

**ECH 3203:**  
Section 4009

**Fluid and Solid Operations**

3 credits  
Spring 2016

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<u>Class Hours</u>	<u>Location</u>
Tuesday, Thursday, Periods 9, 10 (4:05– 6:00 PM)	LAR 330
Final Exam, 26E, Tuesday, April 26, 2016 (5:30 PM-7:30 PM)	LAR 330

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1. *Catalog Description:*  
Characteristics of laminar and turbulent flow, mechanical energy balance, flow through packed beds and fluidization of solids, design of pumping systems and piping networks and metering of fluids.
2. *Prerequisites and Co-requisites:*  
Prerequisites: COT 3502 and ECH 3264.
3. *Instructor:*  
See above.
4. *Teaching Assistant:*  
See above.
5. *Class Meetings:*  
See above.
6. *Class Website:*  
<https://ufl.instructure.com/>.
7. *Textbooks and Software Required:*  
C. J. Geankoplis, *Transport Processes and Separation Process Principles (Includes Unit Operations)*, 4<sup>th</sup> edition, Prentice Hall, Englewood Cliffs, N. J., 2003.  
Note: Some exams will be open-book, and use of computers and phones will be prohibited. Thus, a paper copy of the book will be required.

Recommended Reading and Resources

R. B. Bird, W. E. Stewart, and E. H. Lightfoot, *Transport Phenomena*, Wiley, Hoboken, NJ, 1960.  
R. B. Bird, W. E. Stewart, and E. H. Lightfoot, *Transport Phenomena*, 2<sup>nd</sup> edition, Hoboken, NJ, 2006.  
W. L. McCabe, J. C. Smith, and P. Harriott, *Unit Operations of Chemical Engineering*, 7th Edition, McGraw-Hill, Inc., New York, New York, 2004.  
R. H. Perry and D. W. Green, editors, [\*Perry's Chemical Engineers' Handbook\*](#), 8<sup>th</sup> edition, McGraw Hill, New York, 2007.  
D. R. Lide, Jr., editor, [\*CRC Handbook of Chemistry and Physics\*](#), 96<sup>th</sup> edition, CRC Press, Cleveland Ohio, 2015-2016.

8. *Exam Dates:*  
The tentative schedule for exams and materials covered is attached.

### 9. Course Objectives:

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

- Identify process variables and conduct a dimensional analysis.
- Apply shell balance approach to set up mass and momentum balances.
- Evaluate the operation of process involving a flow through pipes (pressure drop, frictional loss, flow rate).
- Design a pipe network for a specific process.
- Estimate the drag force on an object immersed in a fluid flow.
- Evaluate the operation of packed beds, fluidized beds, and filters for specific fluids.
- Select and evaluate the performance of pumps.
- Work ethically with other students, engaging in discussions and working independently as appropriate.

Specific topics covered will include:

- Unit systems.
- Dimensional analysis.
- Thermo-physical properties.
- Hydrostatic equilibrium, barometric equation, manometer, buoyancy force.
- Integral mass and momentum balances.
- Potential flow, Bernoulli's equation, and friction factors.
- Laminar and turbulent flows.
- Pipe network.
- Pumps and flow meters.
- Flow of compressible fluids (adiabatic and isothermal flows).
- Stokes' law, drag coefficient, settling velocity.
- Flow through porous media, Darcy's law.
- Packed bed, fluidized bed.
- Operations involving particulates (filtration, mixing, gas cleaning).

### 10. Course Outline:

The tentative schedule for exams and materials covered is attached.

### 11. Grading Criteria

#### Grading

Grades are based on exams, completion of homework assignments, attendance, and participation in the class.

Homework and quizzes	10%
Mid-term exams (2)	50%
Final exam	40%

#### Attendance and Expectations

Attendance is required; penalties for absence and tardiness may be assigned at the discretion of the instructor. Cell phones may not be used in class.

### 12. Grading Scale:

Grades for this class are curved at the discretion of the instructor. Attendance and class participation will be considered.

Please note: A score of C or better required before continuing in the Chemical Engineering program. By University of Florida policy, 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>."

**13. Make-up Exam Policy:**

Exams/quizzes will be rescheduled only for those students who missed due to an acceptable reason (illness, serious family emergencies, military obligation, religious holidays, and participation in official university activities) as listed in the undergraduate catalog.

See <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

Students arriving late for a quiz/exam will be given only the balance of time remaining to complete their work unless an acceptable reason (see above) is provided.

**14. 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.

**15. 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.

**16. 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.

**17. 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.

**18. Relevant Aspects of the Chemical Engineering Policy on Exams**

- a) All exams will include the honor pledge and students must sign their name by the pledge.
- b) All students must leave backpacks, bags, etc., in the front of the classroom as they enter.
- c) Students are asked not to bring cell phones in the exam. In case they do, they have to place the cell phones in the front of the classroom. The department and proctors have no responsibility in case of theft (cell phones should not be brought). A cell phone discovered on a student's person may result in a zero grade for the exam. If a student is expecting an important call, he or she must discuss this with the proctors before starting the exam.
- d) Students are required to remove their hats during the exam and place them in the front of the classroom.
- e) In open book exams no printed material other than the textbook is allowed. A solution manual or printouts from solution manuals will result in a zero grade for the exam and additional harsher penalties.
- f) Any talking between students is strictly prohibited and will result in a zero grade for the exam.
- g) Students may not leave the room before turning in the exam.

**Tentative Schedule (updated January 3, 2016)**

<b>Date</b>	<b>Topics Covered</b>
Jan. 5, 2016	Introduction. Distinction between fundamental and derived units. American Engineering and SI systems of units. Fluid Statics.
Jan. 7, 2016	Fluid Statics. Discussion Section: Video: FLUID MECHANICS OF DRAG: 1. Some Curious Experiments.
Jan. 12, 2016	General Molecular Transport Equations. Viscosity of Fluids.
Jan. 14, 2016	Shell Momentum Balance and Velocity Profile in Laminar Flow. Discussion Section:
Jan. 19, 2016	Differential Equations of Continuity and Motion.
Jan. 21, 2016	Discussion Section:
Jan. 26, 2016	Use of Differential Equations and Motion.
Jan. 28, 2016	Video: FLUID MECHANICS OF DRAG: 2. Fundamental Concepts. Discussion Section:
Feb. 2, 2016	Types of Fluid Flow and Reynolds Number. Design Equations for Laminar and Turbulent Flow in Pipes.
Feb. 4, 2016	Flow past Immersed Objects and Packed and Fluidized Beds. Discussion Section:
Feb. 9, 2016	Overall Mass Balance and Continuity Equation. Overall Energy Balance. Overall Momentum Balance.
Feb. 11, 2016	Bernoulli's equation. Discussion Section:
Feb. 16, 2016	Measurement of Flow of Fluids. Pumps and Gas-Moving Equipment.
Feb. 18, 2016	Agitation and Mixing of Fluids and Power Requirements. Discussion Section:
Feb. 23, 2016	Compressible Flow of Gases.
Feb. 25, 2016	Discussion Section:
Mar. 1, 2016	Spring Break (class not held)
Mar. 3, 2016	Spring Break (class not held)
Mar. 8, 2016	Non-Newtonian Fluids.
Mar. 10, 2016	Discussion Section:
Mar. 15, 2016	Dimensional Analysis in Momentum Transfer.
Mar. 17, 2016	Video: FLUID MECHANICS OF DRAG: 3. The Laws of Drag in Fluids of High and Low Viscosity. Discussion Section:
Mar. 22, 2016	FLUID MECHANICS OF DRAG: 4. How to Reduce Drag.
Mar. 24, 2016	Discussion Section:
Mar. 29, 2016	14. Mechanical-Physical Separation Processes. Filtration.
Mar. 31, 2016	Discussion Section:
Apr. 5, 2016	Settling and Sedimentation.
Apr. 7, 2016	Discussion Section:
Apr. 12, 2016	Centrifugal Separation.
Apr. 14, 2016	Expression. Discussion Section:
Apr. 19, 2016	Review.
<b>Apr. 26, 2016</b>	<b>Final Exam (5:30-7:30 PM)</b>