

ENGPYHS 2H04
Statistical Thermodynamics
Winter 2018
Course Outline

CALENDAR/COURSE DESCRIPTION

The objective of the course is to give an introduction to thermodynamics and its statistical basis at the microscopic level, with applications. We will develop a comprehensive description of the thermodynamic properties of physical systems, emphasizing the close correlation between the microscopic behaviour of individual components and the macroscopic consequences. In the labs, we will apply these principles to problems originating in a modern laboratory and/or engineering environment.

PRE-REQUISITES AND ANTI-REQUISITES

EP 2H04

Prerequisite(s): Registration in Level 2 Engineering Physics or higher.

Antirequisite(s): ENGINEER 2H03, 2V04, MATLS 2B03

Phys 2H04

Prerequisite(s): One of PHYSICS 1A03, 1B03, 1C03, and credit or registration in PHYSICS 1AA3, 1BA3, 1BB3, 1CC3, or registration in Honours Biophysics, or ARTSSCI 2D06 A/B or ISCI 1A24 A/B; and credit or registration in MATH 2A03 (or 2X03), 2C03

Antirequisite(s): CHEM 2PA3, 2PD3, 2R03, CHEMBIO 2P03, ENGINEER 2H03, MATLS 2B03

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Adriaan Buijs (lectures)

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Office Hours:

By appointment

Dr. A. Turak (labs)

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Office Hours:

M 11:30-12:20

R 11:30-12:20

Or by appointment

Lab Technician TBD

Office Hours:

TBD

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

Greg Hanta (Lect.)
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COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

<http://avenue.mcmaster.ca/>

COURSE OBJECTIVES

By the end of this course, students should be able to:

1. Explain the laws of thermodynamics and illustrate them using examples
2. Solve thermodynamic problems through significant variable selection, appropriate assumption choice and manipulation of differential equations. This takes three forms, to
 - a. Identify properties of a thermodynamic system that allow you to reduce variables in order to solve corresponding problems;
 - b. Solve thermodynamic problems through the reduction of variables by manipulation of differential energy equations;
 - c. Solve thermodynamic problems by identifying properties of a thermodynamic system that allow you to reduce the appropriate variables
3. Discriminate between basic thermodynamic models (ideal gas law, van der Waals gas, etc.)
4. Outline the statistical underpinnings of thermodynamics

MATERIALS AND FEES

Required Texts:

Stephen Blundell and Katherine Blundell, *Concepts in Thermal Physics*, 2nd Edition, Oxford University Press 2010.

The Laboratory Handbook is posted on the course lab web page, on Avenue to Learn.

Optional Texts:

Keith Stowe, *Introduction to Statistical Mechanics and Thermodynamics*, 2nd Ed., Cambridge University Press 2007.

Daniel Schroeder, *An Introduction to Thermal Physics*, Addison Wesley, 2000.

Calculator: Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

COURSE OVERVIEW

Week	Topic	Pages, sections
1	1. Introduction, 2. Heat, 3. Probability	3 - 29
2	4. Temperature and the Boltzmann factor	32 - 46
3	5. The Maxwell-Boltzmann distribution, 6. Pressure, 7. Molecular effusion	48 - 69
4	8. Mean free path and collisions, 9. Transport properties in gases	70 - 88
5	10. The thermal diffusion equation	90 - 103
6	11. Energy, 12. Isothermal and adiabatic processes	108 - 123
	Spring Break	
7	13. Heat engines and the Second Law, 14. Entropy	126 - 153
8	16. Thermodynamic potentials, 18. The Third Law	172 - 187, 203 - 208
9	19. Equipartition of energy, 20. The partition function	210 - 232
	Last date for withdrawal	
10	21. Statistical mechanics of an ideal gas, 22. The chemical potential	233 - 261
11	23. Photons, 26. Real gases, 28. Phase transitions	269 - 274, 26.1, 26.3, 28.8
12	29. Bose-Einstein and Fermi-Dirac distributions, 30. Quantum gases and condensates	346 - 373

ASSESSMENT

Component	Weight
Pre-lecture quizzes	10 %
Weekly quizzes	15 %
Midterm exam (optional, otherwise added to final)	10 %
Final Exam	40 %
Labs	25 %
Total	100%

ADDITIONAL DETAILS REGARDING COURSE MANAGEMENT AND ASSESSMENT

Labs:

In the laboratory, students are required to complete five assigned experiments. A detailed laboratory notebook must be kept and submitted for grading. Formal reports are required for three of the experiments (detailed instructions will be given in the introductory lab session). Completion of all the lab requirements with a passing grade is a prerequisite for passing the course.

Policies on missed work, extensions, and late policies:

- MSAF accommodations: students who MSAF any component are required to contact Dr. Bujs as soon as possible as per university policy. If you MSAF an assignment or a quiz, the weighting of the final exam will increase appropriately. See below for university policy on MSAF.
- Labs: There is no need to MSAF a lab -- a missed lab can be made up at a later date in consultation with the TAs;
- Lab reports: If you MSAF a lab report, it will be due two days after your MSAF ends. Late submissions of lab reports are not acceptable, except with prior permission from the instructor. Permission must be obtained at least two days in advance of the deadline to waive the hand-in penalty.

Final exam:

The final examination will be scheduled by the University during its regular April examination period. To pass the course it is necessary to obtain at least **50%** on the final examination.

It will be a test of cumulative knowledge and may include all topics covered in the lectures.

ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only, and will not be directly taken into consideration in determining a student's actual grade in the course.

Outcomes

Indicators

Explain the laws of thermodynamics and illustrate them using examples, outline the statistical underpinnings of thermodynamics, and discriminate between basic thermodynamic models (ideal gas law, van der Waals gas, etc.	1.2 - Competence in Natural Sciences
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For more information on Accreditation, please visit: <https://www.engineerscanada.ca>

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <http://www.mcmaster.ca/academicintegrity>

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

ACADEMIC ACCOMMODATIONS

Students who require academic accommodation must contact Student accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University's Policy for [Academic Accommodation of Students with Disabilities](#).

NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

1. The [McMaster Student Absence Form](#) is a self-reporting tool for Undergraduate Students to report absences DUE TO MINOR MEDICAL SITUATIONS that last up to 3 days and provides the ability to request accommodation for any missed academic work. Please note this tool cannot be used during any final examination period.
2. You may submit a maximum of 1 Academic Work Missed request per term. It is YOUR responsibility to follow up with your Instructor immediately (NORMALLY WITHIN TWO WORKING DAYS) regarding the nature of the accommodation. Relief for missed academic work is not guaranteed.
3. If you are absent for reasons other than medical reasons, for more than 3 days, or exceed 1 request per term you MUST visit the Associate Dean's Office (JHE/H301). You may be required to provide supporting documentation.
4. This form must be submitted during the period of absence or the following day, and is only valid for academic work missed during this period of absence.
5. It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.
6. You should expect to have academic commitments Monday through Saturday but not on Sunday or statutory holidays. If you require an accommodation to meet a religious obligation or to celebrate an important religious holiday, you may submit the Academic Accommodation for Religious, Indigenous and Spiritual Observances (RISO) Form to the Associate Dean's Office. You can find all paperwork needed here: <https://www.eng.mcmaster.ca/programs/academic-advising>

NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

TURNITIN.COM STATEMENT

In this course we will be using a web-based service (Turnitin.com) to reveal plagiarism. Students will be expected to submit their work electronically to Turnitin.com and in hard copy so that it can be checked for academic dishonesty. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to <http://www.mcmaster.ca/academicintegrity/>.

ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK

In this course, we will be using Avenue to Learn. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

REFERENCE TO RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to <http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf>.