The University of St. Thomas  
Mathematics Department  
Math 3336 Engineering Thermodynamics

Instructor: Dr. Henry Foust  
MATH 116  
M, W – T, Th 9:35 to 10:50 a.m.  
Office Hours: (See Separate Schedule)  
Additional Hours by Appointment  
Office Phone: 713/942-5967  
Office: Tiller Hall 203 fousth@stthom.edu

Catalog Course Description

MATH 3336 - Thermodynamics Mathematics

(PHYS 3336) Fundamental properties of heat, work and energy. Analysis of  
thermodynamics systems, control–volume analysis and the mathematical modeling of  
ergy transfer systems. Prerequisites: CHEM 1342, MATH 2431, PHYS 2333.

Course Objectives

- Find the thermodynamic properties of a pure substance given the states of the substance  
- Apply the First Law of Thermodynamics to open and closed systems  
- Apply the Second Law of Thermodynamics to open and closed systems  
- Understand the concept of entropy and how to apply it to engineering systems

Text

The textbook for this course is Fundamentals of Thermodynamics (8th edition)  
Richard E. Sonntag (Author), Claus Borgnakke (Author)

This text is required. You cannot succeed in this course without this text.

Reading assignments and problem assignments will refer only to the current edition of this text.

Calculators

The use of a calculator will be limited to basic arithmetic functions – addition, subtraction,  
multiplication, division, square roots, powers, logarithms, and the number $e$  
(approximately 2.71828...).

A calculator which includes various financial calculations will be of NO EXTRA VALUE  
in this course. You will need to illustrate how you arrive at all answers using only the  
functions listed above. A graphing calculator will NOT add value in this course. All graphs  
are to be done manually or using software on a personal computer.
Any calculator used in exams must be STAND-ALONE – not part of a cell phone, iPad, iPhone, or any tablet device.

You will also be coached on estimating, especially trying to break you away from any unquestioning dependence on a calculator.

Make sure you have spare batteries for your calculator with you during any exams. If you are going to depend on a calculator at all, you have the responsibility to maintain it.

Various software, including EXCEL will be used to illustrate certain points. No prior knowledge of this software is assumed.

But on exams and short quizzes you will NOT have access to a personal computer. You will need to know the justification for various financial calculations and be able to explain them on your test papers to the degree of detail I explicitly request.

Computers and calculators are instruments for ENHANCING understanding of concepts, NOT for REPLACING understanding of these concepts. I have seen many absurd conclusions reached by people with calculators, having total faith in numbers read from a screen, whether or not they are relevant to the logic demanded by the problem, or even entered correctly.

Personal Electronic Equipment
All cell phones are to be set to silent ring. If you need to take a call or receive (or send) a text message during class you are asked to step outside immediately. There will be NO TALKING on cell phones in the classroom, and NO MESSAGING, inbound or outbound.

Any electronic recording (audio or video) of classroom illustrations will be permitted only for students with recognized disabilities. These disabilities must be documented by the UST Office of Disabilities. If you have a documented disability, please communicate that to me at the end of either of the first two class sessions.

Otherwise, no personal listening or recording (voice or picture) devices may be used in this class.

Disabilities
The Office of Disability Services makes special arrangements for students with special requirements, for instance, separate rooms and times for examinations, recording of lectures, etc. Accommodations for individual students can only be approved by this office, NOT by the instructor.

Any student with a documented disability needing academic accommodations is requested to speak with me as early as possible. All discussions will remain confidential. Students with disabilities will also need to contact Counseling and Disability Services in Crooker Center. This office can be reached at (713) 525-2169 or 6953.
If you have a special requirement, have it documented through the Office of Disability Services and have this office forward verification directly to me at the end of one of the first two class sessions.

We can then have a private conversation to work out the details of any special arrangements for this course.

**Academic Dishonesty**

It is expected that all students will conduct themselves in an ethical manner at all times.

For the purpose of this course students may work together on the homework assignments (this does NOT mean copying from each other, rather, helping each other to learn the concepts and procedures for problem solving).

The exams and any short quizzes will be closed book determinations of what material has been retained, and what skills have been learned. These will be individual efforts. Again, note the distinction between completing a homework paper and learning a skill.

There will be no telecommunications of any kind during quizzes and exams.

“The penalty for an incident of academic dishonesty is, at the discretion of the faculty member, either a mark of zero for the work in question or the grade of “F” for the course.” [see the University of St Thomas website www.stthom.edu; website search: “dishonesty”.]

**Availability of instructor**

Take advantage of my office hours.

**Assignments**

Reading assignments and problem assignments will be given in most class sessions. Whether or not a written assignment is collected, you will be responsible for knowing how to do it on a short quiz or longer exam. Some problems will be worked in class. You can get help with any other problems during my office hours, or by phone and e-mail.

I will post homework problems on the chalkboard in each class session, or shortly thereafter on Blackboard. The continually updated list of assignments will be available on Blackboard, in reverse chronological order. The cumulative list will always be available under the same file name:

Math_3336_ASSIGNMENTS_reverse_chrono.pdf,
so you will usually only need to read and/or print the first page.

I will occasionally collect homework but the REAL GRADING of the proficiency gained in dong homework will be on the exams. (Although I endorse studying in teams, I see no reason to spend time on reading solutions you may have gleaned from others in group study sessions or from the Internet.)

You are always welcome to discuss the solutions to homework problems and any individual difficulties during my office hours. (See the section of Blackboard which has been set up for this course for a list of my office hours.)
I can often spot gaps in individuals’ math background which, once overcome, can lead them to solve problems with minimal additional coaching. A conference room is also available in Tiller to facilitate problem sessions with multiple students. Solutions to homework problems will be presented in class only as time permits.

**Note taking and notebooks**

Laptop computers or any variants of tablet computers are not to be used in class. In a math class there is no effective way to take notes other than on paper. Of course no laptops or tablet computers will be allowed on exams.

Maintain an 8 ½ by 11 inch 3-ring loose-leaf notebook for this course. A spiral bound notebook is **NOT** viable. If you do your work in pencil make sure you use a pencil soft enough to make dark marks on the paper. I will not strain to read faint handwriting. If you do your homework or write your exams in ink, be sure to clearly strike out any extraneous material or false starts.

Organize your evolution of the solution to a problem. It is impractical for the reader to guess the sequence of steps you have taken. In a working environment your presentation of a solution is only as good as your ability to substantiate the logic on which you based your conclusion.

I strongly suggest that you take notes in class. There will always be concepts you need to review, and details you need to refer back to when doing homework assignments. Keep these notes in your loose-leaf notebook, **collated** with the homework assignments.

[ See the separate 3 page posting on Blackboard: “29 Lecture Note-Taking Tips”, from “Teaching at its Best, a Research-Based Resource for College Instructors” by Linda B. Nilson.]

In grading homework, quizzes and exams I will put a high premium on the **organization** within each problem as well as the logical and orderly presentation of details. Do not bother to re-write the problem statement in written problems. In many problems, a bonafide answer requires phrases and sentences to justify simple numerical results and the logical conclusions based on them.

File all your homework problems in your loose-leaf notebook. Be sure **NOT** to write class notes and homework solutions on the same physical page, since at various times during the semester I may ask you to **remove certain homework solutions from your notebook and hand them in**.

For each problem, be sure to identify the page number and problem number. This will also help you in retrieving information from your notes.

**Grading**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>0%</td>
</tr>
<tr>
<td>Major Exams (four)</td>
<td>60% COMPREHENSIVE</td>
</tr>
<tr>
<td>Final Project</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
</tr>
</tbody>
</table>

There will be three hour exams during the term. If you turn in all home works complete and on time, I’ll drop your lowest test grade. There will also be a final exam.
If you know you will need to miss, or have missed an exam or quiz, communicate this to me by phone or e-mail. Missed exams or quizzes without communication of a valid timely excuse will result in a grade of zero. (I will judge the validity.)

**Grading scale:**

93-100 A
90-92.9 A-
87-89.9 B+
83-86.9 B
80-82.9 B-
77-79.9 C+
73-76.9 C
70-72.9 C-
67-69.9 D+
60-66.9 D
<60 F

Exams and quizzes refer to closed book, in-class, testing over the material covered. You will NOT have access to a personal computer in any quiz or exam.

Attendance is mandatory. Absences will detract from your grade if your total points in the course happen to fall near a cutoff point between grades.

MAKE-UP TESTS AND EXAMS are given only in case of medical or family emergencies, or the student’s required attendance at another University function. A student who is unable to attend an examination is required to contact the instructor within 24 hours of the exam time. It is the student's responsibility to keep the instructor’s phone numbers available for reference.

NO “REDO” EXAMS – there will be NO opportunity for individuals to take a test again to obtain a higher grade.

DROPPING THE COURSE: If you decide you do not wish to continue the course, it is your responsibility to go through the proper channels and officially drop the course within the time frame prescribed by the University.

**Web Access**

Occasionally during the semester I will need to distribute handouts to the class. They will usually be posted on the COURSE CONTENT section of the Blackboard system.

You also have the responsibility to check your e-mail for any last minute (including late-night) announcements regarding this course. I occasionally respond to the whole class about questions raised by individuals - I do not identify the individual who raised the question, so do not hesitate to ask questions by phone or e-mail.

You have the option of making arrangements with the Information Technology department to have any University of St Thomas e-mail forwarded automatically using the Blackboard e-address list to an e-address of your choice.

You have two responsibilities with respect to UST’s Blackboard computer system:
1. to check the system periodically to see what assignments and/or supplemental materials have been posted
2. to keep your preferred e-address up to date in the Blackboard system so that you can receive occasional e-mails which I broadcast to the entire class.

**Policies of the University**
You are referred to [www.stthom.edu](http://www.stthom.edu) for policy guidelines of the University.

**Reading files attached to e-mail**
At whatever computer (your own, or a University computer) you read your e-mail, you will need to be able to read files in either *.doc* (Microsoft WORD), *.xls* (Microsoft EXCEL), or *.pdf* (Adobe Acrobat) format.

A free copy of the Adobe Acrobat Reader can be downloaded from Adobe.com. Free downloadable readers should also be available for WORD and EXCEL. (They are not needed if you already own copies of these software products.)

**CONDENSED COURSE OUTLINE**

Week 1 – Fluid Mechanics
   a) Conservation of Mass
   b) Conservation of Energy

Week 2 – Polytrophic Processes
   a) Definition of Work and how it is path dependent
   b) Presenting Equations for various processes (Ideal, Perfect Gas)

Week 3 – Thermodynamic Properties of Pure Substances
   a) Showing P vs. nu, T vs. nu, and
   b) Show worked problems

Week 4 – Thermodynamic Properties of Pure Substances
   a) **Board Work**
   b) Define Enthalpy and present specific heat

**Test 1 – Ideal Gas and Thermodynamic Properties of Pure Substances**

Week 5 – 1st Law, No Flow
   a) Show equations for No Flow
   b) Show worked Problems

Week 6 – 1st Law, No Flow
   a) **Simpler Board Work**
   b) Show worked Problems

**Test 2 – 1st Law, No Flow**

Week 7 – 1st Law, Control Volumes, Engineering Devices
   a) Presentation of Equations
   b) Simplifications for Engineering Processes using 1st Law

Week 8 – Rankine Cycle – Energy Balance for a Power Plant
   Utilizing 1st Law and thermodynamic properties show Energy balance for all elements of a power plant

**Test 3 – 1st Law Control Volumes and Rankine Cycle**

Week 9 – Entropy, Reversibility and the Second Law
   a) Define Reversibility, Irreversibility, and Entropy
   b) Present 2nd Law
c) Present Equations for Entropy of gas and solid/liquid
d) Show heat is the area under the curve for a T vs. S graph
e) Show that entropy is a state equation

Week 10 – Carnot Cycle
   a) Present using P vs. nu and T vs. S graphs what a Carnot Cycle is
   b) Define Efficiency
   c) Present the efficiency of a Carnot Cycle in terms of reservoir temperatures

Week 11 – Entropy of Gases
   a) Show worked Problems
   b) Board Work

Week 12 – Entropy of Liquids and Solids
   a) Show worked Problems
   b) Board Work

Test 4 – Entropy, Second Law and Carnot Cycle

Week 13 – Gas Power and Refrigeration Cycles
   a) Brayton Cycle
   b) Brayton Cycle

Week 14 – Gas Power and Refrigeration Cycles
   a) Present Otto Cycle
   b) Present Reverse Carnot Cycle
   c) Present Heat Pumps