

COURSE OUTLINE — WINTER 2021

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TA's: Refer to LEARN.

Course Overview: Achieving significant reductions in building energy consumption will be important in efforts to deal with the environmental and socioeconomic impacts of energy use. The energy use of heating, ventilating, and air-conditioning (HVAC) systems is a large portion of the energy consumption of most commercial, institutional, and residential buildings. This course introduces selected topics in HVAC systems design with focus on energy-efficiency and environmental-sustainability. Topics studied will include: heating and cooling distribution using air-, water-, and refrigerant-based systems; constant- and variable-flow systems; heat- and energy-recovery systems; vapor-compression refrigeration and heat-pump systems, including air- and geothermal-source heat pumps.

Recommended Preparation: It is helpful (but not essential) that students have engaged in some prior study of thermodynamics (including basic psychrometrics) and fluid mechanics, and/or have previously completed the special topics course “Building Energy Analysis”.

Key Learning Objectives: By the end of this course, you should be able to: a) perform simple thermodynamic calculations for selected HVAC components and systems, b) explain operational characteristics of selected energy-saving strategies for HVAC systems, and, c) assess the potential for selected energy-saving strategies to operate effectively under differing operating conditions and for different applications.

Course Format: The course will be delivered fully online. A variety of methods will be employed to facilitate learning, including independent study, pre-recorded lectures, and live lectures and discussions. The teaching team will facilitate learning throughout the term and will be available for consultation by email, web meeting, and other methods. All assessments will be administered electronically. Where live lectures are held, sessions will be recorded for viewing by those unable to participate live.

Waterloo LEARN: Your primary method of accessing the course will be through LEARN. Links to access live web-meetings (e.g. using WebEx) will be provided in LEARN. It is recommended that you check LEARN for updates (e.g. announcements, new content posted, etc.) at least twice per week throughout the entire term.

Equipment and Software Requirements: Students must have a reasonably reliable internet connection. To participate in online two-way communication (e.g. WebEx), it will be preferable to have a webcam, microphone, and headset/earbuds. For viewing course materials, it will be preferable to use a reasonably large display (e.g. computer monitor or laptop screen) rather than a small screen (i.e. smartphone). For some quizzes, students may be required to submit images of calculations or other workings, i.e. captured by digital camera or scanner.

LEARN Discussion Forum: The discussion forum in LEARN will be one of the methods used to discuss course content. An important benefit of the forum is that all participants can see questions and responses. (Questions can be posted anonymously.) When a question is posted, the teaching team will endeavour to respond within 24 hours. If your question needs an urgent reply, please send it by email instead of using the forum.

Dates and Times: Unless otherwise noted, dates and times listed in this document refer to the local date and time in Waterloo, Ontario, Canada (i.e. EST/EDT).

Schedule: Our weekly “lecture session” is scheduled for Tuesdays, 6:30-9:20 pm. Please reserve this time in your schedule each week. (Please note: Although this is three-hour lecture block, it is expected that typical weekly *live* sessions will be between 1.25 to 2 hours as additional course content will be provided through pre-recorded lectures or other methods.)

Textbook: No recommended text. Course notes and links to reference documents will be posted in LEARN.

Useful References: Students seeking a textbook covering general aspects of HVAC design and analysis might consider: "Heating and Cooling of Buildings: Principles and Practice of Energy Efficient Design (Third Edition)", by T.A. Reddy *et al.*. CRC Press, 2016.

Practice Problems and Solutions: Practice problems and solutions will be provided throughout the course. Careful review of the course notes and completion of the practice problems should be viewed as the primary activities to help you develop understanding of the course material. It is strongly recommended that you be persistent in your attempts to fully solve the problems before referring to the solutions.

Student Workload: For undergraduate engineering courses, it is a typical expectation that students will invest around 100 hours of focused work for each course. This includes time spent reviewing course notes, participating in lectures and/or viewing videos, completing homework, completing projects, and studying for tests. Based on a 14-week schedule, this equates to an average of about 7.5 hours/week. For graduate courses, the workload is usually somewhat greater. Note that this information is provided only as a guideline.

LIST OF TOPICS (tentative)

- Introduction & Overview
- HVAC Design Loads vs Operating Loads
- Aspects of Hydronic Heating Systems
- Constant and Variable Flow Systems
- Aspects of Ventilation Design
- Air-to-Air Energy Recovery
- Condensing Boilers and Low-Temperature Heating Systems
- Vapor Compression Refrigeration Cycle & Equipment
- Refrigeration Waste-Heat Recovery
- Heat-Pump Systems and Equipment
- Aspects of Ground-Loop Heat Exchangers

ACADEMIC INTEGRITY QUIZ (AIQ)

Our present need to work, teach, and learn remotely due to the COVID-19 pandemic has introduced new challenges in maintaining standards of academic integrity. Unfortunately, we have recently encountered incidents of students using the situation to rationalize conduct that they know to be unacceptable. If you elect to proceed with this course, you are encouraged and requested to view this situation as a challenge to be overcome and an opportunity to demonstrate your ability to uphold high standards of personal honour and integrity. This is the expectation for those seeking entry into the [engineering profession](#).

To emphasize the importance of academic integrity, students who elect to take this course must successfully complete a brief "Academic Integrity Quiz" (AIQ). **The AIQ must be completed before you will be granted access to the other quizzes.** The AIQ includes a "Statement of Acknowledgment" of certain principles of academic integrity. This quiz may be attempted as many times as needed until passed.

ASSESSMENTS

All students will complete six quizzes. Further, students enrolled in a graduate version of the course (ME760 or CIVE700) will complete an independent study project.

Quizzes

The duration each quiz will be between 45-60 minutes (tentative). All quizzes will be open book and administered using LEARN. Each must be completed within a limited window of availability. Some key information has been provided below and additional information will be provided separately.

CR/NCR Quizzes

Quiz 1 and Quiz 4 will both be assessed on credit/no-credit (CR/NCR) basis. The passing grade is 80%. Three attempts will be permitted for each. Each will be available to write during a 48-hour window as indicated below.

Graded Quizzes

Quiz 2, Quiz 3, Quiz 5, and Quiz 6 will be graded quizzes. Each will be available to start during a brief time window. Quiz 2 and 3 will occur on the same day (with a brief break between them). Similarly, Quiz 5 and 6 will occur on the same day (with a brief break between them). Quizzes 5 and 6 will occur during an exam block during the Final Exam period (tentative). Where appropriate, the teaching team will arrange alternate timing for students in time-zones outside of North America. Additional information is provided below.

Notes about Quizzes

- *Help during a Quiz:* A member of the teaching team will be available during the regular availability window of each graded quiz. If you have a problem or question, please contact us and we will attempt to respond immediately. Contact instructions will be provided in LEARN.
- *Academic Integrity:* As would be expected for an in-person quiz, each quiz is to be completed without communicating with any other persons except for members of the teaching team. Please be aware that the [penalties](#) for academic integrity violations occurring during tests (including “quizzes”) can be severe.

Independent Study Project (ME760 and CIVE700 only)

Students will undertake an independent study project involving research and/or analysis and preparation of a brief report. Your report submission will be screened using Turnitin plagiarism detection software. Additional information will be provided separately.

COURSE GRADE

Component	CIVE497 / ME599	CIVE700 / ME760
Quiz 1 (CR/NCR)	10%	5%
Quiz 2	20%	17.5%
Quiz 3	20%	17.5%
Quiz 4 (CR/NCR)	10%	5%
Quiz 5	20%	17.5%
Quiz 6	20%	17.5%
Independent Study Project	<i>n/a</i>	20%
<i>Total</i>	<i>100%</i>	<i>100%</i>

Term Schedule (tentative)

Scheduled lecture period = Tuesdays 6:30 to 9:20 pm (EST)

L# = Live lecture

SUN	MON	TUE	WED	THU	FRI	SAT
Jan 10	11	12 L1	13	14	15	16
17	18	19 L2	20	21	22	23
24	25	26 L3	27	28	29	30
31	Feb 1	2 L4	3	4	5	6 Q1 <small>Availability starts 12:00 am</small>
7 Q1 <small>Availability ends 11:59 pm</small>	8	9 L5	10	11	12	13
14	15 Holiday	16-20 Reading Week				20
21	22	23 L6	24	25	26	27
28	Mar 1	2 Q2 Q3 <small>During lecture period</small>	3	4	5	6
7	8	9 L7	10	11	12	13
14	15 UW Holiday	16 UW Holiday	17	18	19	20
21 ISP Due	22	23 L8	24	25	26	27 Q4 <small>Availability starts 12:00 am</small>
28 Q4 <small>Availability ends 11:59 pm</small>	29	30 L9	31	Apr 1	2 Holiday	3
4	5	6 L10	7	8	9	10
11	12	13 L11	14	15	16	17 Final Exams
18	19	20	21	22	23	24
Final Exams			Q5 Q6 <small>Date and Time TBD.</small>		Final Exams	

Additional Information

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g. scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin® in this course.

Report Standards: In general, reports should be prepared in adherence with good practice, such as that described in "Introduction to Professional Engineering in Canada" (Andrews et al., Pearson Canada Inc., 5th ed.). This includes providing a cover page, page numbers, table of contents, and list of reference citations.

Writing and Communication Centre: The Writing and Communication Centre (WCC) works with students as they develop their ideas, draft, and revise. Writing and communication specialists offer one-on-one support in planning assignments, synthesizing and citing research, organizing papers and reports, designing presentations, and revising for clarity and coherence. For more information, visit uwaterloo.ca/wcc.

Academic Integrity: All members of the University of Waterloo community are expected to adhere to principles of academic integrity. Further, members of the engineering profession—and those seeking entry into the profession—are expected to uphold high standards of personal honour and integrity. Please consider that the personal traits and habits that you develop during your education are carried forward into your career. Those who find ways to justify "taking short-cuts" as they pursue their education may be unintentionally training themselves to do the same in their careers. Unfortunately, engineers who have "taken short-cuts" have been responsible for many disasters and failures. Please ask the instructor if you have any questions or concerns. Check the [Academic Integrity Office](#) for more information.

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. If in doubt, please contact the department's administrative assistant for assistance.

Discipline: Students are expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for their actions. Check the Office of Academic Integrity for more information. A student who is unsure if an action constitutes an offence, or who needs help in learning how to avoid offences or about rules for group work/collaboration should seek guidance from the course instructor, academic advisor, or the associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is an appropriate rationale. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals.

UW AccessAbility Services: [AccessAbility Services](#) collaborates with academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of a disability, please register with AccessAbility Services at the beginning of each academic term.

Acceptable Use of Course Materials: Materials provided to students in any format (including, but not limited to: electronic and hard-copy documents, video recordings, etc.) are provided solely for their personal use in completing the coursework. Students are not permitted to share or distribute course materials by any means (including, but not limited to: uploading to a 3rd party website, emailing, etc.), unless prior written permission is provided by the instructor. Unauthorized distribution of any material will be considered an academic offense and may constitute copyright infringement. (Note: As clarification to the above, it is acceptable for students enrolled in the course to share material with other students enrolled in the course, while they are both enrolled.)

Confidentiality of Tests: The content of all tests (including quizzes and exams) used in this course is confidential. It is a violation of academic integrity to convey and/or transmit content from any test to another person by any means. Further, it is a violation of academic integrity to record, copy, photograph, or store images or descriptions of the content of tests, for any purpose.