations (582-585)

4. Advanced topics

15. Attendance and Expectations (is attendance required, penalties for absence, tardiness, cell phone policy, etc.)
    Attendance to lectures is strongly recommended but not mandatory.
16. Grading – methods of evaluation (e.g., quizzes 20%, homework 15%, term paper 30%, final exam 35%)

Homework	0%
Quizzes	25%
First Exam	20%
Second Exam	20%
Final Exam	35%
Total	100%

It is expected that each student will have the total score larger than 50% for all homework assignments during the semester. Similarly, the total score larger than 40% is expected for all quizzes during the semester. A failing grade will be assigned to students if the total score for all homework assignments and/or the total score for all quizzes are smaller than 50% and 40%, respectively. For each homework only one randomly selected problem will be graded. Instructor will make the problem selection.

Homework:

1. Homework will be assigned approximately once a week.
2. Solutions will be posted on the course website
3. The homework must be turned in at the beginning of class on the due date.

4. Late homework will be accepted only with instructor approval. As a rule, there will be a 20% penalty for each day it is late. No late homework accepted after the solutions are posted.
5. No credit will be given for problems that have a solution but all the work leading to this solution is not shown.
6. The following format has to be used:

    a. The student's name should be written on the front page.
    b. Begin each problem on a new page.
    c. Write only on one side of a page.
    d. All pages must be stapled.
    e. Underline all intermediate answers. Box all final answers.

Details about Quizzes: In-class quizzes will be announced at least 1 week in advance. Unannounced quizzes may also be given.

Details about Exams: Partial credit will be assigned based on the rules that will be consistently applied to all exams. No credit will be given for problems that have a solution but all the work leading to this solution is not shown. Tentative dates of the first and second exams will be discussed during the first class meeting.

17. Grading Scale (e.g., 90-100 A, 85-89 B+, 80-84 B, etc.)

    Grades will be curved.

"A C- will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

18. Make-up Exam Policy: Make up exams will only be allowed under exceptional circumstances such as medical grounds, serious personal reasons, etc on a case by case basis.
19. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.
20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.
21. UF Counseling Services –Resources are available on-campus for students having

personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

22. Software Use – All faculty, staff and student 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.