CENG 2220 Transport Phenomena I [3-1-0:3]

Prerequisite: PHYS 1111 or PHYS 1112 or PHYS 1312
Background: BIEN/CENG 2310 or basic programming.

Instructor: I-Ming Hsing (CYT 2002A, kehsing@ust.hk), Office hrs: W 4:30-5:30, or by appointment

Teaching assistant: Benny Zibin Zhao (zzhaobz@connect.ust.hk) Maria J. Alvina (mjalvina@connect.ust.hk).

Course objectives:

Fundamentals of transport phenomena with emphasis on physical properties, flow behavior and diffusive transport of fluids in chemical and biological systems. Engineering derivation and quantitiatve analysis of fluid tranport in confined domains. Emphasis on practical application of transport phenomena in chemical and biological engineering. Use of software for solving problems in transport phenomena.

Textbook (recommended):
Bird R.B., Stewart W.E., Lightfoot E.N, Klingenberg D.J.: Introductory Transport Phenomena, Wiley, 2015.
A simplified version of the classic BSL Transport Phenomena book with more mathematical derivations comprehensible by undergraduate students. Good review of vectors and tensors in appendix.
Welty J.R., Rorrer G.L., Foster D.G.: Fundamentals of Momentum, Heat, and Mass Transfer, 6th edition, Wiley 2015
This is a recommended textbook to be used at CENG 3220

Additional references (optional):
Fournier R.L.: Basic Transport Phenomena in Biomedical Engineering, 4th edition, CRC Press, 2018
Truskey G.A., Yuan F., Katz D.F.: Transport Phenomena in Biological Systems, 2nd edition, Pearson Prentice-Hall, 2009

Recitation: The objective of recitation class is to discuss HWs and quiz problems, and to review the lectured material and give more in-class examples.

Exam and grading: There will be mid-term and final exams taking up 35% and 45 % of the grade, respectively. Homework assignments will be regularly given and will take 20% of the final grade.

Classes:
Lec. 15:00-16:20, W.F., **Room 2503**
Rec. 18:00-18:50 pm, W., **Room 1104**

POLICY FOR ACADEMIC CONDUCT:

The assignments and exams, which are required, have the primary function of helping you learn the material. The secondary function of these homework assignments is to help the staff in assessing your understanding of the class material, in particular when the time comes to provide a final grade for the course. To this end, the extent to which you collaborate with your colleagues in preparing these materials must be understood and agreed upon by both the students and the staff. The following is our policy regarding permissible levels of collaboration. This is intended to provide guidance, but please recognize that a violation of this policy will be dealt with in the most severe manner available to the staff.

The homework assignments are intended nearly exclusively to serve as a learning tool. As such, we are comfortable with collaboration amongst students on the solving of these assignments provided all collaborators are equal contributors to the solution. None the less, the written materials, which you hand in must be your own, and any discussion or collaborations with fellow students must be identified in writing on the cover page of the homework document. (E.g., the solution documented for problem 3 was the result of a discussion with IM Hsing and Kathy Vaeth.). The HW will be graded 50% based on the effort and the rest 50% based on the accuracy.

Mid-term and final exams are important to the staff in assessing your performance. Collaboration or cheating in taking these exams is absolutely **NOT** permitted.

If you have any suggestion or feedback to the policy or material of the course, please let me know.

COURSE INTENDED LEARNING OUTCOMES (CILOS)

By the completion of the course,

- The students are expected to understand the constitutive equations and fluid properties and how they impact the fluid flow behavior.
- The students are expected to acquire sound knowledge in dimensional analysis to perform order of magnitude analysis in engineering equations.
- The students are expected to know how to apply the knowledge of mathematics and physics and the principle of conservation equation to formulate and understand fluid flow problems.
- The students are expected to be able to appreciate, conceptualize, and analyze transport problems in practical chemical and biological systems.

Weekly class schedule

DATE	Reading and Info.	Topics
Week 1 01/31 No recitation		Course administrative matters, Introduction, fluid properties
Week 2	**HW 1 out**	Fluid properties, Stress in fluid
02/07 recitation	**Regular lecture**	
Week 3	**HW 2 out**	Fluid properties, Stress in fluid
02/14 Recitation	**HW 1 due before the recitation starts, late submission won't be accepted**	
Week 4		Dimensional analysis, fluid frictions in pipes
02/21 Recitation	**HW 2 due**	
Week 5	**HW 3 out**	fluid frictions in pipes, engineering Bernoulli equation
02/28 Recitation	**HW 3 due**	
Week 6	**HW 4 out**	engineering Bernoulli equation, Hydrostatics, manometry
03/06 Recitation	**HW 4 due**	
Week 7		Hydrostatics, manometry, Drag on submerged objects
03/13 Recitation	Exam review	
Week 8		Stress tensor, constitutive equations
03/20 Mid-term No recitation	**In-class Mid-term Examination, no recitation**	
Week 9	**HW 5 out**	Microscopic balances: conservation of mass and momentum
04/10 Recitation	**HW 5 due**	
Week 10	**HW 6 out**	Analysis of laminar flows
04/17 Recitation	Regular lecture	
Week 11		Analysis of laminar flows and laminar boundary layers
04/17 Recitation	**HW 6 due**	
Week 12		Mass transport in Chemical/biological

		system: diffusion and diffusive transport
04/24 Recitation		
Week 13	**HW 7 out**	Mass transport in chemical/biological system: diffusion and diffusive transport
Week 14		Exam Review
05/08 Recitation	**HW 7 due**	
Final Exam (TBA)	**Final Exam**	