Course Number and Title: PHYS 4362: Thermodynamics II

Instructor Name: Dr. Tikhon Bykov

Contact Information:
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- Phone: 793-4875,
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Office Hours:
- Monday 2:00 pm-5:30 pm;
- Tuesday 1:00 pm-5:30 pm;
- Thursday 1:00 pm-2:00 pm;
- Friday 9:00 am-12:00 pm
or by appointment.

Catalog Description: This course serves as an advanced elective for physics majors. The second of two parts, this course will concentrate on fundamental principles of statistical thermodynamics. It will show how these principles are related to classical thermodynamics and classical mechanics. It will consider application of those principles towards simple microscopic models of gases, liquids, and solids. More in-depth study of phase transitions and physical kinetics is also possible.

Pre-requisites: PHYS 4360,
Co-requisites: PHYS 4300, MATH 3351

Course Overview:

Thermodynamics II (3 cr.) is the upper division calculus-based science course primary intended for Physics and Pre-Engineering majors. The subject of thermodynamics, which is study of heat and related energy transfers, can be considered from two different perspectives one of classical and another of statistical thermodynamics. This second part of the course is devoted to Statistical Thermodynamics. However, the course is built in such a way, that it will allow demonstrating natural connections between the two approaches. It also covers applications of the methods of Statistical Thermodynamics towards description of real physical systems. The objective of the student is to develop the skills necessary to analyze the behavior of simple thermodynamic systems based on microscopic approach governed by the laws of Statistical Thermodynamics. The skills developed in this class should form the basis for one of the most general thermodynamic ways of treating physical systems, which can be further developed in application to more complex problems which students may account in their future academic or engineering carriers.

Course Objectives:
- Students will demonstrate conceptual understanding of the basic principles of Statistical Thermodynamics, mainly the method of thermodynamic ensembles.
- Students will demonstrate the ability to apply basic methods of Statistical Thermodynamics, which includes analytical and numerical calculations of Partition Functions, towards solutions of various problems, including the problems about 1) ideal and real gases, 2) simple models of solids, 3) quantum gases, and other thermodynamic systems.
- Students will demonstrate their conceptual and practical understanding of the Advanced Kinetic theory and Transport Phenomena.
Course Materials and Support:

Required Course Materials:


The additional lecture notes will be provided for some topics.

*Class Web Page* is located at [http://www.mcm.edu/~bykov.tikhon/phys4362/phys4362.html](http://www.mcm.edu/~bykov.tikhon/phys4362/phys4362.html). Most of the course assignments will be available through the course account on Moodle. The access to the Moodle web site is password protected and available through the Student Portal at the main McMurry web site ([http://www.mcm.edu](http://www.mcm.edu)).

Optional or Recommended Course Materials:

*Statistical Physics, Volume 5 of Course of Theoretical Physics*, by L.D. Landau, E.M. Lifshitz (any edition)


*An Introduction to Statistical Thermodynamics*, by Terrell L. Hill, Addison-Wesley, Inc. 1962

AEC and Other Educational Support Resources:

Your instructor is normally available at the posted office hours or by appointment. You may drop in without an appointment, but may be asked to come back later. You may ask questions by E-mail. This usually works fine for short questions about a specific concept or method, but do not expect that the instructor will do the entire assignment for you. Your instructor and fellow students won't be much help if they merely provide answers.

Course Policies:

Attendance:

It is understood that attendance is part of the learning commitment — placing oneself in a class setting where effective educational communication and interaction can happen. Students are expected to be regular and punctual in their attendance habits. The students who are late may not be admitted to the class room. Attendance is required and will be noted through activity participation. Any necessary absence occurring while a student is representing the University in some official way will be considered an authorized absence. Work missed due to such an absence is to be made up as the instructor determines. It is the students’ responsibility to inform the instructor about their authorized absences in advance and arrange the make-ups.

Grade Determination:

**Homework:** Homework is due according to the strict deadlines specified on the schedule and is worth 30% of the class grade. *No late homework will be accepted.*

**Reading Quizzes:** Reading quizzes are due online before every class period and are worth 5% of the course grade.

**In-class discussions:** Attendance and participation is worth 5% of the class grade.
Exams: Each of the 3 Unit Exams is worth 15% of the total grade. The in-class portions of the unit exams are given on the regular class days: September 26, October 31, and December 5. There will also be take-home parts for each of the exams. No make-up exams will be given unless important reasons take place. All make-ups must be arranged in advance.

Final Project: The grade for the final project will be based on the final oral presentation and the final written report. It is worth 15% of the total class grade.

The scale for the letter grades is the following: A=93-100, A-=90-92, B+=87-89, B=83-86, B-=80-82, C+=77-79, C=73-76, C-=70-72, D+=67-69, D=63-66, D-=60-62. Grades are final and cannot be negotiated unless an error has occurred. Although great care is taken in the recording of grades, errors do occur, so, please do make sure that the recorded scores are correct!

Make-up Work:
All make-ups have to be authorized by instructor and arranged in advance.

+/− Grade System: See the grade scale above.

Academic Dishonesty:
Every student is fully responsible for the work which he/she submits as his/her own. Some of the class activities are designated as a group work. In these cases every group member should have the complete understanding and active participation in the group work. In some designated cases collaboration between the students is encouraged, but every student should keep in mind that this collaboration is not possible for other activities, especially during the exams. For individual assignments, presenting other people’s work as your own automatically leads to the assignment failure and may have even harder consequences up to expelling from the University.

ADA Compliance:
McMurry University abides by Section 504 of the Rehabilitation Act of 1973, which stipulates that no otherwise qualified student shall be denied the benefits of an education “solely by reason of a handicap”. If you have a documented disability that may impact your performance in this class and for which you may be requesting accommodation, you must be registered with and provide documentation of your disability to the Disability Services Office. Arrangements will be made for students needing special accommodations.

Cell Phones, Calculators, and other Electronic Devices:
You must disable all audible communication devices and anything else that goes ‘beep’ or ‘ding’. PCs are to be used during the class periods strictly according to the instructor’s directions. They shall not be used for browsing internet, playing videogames, charting with friends and/or any other activities not directly related to the content of the class. In the case if these rules are violated, the student maybe asked to leave the classroom until the end of the current class period and the missed class activities will be counted as unexcused absence.

Other Course Policies:
This syllabus spells out specific policies concerning attendance, participation, assignments, deadlines and examinations; however, it is subject to change according to particular circumstances which may take place during the term. In addition to this syllabus, you have rights and responsibilities described in the Student Handbook and Schedule of Classes. Of particular importance are maintaining academic honesty and personal conduct. It is the responsibility of all members of McMurry University scholarly community to conduct themselves in a professional manner. It is also the policy of McMurry University to not discriminate on the basis of sex, sexual orientation, disability, race, color, religion, national or ethnic origin in its educational programs. This means you should not engage in behavior disruptive to the class or the learning experience of other students. You must fully participate in class which includes being seated and ready to participate in all class activities and waiting until class is over before packing up your things and leaving. During the class periods you may not read material and participate in any discussions not directly connected with the course content as well as you may not comment loud on any other subjects but physics.
Major Projects, Required Activities, and Assignments:

Thermodynamics II is a skills-building course, where every new topic is based on the knowledge of the previous subject, it is particularly important to attend all the lectures and to do all assigned homework. Mastery of a subject comes not just from the instructor or the text or the tests, but from the active engagement of every student in consideration of the concepts and methods of physics.

The specific methods designed to achieve this mastery of the subject:

- **Reading** the text and **working through** the example problems.
- **Lectures** consisting of explanations, discussions, solving example problems.
- **Homework** exercises on basic concepts and problem solving.
- **Discussions** with peers about main principles of classical mechanics and solving problems in peer groups.
- **Exams** on concepts and problem solving

Course Activities

**Class Preparation:** You are responsible for all material in the assigned reading, in handouts and exercises, presented in lecture, during discussions and posted on the class web site.

**Reading:** You are required to read the assigned sections of the text before the lecture then you can reread them once again after the lecture. The reading quizzes consisting of several short questions will be given online before every lecture. This is needed in order to spend the lecture time in the most efficient way not by repeating again and again the facts which are presented in the book in much more detailed form than any lecture time can possible allow but to concentrate on the most important points of the course and clarify them for students as much as possible.

**Lecture:** Attendance and participation at all lectures is required. Lectures are an activity and should not be wasted by passivity: listen -- think -- discuss -- ask questions -- answer questions. The only way for me as the instructor to know how the class understands the material is by receiving questions and answering those questions, so please do ask them.

**Homework:** The assignments will be posted on the class web page. The assigned problems will be taken from the book or will be given on handouts. It will be a set problems assigned to the each block of the material. The exact deadlines will be placed on the course web page. Collaboration is encouraged on the homework. However, each student should have a full understanding of any work that he/she submits as his/her own. The assignments are also open-book open-notes.

**Online Materials and Discussions:** The online component of this class will be administrated through “Moodle”. It allows posting of handouts, online assignments and organize online forums related to topics discussed in class.

**Final Project:** This course will have a Final Project, where the students are expected to create a Density Functional Theory-based code for computer simulation of a simple thermodynamic system, and demonstrate behavior of this system based on output data from the code created.

**Tentative Course Schedule:**

The tentative course schedule is published online at [http://mail.mcm.edu/~bykov.tikhon/phys4362/Physics4362/sec.html](http://mail.mcm.edu/~bykov.tikhon/phys4362/Physics4362/sec.html)
## Course Objectives/Student Learning Outcomes and their Linkage to Program and University Goals and Outcomes.

**Course Number and Title:** Physics 4362, Thermodynamics II

<table>
<thead>
<tr>
<th>Course objectives and goals</th>
<th>Linked to which departmental program goal(s)</th>
<th>Linked to which institutional goal(s)?</th>
<th>Types of evidence that might be used to demonstrate student achievement of objectives &amp; goals</th>
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</thead>
<tbody>
<tr>
<td>Students will demonstrate conceptual understanding of the basic principles of Statistical Thermodynamics, mainly the method of thermodynamic ensembles</td>
<td>- to prepare physics graduates for a wide range of career opportunities including not only graduate study in physics, engineering, pre-med, or other sciences; but also, science teaching and careers in industry and science-related business</td>
<td>1, 2, 3, 8</td>
<td>Successful completion of the in-class essay questions during the exams.</td>
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<td>Students will demonstrate the ability to apply basic methods of Statistical Thermodynamics, which includes analytical and numerical calculations of Partition Functions, towards solutions of various problems, including the problems about 1) ideal and real gases, 2) simple models of solids, 3) quantum gases, and other thermodynamic systems</td>
<td>- to prepare physics graduates for a wide range of career opportunities including not only graduate study in physics, engineering, pre-med, or other sciences; but also, science teaching and careers in industry and science-related business</td>
<td>1, 2, 3, 8</td>
<td>Successful solving of appropriate problems during in-class discussions, homework and exams. Successful completion of the Final Group Project.</td>
</tr>
<tr>
<td>Students will demonstrate their conceptual and practical understanding of the Advanced Kinetic theory and Transport Phenomena</td>
<td>- to prepare physics graduates for a wide range of career opportunities including not only graduate study in physics, engineering, pre-med, or other sciences; but also, science teaching and careers in industry and science-related business</td>
<td>1, 2, 3, 8</td>
<td>Successful solving of appropriate problems and essay questions during in-class discussions, homework and exams.</td>
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Institutional Goals:
1. Students acquire an education shaped by Christian values.
2. Students are equipped for successful careers and post-graduate education.
3. Students acquire an enthusiasm for lifelong learning through expanded intellectual and cultural experiences.
4. Students, in a community where leadership is cultivated, acquire a solid basis for future lives of leadership.
5. The institution will engage in an ongoing pursuit of excellence in curricula, programs, and policies.