"Policy about course outlines can be found in Section 23.4(2) of the University Calendar"

PHYSICS 310

Thermodynamics and Kinetic Theory

Instructor: Dr. Jan Alexander Jung **Phone:** 780-492-5032
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Prerequisites: Phys 126 or Phys 146 or EN PH 131; Math 215 or Math 317 or equivalent. Students who wish to receive credit for the course, but who do not have the necessary prerequisites, must fill out the application form "Waiver of Prerequisite" and see Janet Couch in the Physics General Office on the 4th floor of CCIS 4-183.

Classroom & Lecture time: Room 436 on the 4th floor of CEB (Civil/Engineering Building), Tuesdays & Thursdays between 9:30 a.m. and 10:50 p.m.

Office Hours: Tuesdays & Thursdays from 3:00 to 5:00 pm in room 3-183 CCIS Bldg 3rd floor. During office hours, you could receive help with assignments, concepts, etc. To arrange a meeting outside of regular office hours, you can (i) also email for an appointment or (ii) simply drop by.

Textbook: *Thermal Physics* by CBP Finn & *Phys 310 Course Pack*

Course Content/Calendar Description: Temperature, heat, work and the first law of thermodynamics; entropy and the second law, enthalpy, Helmholtz and Gibbs free energy; thermodynamic equilibrium criteria, Maxwell's relations, phase transitions; elementary kinetic theory of gases.

Examination Schedule: There will be an in-class mid-term exam (80 minutes; tentatively scheduled during the last week of October), and a scheduled final exam (tentative date: Friday December 13, 2013, lasting 3 hours, covering the entire course; you must verify the date on BearTracks when the Final Exam Schedule is posted). You will be allowed a formula sheet (One letter size sheet 8.5 in. x 11 in.) for both the midterm and final exams, and a calculator. You have to prepare it yourself. You can write on both sides of the formula sheet. You could write formulas and their descriptions on it (including where they should be used). Past exams (without solutions) are posted on the SUB's Exam Registry online. Some of these exam problems will be solved in class.

Assignments: Homework will be assigned regularly (from the text by Finn and from the material in the Course Pack) and will be collected and graded. There will be around 7 assignments (approx. 5-6 problems each). It is important that you complete the assignments since exam questions will be similar to homework problems, some of which may not have been discussed in class. You are permitted (even encouraged) to discuss homework with classmates etc., but are expected to hand in your own work.

Grading Scheme:

Assignments:	25%
Midterm Exam:	25%
Final Exam:	50%

Grades will be determined from your final mark in the course using the overall class distribution, but the exact class average and fractions of A, B, C, D and F grades are not precisely fixed. The percentage range for a particular letter grade is NOT set in advance, but depends on the level of difficulty of the exams and homework. The grading scheme will be applied at the end of the term by means of a grading curve appropriate for the class. The average grade for this course is expected to be 3.00 (B).

Partial Summary of University Policy on Examinations

Refer to the University Calendar for additional regulations.

If you miss an assignment: If you cannot submit an assignment by the due date, please contact me (preferably in advance). Assignments are not accepted after the solutions are posted.

If you miss a midterm: An unexcused absence merits a score of zero for the exam. Acceptance of the excuse is at the discretion of the instructor. If the exemption is granted, the percentage weight allotted to the missed exam will be added to the final exam.

Deferred examination: Saturday, January 25, 2014 at 9:00 a.m., CCIS room L1-047.
A student who must miss the final exam (for a documented compelling reason, as per the University Policy) may formally apply to take a deferred examination. Refer to the University Calendar for additional information.

Re-examination: If you fail the course, you may be considered for a re-examination if (1) your GPA is 2.0 or greater (inclusive of the failed course), and (2) you apply within 10 days of the posting of the results. Refer to the University Calendar for additional restrictions. If your application is approved by the department Chair, the re-examination will be held the same day as deferred exams (see above).

Students with disabilities: Students who require accommodation in this course due to a disability are advised to discuss their needs with Specialized Support & Disability Services (2-800 Students' Union Building).

University Policy regarding Academic Offences

"The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behavior online at www.governance.ualberta.ca/en/StudentAppeals.aspx) and avoid any behavior which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University."

COURSE OUTLINE:

Part 1: Introduction:

Thermodynamic systems and variables, equilibrium states, pressure, thermometers and temperature scales, ideal gases.

Part 2: Thermodynamic processes:

Reversible processes, indicator diagrams, mechanical work, isothermal and adiabatic processes, thermal expansion and compressibility, and dissipative (irreversible) processes.

Part 3: First law of thermodynamics:

Work, heat and internal energy, energy conservation, heat capacities, enthalpy, and expansion of gases: adiabatic, free expansion.

Part 4: Properties of gases:

Microscopic models of ideal gas, Van der Waals gases, and virial expansion.

Part 5: Second law of thermodynamics:

Cycles, engines and refrigerators, Carnot cycles, the second law, entropy (S), reversible and irreversible processes, phase changes and latent heat, and application to gases and simple systems.

Part 6: Third law of thermodynamics:

Entropy and its approach to absolute zero. Microscopic meaning of entropy, disorder, and an increase of entropy.

Part 7: Thermodynamic potentials and applications:

Internal energy, enthalpy, Helmholtz and Gibbs free energies, Maxwell relations, TdS equations, and applications to processes and systems.

Part 8: Phase transitions:

States of matter, first order transitions, latent heat, and Clausius-Clapeyron equation.

Note: This is a busy schedule. It is therefore likely that some material/sections will not be covered.

Required Texts for Phys 310:

(1) Thermal Physics, 2nd edition (1993) by CBP Finn

This concise introductory book is the primary text for Phys 310. It is fairly clear, but with relatively few applications or worked examples. We will cover Chapters 1-7, 9, 11.

(2) Course Pack for Phys 310 (available in bookstore) includes:

Introduction to Thermophysics (1994) by TP Espinola, pp. 1-183

At a similar level to the book by Finn, it contains detailed explanations, worked examples and applications, but unfortunately is now out of print. It covers most of the same material as Finn and uses nearly identical notation, so should be a good supplement to it. We will cover the material included in the course pack (Chapters 1-7). I will choose homework problems using both books.

Feynmann Lectures on Physics, Vol. 1 (1964) by RP Feynmann, Chapters 39, 44-46

If you are not familiar with the Feynmann lectures, the three volumes provide an introductory and absolutely unique treatment of nearly all the main topics of physics. The books provide insights and points of view missing from more standard texts; the chapters on thermodynamics are no exception.

Thermodynamic Figures and Data, pp 1-11

Thermodynamics is a very general theory which makes predictions about relationships between macroscopic properties like heat capacity, compressibility, etc., but does not allow the properties themselves to be calculated. The input for thermodynamics can be theoretically calculated using statistical mechanics or experimentally measured. I have included here thermodynamic data from some books since the numbers are sometimes useful.

Any typographical errors in this Course Outline are subject to change and will be announced in class. The date of the final examination is set by the Registrar and takes precedence over the final examination date reported in this syllabus. Note: Recording is permitted only with the prior written consent of the professor or if recording is part of an approved accommodation plan.