Mechanical Engineering 2W04: Engineering Thermodynamics
McMaster University, Faculty of Engineering, Winter 2020

INSTRUCTOR

Dr. J.S. Cotton, JHE 212a, ext. 24899, cottonjs@mcmaster.ca
I am usually available through the day for consultation; you are welcome to drop by my office. Please email me if you would like to see me at a particular time.

OBJECTIVES

To teach the fundamental concepts in thermodynamics and the application of these principles in engineering.

CALENDER DESCRIPTION

Mech Eng 2W04: Introduction to the principles of thermodynamics, and applications in engineering. Basic concepts: energy systems, properties of pure substances, entropy. Laws of thermodynamics, power and refrigeration cycles. Three lectures, one tutorial;

PRESCRIBED TEXT BOOK

- Thermodynamics – An Engineering Approach: Seventh or Eighth Edition, Yunus A. Cengel, Michael A. Boles, McGraw Hill. (Chapters 1-7 and 10)

REFERENCES

- Avenue - You can view and download course information from this site.

LECTURES

Tuesday, Thursday & Friday - 11:30 to 12:20 hours @ MDCL 1105
Students are expected to stay abreast of announcements and schedule changes made in lectures and posted on Avenue.

TUTORIALS

Tutorial participation is a mandatory aspect of course assessment. There are 9 mandatory tutorials - see tutorial schedule. Evaluation is based on participation in 8 of the 9 tutorials

T04 Group A	Wednesdays	8:30 - 10:20 hours	@ T13 107
T02 Group B	Wednesdays	2:30 - 4:20 hours	@ JHE 326H
T01 Group C	Thursday	3:30 - 5:20 hours	@ T13 106
T03 Group D	Friday	3:30 - 5:20 hours	@ T13 107

ASSIGNEMENTS

8 Assignments - Problem sets are planned for roughly every week. Schedule on page 4.

MID-TERM

Mid-term examinations: There will be two tests of 1.5 hour duration.
Midterm #1: Tuesday February 11, 2020 – 6:30pm – 8:00pm
Location: PGCLL 127

Midterm #2: Tuesday March 17, 2020 – 6:30pm – 8:00pm
Location: PGCLL 127

Final examination: 2.5 hours in duration. The final exam will cover all lecture material.
Calculators: Only McMaster Standard Calculator (Casio fx-991) may be used during term tests and the final examination.

ASSESSMENT

The following distribution of marks will be used unless there is a valid and compelling reason to use an alternative weighting. Missed assignments and tests will have a grade of zero entered without legitimate and documented reason. The course of action for missed mid-terms or assignments with Associate Dean's approval is the weight of the mid-term or assignment will be re-distributed to the final exam.

Tutorials	5%
Problem sets:	10%
Mid Tests:	30%
Final Exam:	55%

DETAILED COURSE DESCRIPTION

Introduction:
- Definitions
- Defining Systems (closed, open)
- Fundamental Properties (intensive, extensive),
- Forms of Energy
- Temperature & Pressure
- Problem Solving Methodology

Properties of Pure Substances
- Phase Change Process of Pure Substances
- Property Diagrams & Tables
- The Ideal Gas Equation of State
- Specific Heats

Energy Transfer
- Heat Transfer
- Mechanical Forms of Work
- Non-Mechanical Forms of Work
- Conservation of Mass Principle
- Flow Work and Energy

First Law of Thermodynamics:
- Fundamental Concepts
- Energy Balance for Closed Systems
- Energy Balances for Steady-Flow Systems
- Steady-Flow Engineering Devices
  (nozzles, turbine, compressors, pumps, heat exchangers)
- Energy Balances for Unsteady-Flow Systems

Second Law of Thermodynamics:
- Thermal Energy Reservoirs
- Heat Engines
- Clausius statement, Kelvin-Planck statement
- Reversible/Irreversible processes
- `Black-box' Cycles : heat pumps, refrigerators, power cycles
- Carnot Cycles
- The Carnot Principles

Entropy:
- Clausius Inequality,
- The Increase of Entropy Principle
- Entropy Change of a Pure Substance
- Isentropic Processes
- Process Diagrams Involving Entropy
- Entropy Data (steam tables), TdS equations
- Special Cases: ideal gas, incompressible substance
-

Vapor Power Cycles
- The Carnot Vapor Cycle
- Rankine Cycle
- Deviations of Actual Cycle from Ideal
- Methods to Increase the Efficiency of Rankine Cycle

LEARNING OUTCOMES: Upon successful completion of the course the student are expected to demonstrate the ability to:

1. Identify the unique vocabulary associated with thermodynamics and explain the basic concepts of thermodynamics

2. Determine thermodynamics properties of pure substances, apply the ideal-gas equations, account for compressibility and equations of state.

3. Solve the first law of thermodynamics and mechanisms of energy transfer to and from a system and for common steady-flow and unsteady devices.

4. Solve the conservation of mass principle on various systems including steady- and unsteady-flow control volumes.

5. Apply the Second Law and Carnot principles and solve for the thermal efficiencies and coefficients of performance for reversible heat engines, heat pumps, refrigerators and solve for isentropic efficiencies for various steady-flow devices.

6. Analyze vapor power cycles in which the working fluid is alternately vaporized and condensed.

GRADUATE ATTRIBUTES: This course provides the students opportunity to develop the following measures of graduate attributes

Graduate Attributes	Learning Objectives where it is measured
Knowledge base for Engineering (Indicator 1.03)	1-6
Problem Analysis (Indicator 2.02)	3-6

TEACHING ASSISTANTS

Hassan Ahmed Mohamed	mohaa49@mcmaster.ca	JHE 104a
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ASSIGNMENTS COLLECTION AND EVALUATION

Assessment: TOTAL 10% of Grade

Assignments will be evaluated out of 10 marks.

Missed assignments will have a grade of zero entered without legitimate and documented reason.

Home Work No.	Due Date	Day	Marking TA In-Charge*
1	January 21	Tuesday	TBD
2	January 28	Tuesday	TBD
3	February 11	Tuesday	TBD
4	February 25	Tuesday	TBD
5	March 3	Tuesday	TBD
6	March 10	Tuesday	TBD
7	March 24	Tuesday	TBD
8	April 7	Tuesday	TBD

*MARKING TA SUBJECT TO CHANGE, CHANGES WILL BE POSTED IN AVENUE.

ASSIGNMENT SOLUTIONS FORMAT AND EVALUATION

Format: All homework submissions should adhere to the following format. Adherence to format will help us grade faster and more efficiently. So, help us give you a better grade.

- Use a clean, white, lined or grid 8-1/2" x 11" (letter size) paper. Do not use paper ripped from a note pad or a spiral notebook.
- Follow the approach to problem solving described below:
  - Problem Statement
  - Schematic and Given Data
  - Assumptions
  - Physical Laws
  - Know Data & Properties
  - Analysis/Calc's – with Units
- Numerical substitutions should be made after an algebraic solution has been formulated. You may get a good grade even if your numerical answer is wrong but your algebraic approach is reasonable. Try restraining yourself from numerical substitutions as long as you can.
- **Highlight** your final answer and be sure to not forget the **UNITS.**

If a computer program is used to attain a solution, attach a copy of the program and the data sheet.

ASSIGNMENT SUBMISSIONS

All homework should be submitted in the 'drop-box' marked with the course code ME2W04 located in on the 3rd floor JHE main hallway in the Mech Eng Wing before 2:00 hours on the due date. The assigned TA for the homework will pick the assignments up at 2:30 hours on each due date. NO late submissions will be accepted without permission from the Associate Dean's Office (MSAF).

Procedure for Remarking Term Test Answer Books:
In the event that a student has an issue with the way in which a term test has been evaluated, he/she may lodge their objections within a week of returning the marked papers.

Please follow the steps below while submitting material for remarking:
Compare your solutions to that posted on the course website. Write your concern in a separate piece of paper or email memo indicating: (i) Problem number(s) you have concerns about, (ii) Detailed nature of the discrepancy, and (iii) The marks you think you should have received, in reference to the solution/marking scheme posted on the course website. Please submit this along with your answer book personally to the instructor or TA.

The student will receive a written response from the TA that marked the paper; if the student does not agree with the response, the student may submit the whole documentation to the instructor for arbitration/remarking.

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: 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.*