UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS & ASTRONOMY
COURSE OUTLINE

1. **Course:** PHYS 451, Statistical Mechanics II -- Winter 2018

   Lecture 01: (MWF, 10:00-10:50 in SA147)

Instructor Name	Email	Phone	Office	Hours
David Feder	dfeder@ucalgary.ca	(403) 220-3638	Science B 535	Mondays, 1:00-3:00pm

   Course Site:

   D2L: PHYS 451 L01-(Winter 2018)-Statistical Mechanics II

   Department of Physics & Astronomy: Science B 605, 403 220-5385, office@phas.ucalgary.ca

   Students must use their U of C account for all course correspondence.

2. **Prerequisites:**

   See section 3.5.C in the Faculty of Science section of the online Calendar.

   Physics 449.

3. **Grading:**

   The University policy on grading and related matters is described in F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Component(s)	Weighting %
Weekly Previews	10%
Assignments	40%
Midterm Examination	25%
Final Examination	25%

   Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

   The conversion between a percentage grade and letter grade is as follows;

Letter Grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	D
Minimum Percent Required	94	90	86	82	78	74	70	66	62	58	54

Previews

Approximately every one and a half weeks (I anticipate eight total), you will be asked to write a preview of at most one page each, preferably using the LaTeX typesetting software. This software can be installed on computers running linux, Mac, or Windows. Previews will summarize one or two important conceptual points to be covered in the following weeks. These don't have to be long, often a paragraph or two is sufficient. In fact, I wonâ€™t read beyond a single double-spaced page, and I will deduct marks for unnecessarily long previews. The previews are to be submitted at the beginning of the first lecture of the week they are due (i.e. at 10:00 on Monday mornings), and no late previews will be accepted. The emphasis is on understanding rather than on the formalism. Part of the motivation for these previews is to give you practice expressing yourself clearly in writing,

and I will mark for clarity as well as grammar. Bonus marks for humour! Traditionally, I would deduct marks for the use of mathematics so that you can focus on the concepts. That said, part of the motivation for these previews is so that you can learn LaTeX, which is a powerful package for writing mathematics. So I encourage the limited use of mathematics as a way to complement the writing, but please remember that the written expression of your understanding is key.

Original artistic contributions are also encouraged, including but not limited to poetry, lyrics, song recordings, raps, movies, interpretive dance, comics, paintings, weavings, etc. If you decide to submit a preview in one of these ways, then I will be grading you on your ability to convey the central concepts in an artistic way. You can be oblique, but if I donâ€™t understand it at all then your grade will suffer. You can submit all of your previews in these alternative ways, but you wonâ€™t learn LaTeX this way. But if you already know LaTeX then no worries!

Assignments

There will probably be an assignment every two weeks or so (probably something like 5 or 6 in all, with two weeks for completion.

4. **Missed Components of Term Work:**

   The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in Section 3.6. It is the student's responsibility to familiarize himself/herself with these regulations. See also Section E.3 of the University Calendar

5. **Scheduled out-of-class activities:**

   There are no out-of-class activities scheduled for this course.

   REGULARLY SCHEDULED CLASSES HAVE PRECEDENCE OVER ANY OUT-OF-CLASS-TIME-ACTIVITY. If you have a conflict with the out-of-class-time-activity, please contact your course coordinator/instructor no later than **14 days prior** to the date of the out-of-class activity so that alternative arrangements may be made.

6. **Course Materials:**

   There is no required textbook for this course. I will make detailed course notes freely available. You are encouraged to obtain a copy of Mathematica through the university's site license if you don't already have a copy.

7. **Examination Policy:**

   There is no examination policy for this course.

   Students should also read the Calendar, Section G, on Examinations.

8. **Approved Mandatory and Optional Course Supplemental Fees:**

   There are no mandatory or optional course supplemental fees for this course

9. **Writing across the Curriculum Statement:**

   For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of those reports. See also Section E.2 of the University Calendar.

   Please note that previews, as well as short and long-answer questions on the midterm and final examinations, will be assessed on both the quality of the content and communication.

10. **Human studies statement:**

    Students will not participate as subjects or researchers in human studies.

11. **Reappraisal of Grades:**

    A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See Section I.3 of the University Calendar.

    1. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course

coordinator/instructor within **15 days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall immediately submit the Reappraisal of Graded Term work form to the department in which the course is offered. The department will arrange for a re-assessment of the work if, and only if, the student has sufficient academic grounds. See sections I.1 and I.2 of the University Calendar

2. **Final Exam:**The student shall submit the request to Enrolment Services. See Section I.3 of the University Calendar.

12. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**

a. **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under Section K. Student Misconduct to inform yourself of definitions, processes and penalties. Examples of academic misconduct may include: submitting or presenting work as if it were the student's own work when it is not; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; collaborating in whole or in part without prior agreement of the instructor; borrowing experimental values from others without the instructor's approval; falsification/ fabrication of experimental values in a report. **These are only examples**.

b. **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on assembly points.

c. **Academic Accommodation Policy:** Students needing an accommodation because of a disability or medical condition should contact Student Accessibility Services in accordance with the procedure for accommodations for students with disabilities available at procedure-for-accomodations-for-students-with-disabilities_0.pdf.

Students needing an accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics & Astronomy, Dr. David Feder by email dfeder@ucalgary.ca or phone 403-220-3638. Religious accommodation requests relating to class, test or exam scheduling or absences must be submitted no later than **14 days** prior to the date in question: http://www.ucalgary.ca/pubs/calendar/current/e-4.html

d. **Safewalk:** Campus Security will escort individuals day or night (www.ucalgary.ca/security/safewalk/) . Call 403-220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

e. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see also www.ucalgary.ca/legalservices/foip.

f. **Student Union Information:** VP Academic, Phone: 403-220-3911 Email: suvpaca@ucalgary.ca. SU Faculty Rep., Phone: 403-220-3913 Email: sciencerep@su.ucalgary.ca. Student Ombudsman, Email: suvpaca@ucalgary.ca.

g. **Internet and Electronic Device Information:** Unless instructed otherwise, cell phones should be turned off during class. All communication with other individuals via laptop, tablet, smart phone or other device is prohibited during class unless specifically permitted by the instructor. Students that violate this policy may be asked to leave the classroom. Repeated violations may result in a charge of misconduct.

h. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction (USRI) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.

i. **SU Wellness Center:** The Students Union Wellness Centre provides health and wellness support for students including information and counselling on physical health, mental health and nutrition. For more information, see www.ucalgary.ca/wellnesscentre or call 403-210-9355.

COURSE OUTLINE

1 Boltzmann Statistics (aka The Canonical Ensemble) [Review]

1.1. Bohr-Sommerfeld quantization

1.2 Density of States

1.3 The Maxwell Speed Distribution

1.3.1 Interlude on Averages

5.4.1 Electrons in Metals

5.4.2 Electrons in the Sun

5.4.3 Ultracold Fermionic Atoms in a Harmonic Trap

6 Bosons

6.1 Quantum Oscillators

6.2 Phonons

6.3 Blackbody Radiation

6.4 Bose-Einstein Condensation

6.4.1 BEC in 3D

6.4.2 BEC in Lower Dimensions

6.4.3 BEC in Harmonic Traps

FINAL EXAMINATION

Course Incomes

Coming into this course, you should have a good understanding of the topics presented in PHYS 449 (Statistical Mechanics I). These include:

- Distinguishing the microcanonical and canonical ensembles
- The concept(s) of entropy and how entropy relates to thermodynamical processes and statistical ensembles
- Free energies
- The inter-relationships among thermodynamic quantitites such as pressure, volume, temperature, magnetization, heat capacity, etc.

You should have a solid understanding of calculus.

Department Approval: Electronically Approved **Date:** 2018-01-07 16:11

Course Outcomes

1. The student can give an overview of experimental findings that are in disagreement with classical statistical mechanics --- including the third law of thermodynamics --- and explain how this can be resolved by quantum statistical mechanics
2. The student can explain the basic concepts of microstates, macrostates, density matrix and ensemble theory in quantum statistical mechanics
3. The student can explain the relationships between the different ensembles (microcanonical, canonical and grand-canonical ensembles) and how the ensembles can be derived in the context of quantum mechanics from the fundamental assumption of statistical mechanics. The student can apply these ensembles to solve a given statistical mechanics problem.
4. The student can explain the differences between bosons and fermions and formulate the quantum mechanical description of ideal quantum gases
5. The student can give examples and describe the properties of the degenerate Fermi gas, the degenerate Bose gas and Bose-Einstein condensation and explain how to derive these properties using quantum statistical mechanics
6. The student can describe continuous phase transitions, give examples and explain the concepts of order parameter, control parameter, correlation length, critical point, critical exponent and universality.
7. The student can solve problems individually or in teams and communicate his/her own understanding of a given topic clearly in written and oral form
8. The student is able to solve problems in statistical mechanics with the help of computers, such as coding in python or using symbolic computation programs such as Maple or Mathematica