

EP/PHYS 2H04
Statistical Thermodynamics
 Winter 2017
 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 III Engineering Physics

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. A. Turak

JHEA 321

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ext. 23448

Office Hours:

M 11:30-12:20

R 11:30-12:20

Or by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

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Lab TA's

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Lab helpline:

2h04labhelp@physics.mcmaster.ca

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

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

COURSE OBJECTIVES AND LEARNING OUTCOMES

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

- C1) Explain the laws of thermodynamics and illustrate them using examples
- C2) Solve thermodynamic problems through significant variable selection, appropriate assumption choice and manipulation of differential equations. This takes three forms, to
 - o Identify properties of a thermodynamic system that allow you to reduce variables in order to solve corresponding problems
 - o Solve thermodynamic problems through the reduction of variables by manipulation of differential energy equations
 - o Solve thermodynamic problems by identifying properties of a thermodynamic system that allow you to reduce the appropriate variables
- C3) Discriminate between basic thermodynamic models (ideal gas law, van der Waals gas, etc.)
- C4) Outline the statistical underpinnings of thermodynamics

MATERIALS AND FEES

Required Texts:

Keith Stowe, *Introduction to Statistical Mechanics and Thermodynamics*, 2nd Ed., Cambridge University Press 2007
The [Laboratory Handbook](#) is posted on the course lab web page, on Avenue to Learn

Optional Text:

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.

Other: TopHat (TopHat.com – Thermodynamics, Join Code: 140273) for classroom participation

COURSE OVERVIEW

Topic

Topic A Laws of Thermodynamics

subtopic 1

Internal energy, equipartition, interactions, first law of thermodynamics

subtopic 2

Entropy and the second law of thermodynamics

subtopic 3

Temperature, equilibrium and the zeroth law, heat capacity and the third law

Topic B Thermodynamics of model systems: ideal and real gases, liquids, solids

Topic C Constraints and manipulation of variables

subtopic 1

Natural and imposed constraints

subtopic 2

Manipulation of variables

Topic D
Applications of constraints and models

subtopic 1
Non-equilibrium cooling

ASSESSMENT

Component	Weight
Final examination	45%
In-class assignments (5)	25%
Labs	25%
Participation	5%
Total	100%

ADDITIONAL DETAILS REGARDING COURSE MANAGEMENT AND ASSESSMENT

- Labs:**
In the laboratory, students are required to complete 5 assigned experiments. A detailed laboratory notebook must be kept and submitted for grading. Formal reports are required for two 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 policies: students who MSAF any component are required to contact Dr. Turak as soon as possible.

In-class assignments: If you MSAF an assignment, the weighting of the final exam will increase.

Participation: If you MSAF in-class participation, it will be taken into account in calculating the final participation score

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.
- Attendance requirements:**
Attendance is mandatory. Attendance will count toward the participation mark.
- Class participation expectations:**
Participation is expected in all course activities. This course will include an interactive component in-lecture using TopHat, as well as some surveys on the course website. The level of involvement in these activities will count towards a participation mark.
- Optional project:**
After the third in-class assignment, there will be an option to do a visualization design project on some aspect of thermodynamics. This will be assessed in place of the remaining assignments for the semester.
- Final exam**
The final examination will be scheduled by the University during its regular April examination period. In order to pass the course it is necessary to obtain at least 40% on the final examination. It will be a test of cumulative knowledge and test all topics covered in the lectures.

- **Civil society policy**

The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons concerned, individuals are reminded that they should contact their Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

ACCREDITATION LEARNING OUTCOMES
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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, 1.3
Solve thermodynamic problems through significant variable selection, appropriate assumption choice and manipulation of differential equations.	2.1,2.2, 2.3
Conduct investigations, in groups, of complex thermodynamic problems on topics ranging from the mechanical and electrical equivalences of heat, heat capacities, thermal conductivities, and cycles, while making appropriate assumptions, choosing correct models of interpretation, outlining appropriate uncertainties, and interpreting outcomes using fundamentals of thermodynamics	3.1, 3.2, 3.3, 6.1, 6.3
Present a clear and effective written summary of experimental results obtained during investigations on topics ranging from the mechanical and electrical equivalences of heat, heat capacities, thermal conductivities, and cycles	7.1,7.2, 7.3,

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/A214). 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: <http://www.eng.mcmaster.ca/current/documents.html>

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 or email. 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>.