

THERMAL THERAPIES: THE ENGINEERING BEHIND BODY TEMPERATURE

DESCRIPTION:

Tissue temperature is a marker of activity and energy state, as a result, the development of techniques to control local and global temperature in tissues are fundamental in the optimization of clinical procedures, such as laser therapy or cryosurgery. In this class the fundamentals of tissue heat transfer and the effect of physiology on the tissue temperature distribution during a procedure will be studied.

We will discuss how mathematical modeling can be used to improve current clinical therapies or to develop new ones, and the importance of using multidisciplinary research to solve current problems. This class will give an introduction to Bioheat transfer (BHT), which is a fairly new area of heat transfer that requires the knowledge of anatomy as well as physiology of the system in consideration.

INSTRUCTOR: Dr. Obdulia Ley, Assistant Professor, Department of Mechanical Engineering
Room 317, Engineering Physics Building
Phone: 979-458-2264, oley@tamu.edu

MAIN GOALS OF THIS COURSE:

- You will learn the importance of mathematical modeling for the optimization and improvement of thermal therapies, as well as its use in the design of better experiments and its role in the reduction of animal experimentation necessary for approval of new methodologies and in the creation of simulators that train medical students and show them the importance of continuous monitoring of certain parameters in different therapies.
- You will be able to explain concepts, such as thermal regulation, effect of blood flow in tissue temperature distribution, etc.
- You will be able to answer questions related to the mathematical models studied, their approximation, and the methodologies and therapies that make use of them, and you will be able to identify the factors that need improvement or the problems associated to the different thermal therapies studied in this course.
- Through your understanding of the topic, you will be able to create a teaching tool (presentation, poster, simulation) that can serve to introduce the concepts taught in this class to students in other areas and or other levels of instruction, such as elementary, middle school, or high school. These materials will be presented in the A&M Student Conference and in other school in the area.

TOPICS TO BE STUDIED IN THIS CLASS (for class schedule see the Reading Map)

Part I: Introduction: Body temperature, importance and significance (4 weeks)

- Temperature regulation and health
- Physics of heat exchange between body and the environment
- Temperature alterations: Hypothermia, hyperthermia and hibernation
- Metabolism and Temperature.
- Importance of temperature control and its clinical exploitation

Part II: Application of Heat Transfer Concepts (4 weeks)

- Tissue heat transfer: The different Bioheat equations
- Tissue thermal conductivity and blood flow (measurement and modeling)

Part III: Therapies Involving Temperature Control: Modeling and Direct Temperature Measurement (6 weeks)

- Clinical use of: Lasers and Electromagnetic seeds (thermal vs non-thermal applications)
- Cryotherapy and cryopreservation: Thermodynamics of ice formation in tissue
- Introduction to thermometry: Infrared Imaging , MRI, ultrasound and special thermocouple design
- Studies of Heat transfer in selected organs: brain, heart, lung, eye, arterial wall

CLASS DYNAMICS:

- Scientific knowledge is the result of careful study and discussion. As a result our class time will consist in **1)** discussion about readings, **2)** extraction of important concepts and observations from the discussion, and **3)** understanding of the physiology and physics governing the system.
- All students should participate in items 1 and 2, and I will bring everything together and give you the theory behind therapies and methods (item 3).
- It is important that you prepare for in-class discussions by reading the materials and completing your summaries (homework). There are many contradictory results published and I want you to take sides and be able to defend your side.

EXTRA ACTIVITIES:

- How to read a scientific paper.
- Two sessions will be held at the Evans Library to learn the use of **Pubmed, Inspect and Compindex**, the most used databases in the medical field, engineering and natural sciences.
- We will visit a museum (Natural Science Museum in Houston, and The McGovern Museum of Medicine) to observe materials used to illustrate concepts in Science and Engineering as well as in the Medical field.
- Usage of the FE Multi-physic package: COMSOL.

GRADING POLICY:

Exam I	10%
Exam II	10%
Final Exam	20%
Homework	30%
Final Project	30%

The final weighed average of each student will be calculated based on the indicated grade distribution. The letter grade will be assigned by the following criterion:
A > 90; 80 < B < 90; 70 < C < 80; 60 < D < 70; F < 60.

EXAMINATIONS:

- There will be 2 midterm examinations and a comprehensive final exam.
- The use of the texts, problem solutions or problem sets or notes during the examinations is not permitted.
- The final exam will be cumulative and scheduled in the final exam period. To obtain the academic calendar visit: <http://www.tamu.edu/admissions/records/FESSpring2005.htm>
- All examinations are conducted following the University Honor Code. For details about the honor code, please visit <http://www.tamu.edu/aggiehonor>

HOMEWORK ASSIGNMENT:

- Three types of homework will be assigned: reading summaries, bibliographic searches and problem sets. Reading summaries are due at the beginning of each class, and will cover the reading materials indicated in the **Reading Calendar**.
- **It is extremely important to read the subject matter before lectures and to review the material covered during the previous class.** The reading calendar is available on WebCt and will be handed out during the first class. All reading materials are on reserve at Evans Library.
- Bibliographic searches of specific topic will be requested, you should classify and rank the bibliography obtained based to the paper's abstract descriptions.
- The due date for bibliographic searches and/or problem sets will be clearly marked when handed out.
- Solutions to problem sets will be posted online within a week of the due date.
- Late submission of reading summaries is not allowed and a zero will be assigned for such reading summary.

- Problem sets handed in after the solutions are posted will be assigned a zero

FINAL PROJECT:

- The final project constitutes 30% of your grade. You can work individually or in a group of up to three students.
- You have to create a tool (poster, presentation, simulation) to explain a basic concept studied in class like convection, conduction, homeostasis, etc. I will give you samples of projects and will help you to select a topic and work on it.
- You will have to write a small proposal returning from Spring Break which has a value of 20% of your project grade. This proposal should describe your project and will be presented to the class.
- This final project will allow you to use your creativity and put together all your engineering knowledge and your newly found physiological knowledge.

ADA POLICY:

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute 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 accommodation of their disabilities.

Any student with a disability needing academic adjustments or accommodations should approach the instructor and the Department of Student Life, Services for Student with Disabilities, in Room 126 of the Koldus Building or Call (979) 845 1637. All discussions will remain confidential.

AGGIE HONOR CODE:

“An Aggie does not lie, cheat, or steal, or tolerate those who do.” It is the responsibility of students and instructors to help maintain scholastic integrity at the university by refusing to participate in or tolerate scholastic dishonesty. Conduct contradicting to this policy will be punished according to the current rules and regulations. For details, see <http://www.tamu.edu/aggiehonor/>

The following statement should be printed and signed on all assignments and examination cover pages:

“On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work”

Signature of student

THIS CLASS IN A NUTSHELL:

- Reading and reflecting of the readings is fundamental
- Discussion and active participation are very important
- Class attendance is strongly suggested
- Trying to apply your engineering and physics knowledge into biological systems and explain it to someone else is our goal
- If you need guidance or help with the class, there is a high probability that you can find me at my office!