Instructor

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Course Delivery

online instruction. Class lectures will be delivered via the course MS TEAMS channel ARCH 4212.03 Building Systems Integration Winter 2024.

Availability Outside of Class Hours

Please email AP to arrange a virtual meeting time on the course MS TEAMS channel ARCH 4212.03 Building Systems Integration Winter 2024.

University Policies, Learning and Support Resources

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate: https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog
See the School's "Academic Regulations" page (tinyurl.com/dal-arch-regulations) for links to university policies and resources:

- Academic Integrity
- Accessibility
- Code of Student Conduct
- Diversity and Inclusion – Culture of Respect
- Student Declaration of Absence - go to https://tinyurl.com/dal-sda-form
- Territorial Acknowledgement: Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.[1]
- Work Safety
- Fair Dealing policy
- Important Dates in the Academic Year (including add/drop dates): http://www.dal.ca/academics/important_dates.html
- Dalhousie Grading Practices Policy: https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Learning and Support Resources

- General Academic Support – Advising: https://www.dal.ca/campus_life/academic-support/advising.html

Additional Academic Support

Content and software support are available from the BSI teaching group. Software support for TEAMS and TEAMS is available through the Dalhousie ITS site https://www.dal.ca/dept/its/current.html as well as the School of Architecture's Computer Help Desk. The links to the library and copyright office are below.

- Dalhousie Libraries: http://libraries.dal.ca
- Copyright Office: https://libraries.dal.ca/services/copyright-office.html

Faculty Policy on Equity, Diversity and Inclusion

The Faculty of Architecture and Planning is committed to recognizing and addressing racism, sexism, xenophobia and other forms of oppression within academia and the professions of architecture and planning.

[1] For more information about the purpose of territorial acknowledgements, or information about alternative territorial acknowledgements if your class is offered outside of Nova Scotia, please visit https://native-land.ca/.

We, the faculty, are working to address issues of historic normalization of oppressive politics, segregation, and community disempowerment, which continues within our disciplines today.

Calendar Description

This course emphasizes environmental controls in buildings with a complex program. It examines how passive and active control systems can achieve climatic comfort with low lifetime environmental impacts. It also studies guide for environmental performance, including configurational approaches, quantitative assessments, and associated standards and regulations.

Additional Course Description

This course's subject matter includes performance and comfort standards related to human activities in buildings, active(non-passive) mechanical systems (a.k.a. HVAC - Heating, Ventilation and Air Conditioning), global warming and carbon, bioclimatic design (shaded buildings), passive cooling strategies and whole building systems integration (see **Pedagogy & Competency + Learning Objectives** and **Lecture Schedule** below). Given the range of topics covered over the term. the course will provide you with an overview awareness of the material and in a couple of instances through a focus brought about by the course assignments, an understanding of the carbon consequences of refrigerants and whole building HVAC system physical integration. The course assignments are integrated with ARCH 4005: Design and its term design project - Museum of Halifax Art and Culture (see **Course Assignments** below).

Pedagogy & Competency + Learning Objectives

The course takes a problem-based learning approach where the course's learning objectives are found in the course assignments. The course lectures support the assignments in that the lectures will provide you with an understanding of what is being asked of you for each assignment along with an ability to complete them.

The course's **learning objectives** include:
1. an awareness of HVAC system terminology, components, systems and operation;

2. an awareness of bioclimatic design and passive, low energy cooling strategies;

3. an awareness of global warming, climate modeling, Global Warming Potential of the Greenhouse gases, and carbon dioxide equivalence;

4. an understanding the Global Warming Potential of refrigerants; and

3. an understanding of how to lay out an HVAC system distribution system and in so doing, resolve spatial conflicts between an HVAC system and the building's structural and envelope systems.

Course TEAMS site & Course Resources

On the course TEAMS site - you will find the course outline, course resource materials, the assignments and where you are expected to submit assignments. There is no required textbook, software or equipment required to take this course. You should have received an invite to the TEAMS site and on-line lectures.

Time Spent on the Course

For this three-credit-hour course, you are expected to spend an average of *9 hours per week throughout the term on all course-related activities, including classes, for a total of about 108 hours*. If you find you are spending substantially more time on the course, please notify AP.

Lecture Schedule

This is an online course. There are two one and half hour lectures per week on Tuesday & Thursday morning from 11:00am to 12:30pm. The lectures will be delivered on the course MS TEAMS channel **ARCH 4212.03 Building Systems Integration Winter 2024**. All lectures will be recorded and posted on the course TEAMS site.

lecture schedule

week & date		**Tuesday (T)**	**Thursday (TH)**	**assignment introduction & due dates**
1	(T) January 9 & January 11	Lecture 1 course introduction, HVAC anatomy & HVAC comfort	Lecture 2: ventilation & heating, systems	
2	Professional Practice Week - No Class			
3	(T) January 23 & (TH) January 25	Lecture 3: cooling systems	Lecture 4: climate models & carbon + refrigerants, the vapour compression cycle, Global Warming Potential to $kgCO_2e$	
4	(T) January 30 & (Th) February 1	Lecture 5: distribution systems & terminal units Lecture 6: loads, sizing & fitting	Lecture 7: comprehensive design - mechanical rooms *assignment 1 introduction: understanding a mechanical room & GWP*	*assignment 1 introduced*
5	(T) February 6 & (Th) February 8	Lecture 8: *penultimate review assignment 1: understanding a mechanical room*	Lecture 9: *assignment 1 hand-in & review - GWP & mechanical room layout*	***assignment 1 hand-in (Th) February 8,***
6	(T) February 13 & (Th) February 15	Lecture 10: building systems integration: plenums	Lecture 11: building systems integration: climate modernity	
7	Winter Break - No Class			
8	(T) February 27& (Th) February 29	Lecture 12: bioclimatic design: shaded buildings	Lecture 13: passive & low energy cooling design: options	
9	(T) March 5 & (Th) March 7	Lecture 14: comprehensive design - whole building HVAC 1 *assignment 2 introduction: laying out the whole building's HVAC system*	Lecture 15: comprehensive design- whole building HVAC 2 class exercise - laying out a museum's HVAC system	*assignment 2 introduced*
10	(T) March 12 & (Th) March 14	Lecture 16: comprehensive design- whole building HVAC 3 - hybrid systems	Lecture 17: comprehensive design- whole building HVAC 4 *penultimate review assignment 2: laying out the whole building's HVAC system*	
11	(T) March 19	Lecture 18: comprehensive design- whole building HVAC 5 *assignment 2 hand-in & review* SLEQ		***assignment 2 hand-in (T) March 19***

Course Assignments

There are two course assignments: **1) understanding a mechanical room** & **2) laying out the whole building's HVAC system**. Each assignment is to be done individually and each assignment is worth 50% of your course grade. Please see **Course Grade Scale & Grading Rubric** section below to learn who and how the assignments will be marked along with the late assignment policy.

Assignment 1: understanding a mechanical room (50% of course grade):to be done individually, due 11:00 am Thursday, February 8, 2024

Description: The central mechanical room is where "all the big pieces live" - the heating equipment, cooling equipment and central ventilation equipment which together creates a comfortable year-round indoor environment for the building occupants. This comfort comes at a cost. Aside from the dollars, this equipment can be a major source of a building's life cycle Global Warming Potential (GWP) and ozone depleting substances.

Several points to consider before we proceed with the assignment.
1) The mechanical room contains a lot more than the" mechanical components" i.e., the equipment mentioned above. It also includes the building's electrical panels, the point where the plumbing systems go from inside to the outside and visa versa, the building control system panels and the building sprinkler pump.

2) The mechanical room is noisy. Noise control is something which will not be addressed directly in this assignment. However, you should be aware that mechanical room noise is an issue and locate it accordingly.

3) Be aware that your building will have a fresh air (a.k.a. make-up air) requirement and the mechanical room has to have access to outdoor air.

4) Your buildings will be around for a long time, at least several generations. It is reasonable to expect that over the operational life span of your building, HVAC technology will improve in terms of energy efficiency and environmental emissions. This being the case, expect that HVAC equipment will be switched out and/or more or less equipment will be added to the mechanical room. For this to happen, your layout has to have a degree of spatial flexibility.

The intent of assignment 1) is to provide you with

- an ability to fit heating, cooling and ventilating equipment in a defined space; and
- an understanding of the mechanical room not only as the location of the above equipment but as one source of the building's environmental impacts.

a set of plans and a chart

The assignment asks you to complete two connected exercises. The first exercise is a game of spatial chess and the second exercise is a puzzle. The end goal is to select a set of heating, cooling and ventilating equipment that meets a portion of your museum's conditioning load and 1) fits into a mechanical room of your design and 2) on paper in the service of meeting the required building conditioning loads, produces a minimal, ideally the minimum, environmental impact (Global Warming Potential) in terms of life cycle emissions.

In short, if a selected piece of equipment meets the design conditioning load but doesn't fit in the room then you will need to select another piece of equipment. Also, if a piece of equipment meets the design conditioning load and fits into the room, but has a higher environmental impact, then another piece of equipment of similar specifications, then you will have to choose again. As you can see, this assignment is a tiered two step exercise with an objective of selecting a set of equipment that meets climate load, fits into the mechanical room and produces the least environmental impact. This is the general assignment workflow. The next few paragraphs will fill in the specific pieces you need to complete the assignment.

Mechanical room layout (30%)
For the purposes of this assignment, you are asked to layout a mechanical room which will meet the conditioning loads for the three rooms highlighted in B5 Design 4005 2024 Assignment 1 PROGRAM & SITE Exercise 1 - THE ROOMS 1:5 - 1:20. In THE ROOMS assignment, you are asked to design 3 rooms - the Gallery, Exhibition Room & Event Hall. From the brief, the conditioning loads are as follows: heating (kW), cooling (tons), ventilation. To meet these loads, your mechanical engineer has told you to design the room's layout so it can contain two natural gas boilers, two chillers and an Air Handling Unit (AHU) complete with a coil/filter bank. The engineer also told you the ventilation system will include 20% outdoor (makeup) air. The room is to be designed so that the machinery is accessible for maintenance, repair & replacement.

From a manufacturer's list of equipment (Carrier, Johnson Controls & Trane) you will select a boiler, chiller and AHU that has been sized to meet the comfort loads for a museum located in Halifax. Studying the equipment's data sheets will show each piece of equipment's physical dimensions. You will also determine fan and pump sizes and their corresponding power ratings to determine environmental impact.

Environmental impact chart (20%)
Building on what you learned in class about the environmental impacts from air conditioning equipment, calculate the Global Warming Potential (GWP) and carbon dioxide equivalence for *each* air conditioning plant included in your design. When considering the environmental impacts, assume your museum has an operational life span of 80 years.

Complete the tiered exercise for two cooling plants either from two different manufacturers. Once done, make a design recommendation of the one you would choose, please provide your reasons why you selected this unit.

Note: It is up to you, in consulting with your design tutor, to determine your mechanical room's physical dimensions and location given the above-mentioned requirements and issues.

Deliverables
1) a plan and two sections of the mechanical room showing the plant and ductwork/piping mentioned above on two 11 x 17 sheets. Please submit the two sheets as a .pdf file to the course TEAMS site - name, ARCH 4212.03 2024, assignment 1 - plan and sections.
2) a table listing the projected amounts of cooling plant GWP and carbon dioxide equivalence over the museum's operational life cycle for two options for each cooling plant. Also, please identify your selected equipment for each plant on your table. Please submit the table as a pdf file to the course TEAMS site - name, ARCH 4212.03 2024, assignment 1 - table

Assignment 2: laying out the whole building's HVAC system (50% of course grade): to be done individually, due 11:00 am Tuesday, March 19, 2024
Description: To make the HVAC system work, these different parts need to be connected into one integrated whole. There are three types of building systems integration one needs to consider in any design: physical, visual and performance. We will only be considering physical integration in this assignment.

The mechanical room is one part of a building's HVAC system. The other parts of the building's HVAC system include the heating/cooling/ventilating plants not located in the mechanical room (remote plants), the distribution systems - ductwork in the case of air and pipes in the case of water leading from the mechanical room and/or remote plants and terminal units - radiators, diffusers and grills and controls.

Physical integration demands the HVAC components fit into the space both horizontally (via the plenum in plan) and vertically (walls, vertical chases in section) recognizing the physical needs to weave plants, ductwork, piping and terminal units through the structure and interior architecture all within the envelope (Pompidou Center aside).

The intent of assignment 2) is to provide you with

- an ability to create a schematic layout in plan of these components for a *representative* floor - select a floor that includes a non-gallery space (e.g. a meeting space, cafeteria, entry, etc.) and two or more galleries. This *representative* floor does not have to be the one you will be using in your final design but can be a working *representative* floor given where you are in your design thinking);
- an ability to show the physical relationship in section between this *representative* floor, the roof top units and the mechanical room. Please note, it is important to show how the *representative* floor, roof top units and mechanical room connect together through ductwork or piping as appropriate,
- an ability to note the HVAC system parts in your drawings e.g. a central mechanical room, or local mechanical rooms depending on the type of system you are using, floor ductwork layout, vertical supply and return plenums, air conditioning system piping, terminal units, louvers and roof top units/cooling towers, evaporator, condenser, chiller, terminal units, etc. as relevant.

whole building HVAC system schematic (50%)
The drawing set includes at minimum one, but no more than three 1:50 plan(s) and one, but more than three 1:50 section(s) showing. See **The intent of assignment 2) is to provide you with** points above for clarity as to what is included in the plan(s) and section(s).

Deliverables
*1). Please submit the plans and sections described in the **whole building HVAC system schematic** above as pdfs to the course TEAMS site - name, ARCH 4212.03 2024, assignment 2*

Course Grade Scale & Grading Rubric

The assignments are due @ 11:00 am on their respective hand-in date and will be graded by AP as per Dalhousie University's Undergraduate Grade Scale and Definitions found at: https://www.dal.ca/campus_life/academic-support/grades-and-student-records/grade-scale-and-definitions.html along with the grading rubric found below.

Due Dates and Late Submissions

Deductions for late submissions encourage time management and maintain fairness among students.

	Due date	Is a late assignment accepted?	If so, what is the deduction per weekday? *	Is there a final deadline for a late submission?	What happens after that?
Assignment 1	(Th) February 8	yes	3%	(T) February 15	receives 0% and no comments
Assignment 2	(T) March 19	no		no	receives 0% and no comments

* For example, if an assignment is evaluated at 75% before applying a 3%-per-weekday deduction, it would receive 72% for being 1–24 hours late; 69% for 25–48 hours late; etc.

Note: The following University or School policies take precedence over course-specific policies:

- No late assignments are accepted after the last day of weekly classes (the Friday before review week).
- With a Student Declaration of Absence (maximum two per course), an assignment may be submitted up to three weekdays late without penalty. An SDA cannot be used for the final assignment.
- With a medical note submitted to the School office, a course assignment (including a final assignment) may be submitted more than three weekdays late without penalty. The number of weekdays depends on how long you were unable to work, as indicated in the medical note. If more than one course is affected,

you should consult with the Undergraduate/Graduate Coordinator to set a new schedule of due dates.
- A student with an accessibility plan that allows for deadline extensions does not need to submit an SDA.

If you need to complete a Student Declaration of Absence form, https://cdn.dal.ca/content/dam/dalhousie/pdf/campuslife/Health%20and%20wellness/FINAL%20Student%20Declaration%20of%20Absence%20Form.pdf please submit it to AP via email.

Grading rubric

A+: 90 - 100% (excellent)
The term's work is complete and correct in terms of the selection table and 2D schematics for assignment 1 and the plans and sections for assignments 2. The work is an *example of best practice*. There is considerable evidence of original thinking; outstanding grasp of subject matter; evidence of extensive knowledge base. It can be included in a publication others can use to teach or study from.

A: 85-89% (excellent - competent)
The term's work is complete and correct in terms of the selection table and 2D schematics for assignment 1 and the plans and sections for assignments 2. The work is an *industry ready document but not an example of best practice.* It would not be used in a publication others would use to study or teach from because it is derivative - imitative of the work found in other publications.

A-: 80-84% (excellent - conditionally competent)
The term's work is complete and correct in terms of the selection table and 2D schematics for assignment 1 and the plans and sections for assignments 2. One or more aspects of the work is either missing or not developed. The work is an *industry ready document with minor revisions.*

B+: 77-79% (good - understand)
The term's work shows evidence of a grasp of subject matter; some evidence of critical capacity and analytical ability; reasonable understanding of relevant issues; evidence of familiarity with the subject. The work is not industry ready. It shows a *weakness* in one or more areas. The work can be completed with minor supervision.

B: 73-76% (good - aware)
The term's work shows evidence of a grasp of subject matter; some evidence of critical capacity and analytical ability; reasonable understanding of relevant issues; evidence of familiarity with the subject. The work is not industry ready. It has *substantial weaknesses* in multiple areas. The work requires direct supervision to complete.

B-:70-72% (good - conditionally aware)
The term's work shows evidence of a grasp of subject matter; some evidence of critical capacity and analytical ability; reasonable understanding of relevant issues; evidence of familiarity with the subject. The work is passable work. It shows a *minimal understanding* having considerable weakness and/or errors in one or more areas. The work requires direct supervision with explicit directions to complete.

C+:65–69%, C: 60–64%, C–: 55–59% (satisfactory)
Evidence of some understanding of the subject matter; ability to develop solutions to simple problems.

D: 50–54% (marginal pass)
Evidence of minimal familiarity with the subject matter; minimal analytical and critical skill.

F: <50% (fail)
The term's work does not meet the requirements of the course's deliverables and/or is absent.

Note the terms in the () are AP's terms and are intended to complement but not replace the University's terminology.
AP
January 1, 2024