Syllabus for BMEN 341 Section 500 (200 for HNR-Biotransport)
Biotransport
Texas A&M University

Term:	Spring 2024	**Instructor:**	Jason T. George, M.D., Ph.D.
Time:	Thursday 3:55 PM–6:25 PM	**Office:**	ETB 5021; IBT 703
Room:	RICH 101	**Phone:**	(979) 845-5532
Credit Hours:	3	**E-mail:**	jason.george@tamu.edu

Office Hours: TBD.

Required Textbooks:

1. *Introduction to Biomechanics: Solids and Fluids, Analysis and Design* by Jay D. Humphrey and Sherry L. O'Rourke. (PDF available through the TAMU library at: `https://link-springer-com.srv-proxy1.library.tamu.edu/book/10.1007%2F978-1-4899-0325-9`)
2. *Transport Phenomena in Biological Systems* by George A. Truskey, Fan Yuaan, and David F. Katz. Second Edition.

Optional Textbooks:

1. *Introduction to continuum biomechanics* by Kyriacos A. Athanasiou and Roman M. Natoli (PDF available at: `http://www.morganclaypool.com/doi/abs/10.2200/S00121ED1V01Y200805BME019`).
2. *Munson, Young and Okiishi's Fundamentals of Fluid Mechanics*, 8$^{\text{th}}$ edition, by Philip M. Gerhart, Andrew L. Gerhart, and John I. Hochstein.

Course Description: This course is designed for upper-level Biomedical Engineering undergraduates and covers core topics in momentum, mass, and energy transport related to living or biomedical systems. Major course topics include transport by diffusion, effects of convection, electrochemical potential, chemical reactions, hydrostatics, the Euler equation, Archimedes' principle, Balance relations, the Navier-Stokes Equations, Couette and Poiseuille flow, Newtonian and non-Newtonian flow, and pulsatile and steady flow. Examples and problem sets will emphasize applications to medicine and biomedical engineering. This is a third year course, and students are expected to be proficient in multivariable calculus, differential equations, and numerical methods.

Course Prerequisites: Grade of C or better in BMEN 207, MATH 251, MATH 308, and either PHYS 207 or PHYS 208; Admission into the major degree sequence in engineering; junior or senior classification.

Learning Outcomes: Upon successful completion of this course, students will be able to:

- Mathematically define and describe general biotransport problems, including deriving governing equations and defining appropriate boundary and initialy conditions.
- Solve and analyze a variety of biotransport problems.
- Develop transport models and approaches to biomedical problems and critically evaluate the solutions. Explain the mechanics of fluids in biomechanics within the context of 1) kinematics, 2) the concept of Cauchy stress, 3) linear momentum balance, 4) constitutive relations, and 5) boundary conditions.
- *ABET Outcomes*: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering and mathematics.

Grading Policy: The final grade will be determined as follows:

Assignment	Weight	Course Points	Final Letter Grade
Homework / Deliverables	30%	90% – 100%	A
Midterm Exam	25%	80% – 90%	B
Final Exam	35%	70% – 80%	C
Participation	10%	60% – 70%	D
		<60%	F

Requests for changes to grades given on any assignment or exam should be submitted in writing within two days after the grade is returned. Regrade requests must include a statement of the specific challenge and the work in question. *Note that the entirety of an assignment or exam is subject to re-grading during such a request.* Rounding up of grades for letter grading purposes is at the professor's discretion exclusively.

Course Schedule: Anticipated list of major covered topics and course schedule as follows:

Major Topics (subject to change)	Hours	Week
Fundamentals and Mass Transport		
Background and introduction, history, mathematics review, definitions, Diffusion, Fick's law, Diffusion as a random walk	3	1
Steady-state diffusion in one dimension	3	2
Unsteady diffusion in one dimension, one dimensional diffusion in a semi-infinite medium, diffusion from a point source	3	3
Diffusion with convection, electrochemical potentials, mass conservation for dilute solutions, electrolyte transport	3	4
Fluid flow through porous media, Darcy's law, Brinkman equation	3	5
Biochemical interactions	3	6
Finish and review		7
Midterm exam		8
Momentum transport		
Stress and pressure, Eulerian vs. Lagrangian perspectives, Kinematics, velocity and acceleration, rigid-body rotation, rate of deformation, constitutive behavior: Newtownian vs. non-Newtonian behavior, Navier-Poisson equations, Blood characteristics and rheology	3	9
Mass balance, linear momentum balance	3	10
Navier-Stokes equations	3	11
Euler equation, Bernoulli equation	3	12
Pouiseuille vs. Couette Flow, flow between parallel plates, Reynolds' number, flow in a cylindrical tube	3	13
Finish and review; *Honors term project due*	3	14
Final Exam		

Midterm Exam – Thursday March 7, 2024 3:55 - 5:25
Final Exam – Monday May 6, 2024 1:00 – 3:00 pm

Term Project: The term project will synthesize many of the concepts that we discuss in class. The project will consist of several parts that will extend topics covered in lecture and require applications of lecture topics to solving complex, real-world problems. The project will be assigned after the first midterm and will be due the week before the final exam. Students are encouraged to work on this project periodically as relevant items are covered in lecture.

General Policies:

- No late homework or projects, except relative to University policies. Specific arrangements for make-up work in approved instances will be handled on a case-by-case basis.
- No makeup exam except in cases of medical emergencies.
- Exam material will come from notes, book chapters, and homework assignments.
- Final exam will be comprehensive.
- Academic dishonesty will not be tolerated.

Attendance Policy:

- In accordance with Texas A&M University policies, only University-excused absences will be accepted for missing classes and for any makeup exams to be given.
- Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade for the reasons stated in Student Rule 7, or other reasons deemed appropriate by the instructor.
- "The instructor is under no obligation to provide an opportunity for the student to make up work misssed because of an unexcused absence" (Student Rule 7, Section 7.4.2).
- Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code (See Student Rule 24).
- It is the student's responsibility to make arrangements to reschedule exams.
- If an absence is excused, the instructor will provide the student an opportunity to make up any exam or other work that contributes to the final grade or provide a satisfactory alternative by a date proposed by the instructor.
- If the instructor has a regularly scheduled make-up exam, students are expected to attend unless they have a university-approved excuse.
- The make-up work must be completed in a timeframe not to exceed 30 calendar days from the last day of the initial absence.
- "Absences related to Title IX of the Education Ammendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" (Student Rule 7, Section 7.4.1).
- Refer to Student Rule 7 for ALL policies regarding excused absences. Please note: "The student is responsible for providing satisfactory evidence to the instructor to substantiate the reason for absence." In the case of injury or illness of 3 or more days, "The medical confirmation note must contain the date and time of the illness and medical professional's confirmation of needed absence."
- Also, in case of injury or illness of less than 3 days, it is the policy of this class that the student likewise will provide a medical confirmation note containing the date and time of the illness and medical professional's confirmation of needed absence.
- Having a legitimate University-excused absence does not relieve the student of responsibility for prior notification and documentation. Failure to notify and/or document properly may result in an unexcused absence. Allowable excuses and documentation thereof must be provided to the professor in a timely manner.
- Other absences may be excused at the discretion of the instructor with prior notification and proper documentation. In cases where prior notification is not feasible (e.g., accident or emergency) the student must provide notification by the end of the second working day after the absence, including an explanation of why notice could not be sent prior to the class.
- Falsification of attendance documentation is a violation of the Honor Code.

Academic Integrity Statement and Policy: The following Honor Pledge shall be printed as a prefix and signed by each student responsible for the submission of all projects, coursework, homeworks, and examinations:

"An Aggie does not lie, cheat, or steal, or tolerate those who do. On my honor, I have neither given nor received any unauthorized aid on this academic work."

Americans with Disabilities (ADA) Policy Statement: The American with Disabilies Act (ADA) is a federal anti-discrimination statue that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accomodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 979-845-1637.