Course Title: Heat, Mass and Momentum Transport
Course Prefix: CHEG **Course No.:** 3013 **Section No.:** P01

Department of | Chemical Engineering | **College of** | Engineering

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Office Hours: | **MWF 10:00 A. M. - 12:30 P.M. & 1:00 P.M. – 2:00 P.M.; F 2:00 P.M. - 4:00 P.M.**
Virtual Office Hours: | **None**

Course Location: | ***New Electrical Engineering Building, Room 115***
Class Meeting Days & Times: | **TR 12:30 P.M - 1:50 P.M.**
Catalog Description: | **(3-0) Credit 3 semester hours. Macroscopic and differential balances for heat, mass, and momentum. Energy balances and mechanical energy balances. Ideal and Newtonian and non-Newtonian fluid behavior. Comparison of the transport processes in laminar and turbulent flow. Dimensional analysis.**

Prerequisites: | **CHEG 2053 and MATH 2043.**
Co-requisites:

Required Text: | **"Transport Processes and Separation Process Principles" by Christie J. Geankoplis, Allen A. Hersel and Daniel H. Lepek, 5th Edition (2018), Prentice Hall-Peasrson Education, Inc., Boston, ISBN-13: 978-0-13-418102-8 or ISBN-10: 0-13-418102-6.**

Recommended Text/Readings: | **1. "Transport Phenomena" by Byron R. Bird, Warren E. Stewart and Edwin N. Lightfoot, Revised 2nd Edition (2007), John Wiley & Sons, Inc., ISBN 978-0-470-11539-8**
2. "Fundamentals of Momentum, Heat and Mass Transfer" by James R. Welty, Charles E. Wicks, Robert E. Wilson, and Gregory L. Rorrer, 5th Edition (2008), John Wiley & Sons, Inc., ISBN 978-0-470-12868-8

Access to Learning Resources: | PVAMU Library:
phone: (936) 261-1500;
web: http://www.tamu.edu/pvamu/library/
University Bookstore:
phone: (936) 261-1990;
web: https://www.bkstr.com/Home/10001-10734-1?demoKey=d

Course Goals or Overview:

The goal of this course is to provide the chemical engineering student the ability to quantitatively describe or model the behavior of processes involving transport phenomena by applying the basic laws of mass, momentum and energy. The systematic techniques which include using the principles of chemistry, physics, and mathematics to obtain equations, which can then be manipulated to predict the effect of variables on a process or system that is under study are to provide the student with experience in chemical engineering analysis.

Course Outcomes/Objectives
At the end of this course, the student will have achieved and demonstrated the following outcomes.

1 | Be able to apply differential and integral calculus and the basic laws of mass and energy to model or

	quantitatively describe heat, mass and momentum transfer processes.
2	Be able to identify engineering problems through ability to sketch the physical situation, identify the subject area and concepts(s) involved, and identify applicable system of units.
3	Be able to formulate engineering problems by demonstrating the ability to define known and unknown variables, state relevant laws and applicable equations, and list and apply relevant assumptions to the applicable equations to obtain equations specific to the problem.
4	Be able to solve engineering problems by implementing a strategy to solve the problem, show the use of consistent units throughout, and evaluate and interpret the result.

Course Requirements & Evaluation Methods

This course will utilize the following instruments to determine student grades and proficiency of the learning outcomes for the course. Continuous assessment of students' homework assignments and exams will be used to evaluate their competence in ABET student outcome 1 (an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics) with the performance criteria:

1. Identify complex engineering problems. Given a problem, the student is able to :
   - understand the given problem and identify the subject/topic area and concepts involved,
   - convert the problem into a well labeled sketch (such as free body diagram, flow chart, functional block diagram, schematic diagram, and
   - identify the system of units applicable to the problem
2. Formulate/analyze complex engineering problems. The student is able to:
   - define the known and the unknown variables in the problem,
   - state relevant laws and equations needed for the problem, and
   - list and apply assumptions to the relevant laws and equations to obtain the specific equations appropriate to the problem
3. Solve complex engineering problems. The student is able to:
   - implement strategy to solve the problem,
   - solve the problem (showing consistent units throughout), and
   - evaluate and interpret the result
4. *Formulate and solve complex engineering problems by applying principles of mathematics*. The student is able to:
   - Formulate and solve complex engineering problems using differential and integral calculus

Exams – written tests designed to measure knowledge of presented course material
Homework Exercises – written assignments designed to supplement and reinforce course material.
Pop Quizzes – surprise in-class assignments to promote student accountability
Class Participation – daily attendance and participation in class discussions

Grading Matrix

Instrument	**Total**
Homework Assignments	10%
Pop Quizzes	10%
Exams	40%
Mid Term Exam	15%
Final Exam	25%
Total	**100%**
Discount for lack of participation	-10%
Extra credit (as assigned by instructor)	

Grade Determination:
A = 100 – 90pts;
B = 89 – 80pts;
C = 70 – 79pts;
D = 60 – 69pts;
F = 59pts or below

Course Procedures

Textbook Policy

Students must acquire the textbook that is listed as "required" on the course syllabus. The textbook must be acquired by the 10th class day. Students are not allowed to share textbooks with other students who are currently registered in the same class. Failure to acquire (or show proof of purchase) the required textbook by the 10th class day will result in the student being administratively dropped from the course. The University will assess financial obligations for the course to the student as with any other dropped class according to the fee schedule. In addition, your financial aid may be affected by the subsequent registration action(s).

Go to http://www.pvamu.edu/pages/195.asp for the Roy G. Perry College of Engineering Textbook Policy.

Conduct:

1. Students will conduct themselves in a manner that is respectful to their fellow classmates and the instructor at all times.
2. **Cell phones, ipads and smart phones or similar electronic devices MUST** be turned off and stowed away during class time. Students are **NOT** allowed to leave class to answer cell phones or use these devices.
3. Students caught using ipads and smart phones or similar electronic devices during exams will receive **ZERO** for the exam and be subject to sanctions as stipulated under **Academic Misconduct**.
4. Students should be prepared to stay in the classroom for the duration of the exam. Students who have any condition that may require them to leave the exam room should make prior arrangements with the Instructor. Students who decide to leave the exam room for any other reason must handover their exam paper and consider the exam over for them.
5. Programmable calculators are **NOT** allowed in class.
6. Students should dress professionally and are **NOT** allowed to wear caps/hats in class.
7. Students are NOT allowed to bring food to the classroom or eat in class
8. Arrive to class prepared to discuss lesson; Always bring essential tools: Textbook, paper, calculator.

Submission of Assignments:

All homework assignments are due directly to the Instructor, prior to the start of class or the assignment will not be accepted. All homework assignments and exams should be written on one side of the page only, and should use the appropriate cover sheet, with the name, assignment title and date. All pages should be numbered. Failure to use the correct cover sheet will result in the assignment grade being reduced by 20%.

Formatting Documents:

Microsoft Word is the standard word processing tool used at PVAMU. If you're using other word processors, be sure to use the "save as" tool and save the document in either the Microsoft Word, Rich-Text, or plain text format.

Exam Policy

Exams should be taken as scheduled. No makeup examinations will be allowed except under documented emergencies (See Student Handbook).

Professional Organizations and Journals

As directed by instructor.

References

As directed by instructor.

16 WEEK CALENDAR

Week One: Topic	Introduction to transport phenomena; Momentum transport - fluids, fluid statics and fluid pressure
Week Two: Topic	Fluid flow, steady and unsteady flows and streamlines; viscosity; Newton's law of viscosity; Newtonian and Non-Newtonian fluids; Mechanism of momentum transport; laminar and turbulent flows
Week Three: Topic	Introduction to macroscopic or integral balances for mass, momentum and energy, and control volumes; macroscopic or integral balance for mass/conservation of mass ; continuity equation, mass velocity and average velocity; macroscopic or integral momentum balance and applications

Week Four: Topic — Introduction to microscopic or differential balances for mass and momentum, and control volumes; microscopic or differential balance for mass, mass velocity vector, divergence of the velocity vector, the differential continuity equation, and the substantial derivative; microscopic momentum balance and shell momentum balance, velocity profile in laminar flow, maximum and average velocities, and Hagen-Poiseuille equation

Week Five: Topic — Macroscopic or integral balance for energy/conservation of energy and energy balance equation, mechanical energy balance, frictional resistance to flow and lost work, the Bernoulli equation

Week Six: Topic — Flow in closed conduits; pressure drop and friction loss in laminar and turbulent flows; friction factors, head-loss determination for pipe flow, head losses due to fittings, equivalent diameter of noncircular conduits and equivalent length of a piping system

Week Seven: Topic — Introduction to Heat Transfer; modes of heat transfer; thermal conductivity; conductive heat transfer, Fourier's law of heat conduction, thermal conductivity and thermal diffusivity; Convective heat transfer and Newton's law of cooling, forced and free (natural) convection ; Radiative heat transfer and Stefan-Boltzmann's law; combined mechanisms of heat transfer; components of thermal resistance; overall heat transfer coefficient

Week Eight: Topic — Microscopic balance or differential equation of heat transfer; general governing equation and shell energy balance; special forms of general differential equation; boundary conditions for solution to governing equation. Steady-state heat conduction through composite walls

Week Nine: Topic — Steady-state conduction through a cylinder; unsteady state heat transfer and lumped parameter analysis

Week Ten: Topic — Convective heat transfer, natural and forced convection; Correlations for convective heat transfer coefficients

Week Eleven: Topic — Introduction to mass transfer; modes of mass transfer; concentration, mass flux, Fick's law, mass-average velocity; diffusive mass transfer; molecular diffusion; convective mass transfer, flux equation for a convective situation, and diffusivities

Week Twelve: Topic — Microscopic (shell) or differential balance for mass transfer; general governing equation for mass transfer; special forms of the differential mass transfer equation; boundary conditions for solution to governing equation; Steady-state molecular diffusion and diffusion through a stagnant film

Week Thirteen: Topic — Convective mass transfer, mass transfer coefficients and overall mass transfer coefficients; comparison of transport processes in laminar and turbulent processes, and analogy between momentum, heat and mass transfer

Week Fourteen: Topic Dimensional analysis; dimensional homogeneity; the Buckingham method; kinematic and dynamic similarity

Week Fifteen: Topic Course Review

Week Sixteen **Final Exam**

University Rules and Procedures

Disability statement (See Student Handbook):
Students with disabilities, including learning disabilities, who wish to request accommodations in class should register with the Services for Students with Disabilities (SSD) early in the semester so that appropriate arrangements may be made. In accordance with federal laws, a student requesting special accommodations must provide documentation of their disability to the SSD coordinator.

Academic misconduct (See Student Handbook):
You are expected to practice academic honesty in every aspect of this course and all other courses. Make sure you are familiar with your Student Handbook, especially the section on academic misconduct. Students who engage in academic misconduct are subject to university disciplinary procedures.

Forms of academic dishonesty:

1. Cheating: deception in which a student misrepresents that he/she has mastered information on an academic exercise that he/she has not mastered; giving or receiving aid unauthorized by the instructor on assignments or examinations.

2. Academic misconduct: tampering with grades or taking part in obtaining or distributing any part of a scheduled test.

3. Fabrication: use of invented information or falsified research.

4. Plagiarism: unacknowledged quotation and/or paraphrase of someone else's words, ideas, or data as one's own in work submitted for credit. Failure to identify information or essays from the Internet and submitting them as one's own work also constitutes plagiarism.

5. Use or possession of textbook solution manual. Since these are restricted by the copyright holder to teaching faculty only who are then prohibited from sharing with students, there is no legitimate way for a student to have a copy of the solution manual.

Nonacademic misconduct (See Student Handbook)
The university respects the rights of instructors to teach and students to learn. Maintenance of these rights requires campus conditions that do not impede their exercise. Campus behavior that interferes with either (1) the instructor's ability to conduct the class, (2) the inability of other students to profit from the instructional program, or (3) campus behavior that interferes with the rights of others will not be tolerated. An individual engaging in such disruptive behavior may be subject to disciplinary action. Such incidents will be adjudicated by the Dean of Students under nonacademic procedures.

Sexual misconduct (See Student Handbook):
Sexual harassment of students and employers at Prairie View A&M University is unacceptable and will not be tolerated. Any member of the university community violating this policy will be subject to disciplinary action.

Attendance Policy:
Prairie View A&M University requires regular class attendance. Excessive absences will result in lowered grades. Excessive absenteeism, whether excused or unexcused, may result in a student's course grade being reduced or in assignment of a grade of "F". Absences are accumulated beginning with the first day of class.

Student Academic Appeals Process
Authority and responsibility for assigning grades to students rests with the faculty. However, in those instances where students believe that miscommunication, errors, or unfairness of any kind may have adversely affected the instructor's assessment of their academic performance, the student has a right to appeal by the procedure listed in the Undergraduate Catalog and by doing so within thirty days of receiving the grade or experiencing any other problematic academic event that prompted the complaint.