NJIT | DEPARTMENT OF BIOMEDICAL ENGINEERING

BME 352 Introduction to Thermal Sciences for Biomedical Engineering F2024

Instructor:
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Class Schedule:
Lecture: M, W 10:00– 11:20 AM, Tiernan 105

Office Hours: Thursdays 10am-noon, or by appointment
TA: Mohamadi Mohaddeseh mm2959@njit.edu

Textbook
Thermodynamics: An Engineering Approach. Yunus Cengel, Michael Boles, Mehmet Kanoglu, 9th Edition. Selected chapters will be provided.

Additional References*:

Biomedical Engineering Principles: An Introduction to Fluid, Heat, and Mass Transport Processes. David O. Cooney. Marcel Dekker, Inc. 1976 Marcel Dekker, Inc.

Thermal Science: An Introduction to Thermodynamics, Fluid Mechanics, and Heat Transfer. Potter, Merle and Scott, Elaine. 2004 Brooks/Cole

* You are highly encouraged to check out additional textbooks/materials at the library.

Description: In this course we will begin by studying the fundamental concepts of thermodynamics. Thermodynamics is a basic science that deals with energy and phase changes of substances. Energy is required for biological functions and to perform work. This includes the efficient delivery of energy and removal of heat generated when work is performed. Energy transport is also an important component in many biomedical technologies, surgical methods, and physiological processes. This will be combined with an introduction to heat transfer, with examples of cooling in the human body, such as cooling through breathing. Basic concepts in fluid mechanics, such as viscosity, Bernoulli, and Poiseuille flow will also be covered.

Objectives and Learning Outcomes:
The following student outcomes will be assessed in this course:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Assessment will be made through homework, exams, project, and class participation/discussion.

Grading:
HW + Attendance/class participation: 20 %
Exam 1: 25%
Exam 2: 25%
Final Project/presentation: 30 %

Grading Scale:
90 –100 A
85- 89 B+
80 – 84 B
75 – 79 C+
70 – 74 C
60 – 69 D
Below 60 F

Work Submissions and Exams: All work will be assigned through Canvas. You will hand in the assignments in class or upload assignment files on Canvas. For file uploads, all pictures must be clear and legible, or they may not be accepted for grading.

Academic Integrity: There will be a ZERO TOLERANCE policy for any suspected academic integrity violations. Please review the NJIT academic integrity policy below. By continuing with the course, you have agreed to abide by all NJIT policies and subject to failure of the course or dismissal from the program for any violations.

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. ***Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.*** *If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu*

The following topics will be covered in this course:

Class	Topic
Week 1	Introduction/Basic Concepts of Thermodynamics
Week 2	Properties of a system, problem solving, **HW 1**
Week 3	Energy and Energy Transfer, **HW2**
Week 4	Phases of Pure Substances. Phase Diagrams, Property Tables, **HW3**
Week 5	Review/ Exam 1 (20%)
Week 6	Heat and Enthalpy, **HW4**
Week 7	Biomedical Applications: Water Vapor Therapies, Targeted Vapor Therapy, **HW5**
Week 8	Super Heated Vapor and Compressed Liquid, **HW6**
Week 9	Equations of State and Ideal Gas Law, Oxygen partial pressure in lungs
Week 10	Gas-Vapor Mixtures, Heat Loss fromthe body, **HW7**
Week 11	Review/ Exam 2 (20%)
Week 12	Work, Moving Boundary Work, **HW 8**
Week 13	Mass transfer and control volume, **HW 9**
Week 13	Intro to Fluid Mechanics: Viscosity, Properties of Blood and Non-Newtonian Fluids, **HW10**
Week 14	Bernoulli Equation and Applications: Stenosis, Blood Flow, Bifurcating Artery, ViscousFlow and Poiseuille Equation
Week 15	Final Exam

*This syllabus, including assignments, exams, topics, and projects, is subject to change to best meet the needs of students and to match the pace of the course and class size. Any changes will be clearly announced in advance.

Keys to success:

- **Analyze, don't memorize:** Memorization or cramming at the last minute will not help you in this course! Rather than memorizing problems, learn to recognize the patterns and types of problems. If you rely on cramming, you will only confuse yourself on the day of the exam. Engineering problems are always WORD PROBLEMS. You will find that the math is usually very easy. The challenge is setting up the problem using the information provided and understanding what is being asked.

- **Practice until you get it right, then practice until you can't get it wrong:** As the saying goes, PRRACTICE MAKES PERFECT. Repetition is the key to success. What I assign in the class is the bare minimum and it is intended to steer you in a particular direction and to show you what concepts are important. It is up to you to take responsibility and to

practice additional problems, use the references and other online resources to practice more problems.

- **If it was easy, everybody would do it:** Engineering is not easy, like mastering any task, it takes perseverance and determination. As you progress through the program the courses will get more challenging. In particular, you must know your fundamentals. If you don't remember the fundamentals, you will struggle in this course. The good news is that it is not insurmountable if you are willing to put your mind to it and put in the effort. If you do not put in the effort, you will struggle with this course and you will not see the results that you were expecting.

Policies:

- No cell phones or texting during class. Bring a calculator to class at each exam. You will not be allowed to use your cell phone. Please use the restroom BEFORE the exam. Once the exam starts you will not be allowed to leave until the exam is finished and handed in.

- Make-Up Exams: You must schedule any make-up exam within 1 week of the missed exam or you will receive a grade of zero. You must present documented proof of your absence (i.e. doctor's note, court documents, etc.). If you miss an exam, you must see the dean of students before a make-up will be scheduled. You will NOT be given the same exam. Make-up exams may be harder than the scheduled class exam.