

Dalhousie University School of Architecture

ARCH 5221.03 – Building Systems Design

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Office hours: I'm often in HA31, or please set something up by email.

Meets: Tuesdays, 9:30 – 12:30 in HA18

Brightspace: [Dal.Brightspace.Com](https://dal.brightspace.com)

Open to M.Arch students and to others with the instructor's permission.

A 3 credit-hour graduate course should require about 9 hrs. per week.

Important Note

With the agreement of 2/3 of enrolled students, changes may be made to the course outline – whether in response to campus closures or other contingencies. Changes will **NOT** be recorded in this outline, but only in Brightspace.

Student Services

Dalhousie provides a wide range of student services covering financial stress, tutoring, writing support, physical and mental health counselling, and many other topics. A central directory can be found at:

https://www.dal.ca/current_students.html

Safety First

In this course, safety is not just academic or bureaucratic: it is of immediate, vital importance. Students are expected to understand the [Internal Responsibility Principle](#) that governs Provincial law that Dalhousie necessarily follows. Basically, everyone is responsible for safety wherever they have power or influence. For low-level employees and students, that starts with informing yourself, and knowing you should refuse work for which you don't feel you've been adequately trained. Your [right to refuse work](#) without repercussions is guaranteed under the law. Please study the more detailed information on page 8.

ACADEMIC INFORMATION

Calendar Description

This course investigates the conception and orchestration of building systems. Ideas are drawn from Renaissance and nineteenth-century systematizations of architecture, from twentieth century systems thinking and from contemporary digital practice. Students apply these ideas to the design, construction, and analysis of projects that incorporate real, energized, building systems components.

Rationale

Principles and Pragmatics

Designers may find that abstract principles don't in themselves lead to design accomplishments. This course tackles theory as it arises in and illuminates actual problems in design. The pragmatic task of building an illuminated artifact energized with household current holds lessons for full-scale architectural composition. More generalized systems ideas are applicable to design challenges of all types and scales.

Design Intention and Application

The obvious systems in architecture are the service or MEP systems, often designed by sub-consultants according to their professional requirements and preferences. Architects may want to sculpt these ducts and pipes into a positive element of design (e.g. Richard Rogers), to reduce their visual presence to an absolute minimum (e.g. John Pawson), or to displace them with a passive or integral approach to flows of heat, air, moisture, and such (e.g. Hassan Fathy). Understanding underlying systems principles (rather than technical detail) will help you work more effectively with your consultants.

Furthermore, studying these tangible building systems introduces the tradition of systems thinking that finds related patterns in biology, management, computer science, and other fields. Systems principles can help you see buildings as biophysical creatures embedded in an eco-systemic context, as spatial compositions systemically intertwined with their beholders' perception, or as social constructs embroiled in systems of identity, exclusion, and bias.

Systems tools are primarily diagrammatic, so they work well for many designers. Because they emphasize patterns of relationship rather than parts or members, they can help de-personalize fraught situations. The concepts and skills enabled by the course can be useful in a design thesis, in design practice, and other areas of life.

Class Format

Regular classes have several components:

- Brief review of ongoing work.
- Lectures emphasizing questions and discussions.
- In-class exercises expanding on lecture content.

Optional class, shop, or desk-crit hours may be organized on a small-group basis.

Expenses, Equipment, Software

Students from outside the School unaccustomed to studio work may need to spend money on design software or on general supplies: drawing paper, markers, hand-tools, etc. Architecture students shouldn't need to make special purchases for the course but may choose to buy a few electrical tools. It's not advised to spend money before discussing options in class.

Integration with Other Courses

Students are encouraged to pursue systems ideas that pertain to other classes, particularly in the second project. But it is not recommended to make the relationship too tight, because the emphases and processes of courses may end up interfering with each other. Please be aware that work done in one course should not be *submitted* again in another, although it may be *presented* as useful context.

Sequence of Topics

	WK.	TUES.		PRINCIPLES	PRAGMATICS	DUE	
i	1	12-Sep	Intro	Systemics vs. Systematics; Emergence	Necessary Components	proto-plan	
	2	19-Sep	H1	Composition, Decomposition, Abstraction	Formwork and In	planning permission	
	3	26-Sep	H2	Source, Sink, Cycle; Open vs. Closed Systems	DC Circuits; Switching	construction drawing	
	4	03-Oct	H3	Entity, Context, and Observer	AC wiring; Grounding	hierarchy of assembly	
	5	10-Oct	H4	Feedback and Feedforward, Fluctuation	Concrete Technology	electrical instruction	
	6	17-Oct	H5	Efficiency, Efficacy, Externalities	Trades, Parts, Actants	rough inspection	topic
	7	24-Oct	Fourth Element Review				final inspection
Hard Systems.	8	31-Oct	S1	Bias and Belonging	Visual Tools for Inclusion	proposal	
	9	07-Nov	S2	Time, Culture, and Meaning	Icons and Typefaces	entity & context	
	10	14-Nov	Break				
Soft	11	21-Nov	S3	Learning, Dysfunction, and Evolution	Institutions	area of focus	
	12	28-Nov	S4	Mental Models and Multiple Minds	Embedded Information	argument	
	13	05-Dec	Personal Project Review				SLEQ and wrap-up

Learning Objectives

Students completing the course should develop abilities in four areas.

Analysis:

- Construct valid taxonomies of assigned collections of entities and construct multiple valid taxonomies of the same collections; identify and illustrate sets or kits of discrete parts, trades divisions, budgets, and other taxonomies applicable to building.
- Identify and illustrate systems of function and consequence, including material and energy flow, control, conception, and stability in architectural configurations.
- Use established diagramming methods rigorously and devise one's own.

- Identify and illustrate systems of information flow and control that pertain to architectural decision-making.
- Observe and define conditions of order, organization, simplicity, complexity, sub-optimization, closedness, and bias.

Design

- Orchestrate parts and elements to manage resources and improve systemic results.
- Design material projects to accommodate the movement of components, connectors, and equipment during construction, maintenance, and repair.
- Identify, develop, and exploit languages of formal design.
- Apply systems ideas and terminology to design communication.

Trades Work

- Describe some common components of M and E systems in technical terms.
- Draw and explain some of the systems diagrams used by building services engineers and by the building trades.
- Conceive, schedule and complete work within identified time and resources.
- Reference some of the systems of industrial standards applicable to construction,
- Anticipate some of the invisible conditions with which the building trades must contend.
- Explain the role of designers and trades at the various levels of instruction.

ASSESSMENT

Two Projects Only

There are only two projects in this class, the first individual and the second individual or group. Weekly interim deliverables should help students make better use of the early weeks of the term, keeping the last weeks more available for Studio.

The Fourth Element – 50%

Design and build a lamp with unlimited creative freedom within clear constraints. On the way, students will document the project through familiar architectural drawings and a suite of less familiar systems diagrams. Five weekly deliverables count for 5% each, pertinent in-class work totals 10% and the final project is worth 15%.

Personal Project – 50%

The topic and form is chosen by individuals or groups in consultation with the instructor. It could focus on a second lamp project. Students will choose a topic area by week 6. Five weekly deliverables count for 5% each, in-class work totals 10% and the final submission counts for 15%.

Submissions, Due Times, Late Work

Work should be pinned up in time for class to start promptly. Pdfs should be submitted to the appropriate drop box in Brightspace 11:59 PM the day before.

	Due date	Late work accepted?	Deduction per weekday or part thereof	Final deadline for a late submission	What happens after that?
4 th Element components	Weekly at start of class	yes	3%	Oct. 24	receives 0% and no comments
Personal Project components	Weekly at start of class	yes	3%	Dec. 1	receives 0% and no comments

Please 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.

Group Work

Students in one group will receive the same grades.

Marking and Feedback

Emanuel will mark all work, generally before the following class, so that grades build gradually and 50% of the term mark will be determined by October 31. Only brief feedback will be provided in Brightspace, so students are invited to ask for clarifications in class, over email, or in separate meetings.

Attendance

There is no mark for attendance *per se*, but in-class work counts toward your grade.

Evaluation, Feedback, and Grades

After the in-class review, work will be graded by the instructor according to the relevant rubric. Students are encouraged to follow up on the review and rubric response through additional discussion with the instructor.

Grades given will be numerical and converted to an end-of term letter grade according within Brightspace for review by the instructor and approval by the School.

The following standards will be used.

L.G.	Percent	Definition	Description
A+	90–100%	Excellent	Considerable evidence of original thinking; outstanding capacity to analyze and synthesize; outstanding grasp of subject matter; evidence of extensive knowledge base.
A	85–89%		
A–	80–84%		
B+	77–79%	Good	Evidence of grasp of subject matter, some evidence of critical capacity and analytical ability; reasonable understanding of relevant issues; evidence of familiarity with the literature.
B	73–76%		
B–	70–72%		
C+	65–69%	Satisfactory	Evidence of some understanding of the subject matter; ability to develop solutions to simple problems.
C	60–64%		
C–	55–59%		
D	50–54%	Marginal pass	Evidence of minimal familiarity with the subject matter; minimal analytical and critical skill.
F	0–49%	Fail	Little evidence of understanding of the subject matter; weakness in analytical and critical skills; limited or irrelevant use of the literature.
INC		Incomplete	(counts as zero in GPA calculation)
W		Withdrew after deadline	(neutral in GPA calculation)
ILL		Compassionate reasons, illness	(neutral in GPA calculation)

In a graduate course, a final grade below B– will be recorded as an F.

Credits and References

Guidelines for citing sources can be found at tinyurl.com/dal-arch-writing

Academic Integrity

The instructor may search the internet to check originality of uncredited texts and images. Students may use AI tools **providing** they retain the search terms and processes even of preliminary work.

Lecture Notes or Recordings

The instructor will generally upload lecture slides and notes in pdf. form. Students are welcome to record classes, **providing** their classmates agree with the arrangements, and **providing** they send the recording to the instructor for posting on Brightspace. Students may not circulate pdf's or recordings beyond the class.

FACULTY POLICY

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

UNIVERSITY POLICIES AND RESOURCES

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate. For university regulations, go to

<https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=82&chapterid=4741&loadusercredits=False>.

A. University Statements

Academic Integrity

http://www.dal.ca/dept/university_secretariat/academic-integrity.html

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Read more:

[https://www.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/Syllabus_Statement_\(Aug%202015\).pdf](https://www.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/Syllabus_Statement_(Aug%202015).pdf)

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of: a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (NS, NB, PEI, NFLD). Read more: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, proce-

dures exist for formal dispute resolution. Read more:
https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/student-life-policies/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Read more: <http://www.dal.ca/cultureofrespect.html>

Recognition of Mi'kmaq Territory

Dalhousie University acknowledges that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit the office (McCain Building room 3037) or contact the programs at elders@dal.ca or 902-494-6803 (leave a message).

B. University Policies and Programs

- Important Dates in the Academic Year (including add/drop dates):
http://www.dal.ca/academics/important_dates.html
- University Grading Practices: Statement of Principles and Procedures:
https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html
- Scent-Free Program:
<http://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>
- Student Declaration of Absence:
https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/academic-policies/student-absence.html

C. Learning and Support Resources

- General Academic Support – Advising:
https://www.dal.ca/campus_life/academic-support/advising.html
- Fair Dealing Guidelines:
<https://libraries.dal.ca/services/copyright-office/guidelines/fair-dealing-guidelines.html>
- Dalhousie University Library:
<http://libraries.dal.ca>
- Indigenous Students:
https://www.dal.ca/campus_life/communities/indigenous.html
- Black Students:
https://www.dal.ca/campus_life/communities/black-student-advising.html
- International Students:

https://www.dal.ca/campus_life/international-centre.html

- Student Health Services:
https://www.dal.ca/campus_life/health-and-wellness.html
- Counselling:
https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html
- Copyright Office:
<https://libraries.dal.ca/services/copyright-office.html>
- E-Learning website:
<http://www.dal.ca/dept/elearning.html>
- Dalhousie Student Advocacy Services:
<http://dsu.ca/dsas>
- Dalhousie Ombudsperson:
https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html
- Writing Centre:
https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html
- Faculty or Departmental Advising Support: Studying for Success Program:
http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

D. Safety

Faculty of Architecture and Planning Work Safety

For more information on the faculty-level safety framework please visit

<https://www.dal.ca/faculty/architecture-planning/current-students/inside-building/work-safety.html>

For issues you're uncomfortable discussing with Emanuel or that you can't resolve with him, your first point of contact is Faculty Safety Co-Ordinator Regan Southcott:

(902) 489-7332

regan.southcott@dal.ca

Dalhousie Occupational Health and Safety

Safety at the University level is overseen by the Environmental Health and Safety Office: <https://www.dal.ca/dept/safety/documents-policies-procedures.html>

The School's uniform course template identifies two sample pages on this site.

- Biosafety: <http://www.dal.ca/dept/safety/programs-services/biosafety.html>
- Research Laboratory Safety Policy Manual:
<http://www.dal.ca/dept/safety/documents-policies-procedures.html>

REFERENCES

Any required readings will be uploaded to Brightspace. The following optional readings are available through Dal and may be available to remote students via document delivery through their local libraries. The library has also located some titles on line: links are provided accordingly.

Early Systematizations

- Alberti, Leon Battista. 1987. *The Ten Books of Architecture*. New York: Dover.
- Semper, Gottfried. 2011. *The Four Elements of Architecture and Other Writings*. Cambridge: Cambridge University Press.
- Tzonis, Alexander and Liane Lefaivre. 1986. *Classical Architecture: The Poetics of Order*. Cambridge: MIT Press.

Systems Ideas in Art Historical Views of Architecture

- Arnheim, Rudolf. 1978. *The Dynamics of Architectural Form*. Berkeley: University of California Press.
- Ferguson, Francis. 1975. *Architecture, Cities, and the Systems Approach*. New York: George Braziller. [Internet Archive](#)
- Maki, Fumihiko. 1964. *Investigations in Collective Form*. St. Louis: Washington University. [Washington University in St. Louis](#)
- Venturi, Robert. 2002. *Complexity and Contradiction in Architecture*. New York: The Museum of Modern Art [Washington University has a PDF](#)

Building Systems; M and E Systems

- Allen, Edward. 2005. *How Buildings Work*. New York: Oxford University Press. [\(eBook available through Novanet; unlimited users\)](#)
- Bachman, Leonard. 2003. *Integrated Buildings: The Systems Basis of Architecture*. Hoboken: John Wiley and Sons.
- Choudhury, Ifte and J. Trost. 2004. *Design of Mechanical and Electrical Systems in Buildings*. Upper Saddle River: Prentice Pearson Hall.
- Rush, Richard, ed. 1986. *The Building Systems Integration Handbook*. Boston: Butterworth Heinemann.

Construction Management

- Mordue, Stefan, Paul Swaddle, and David Philip. 2015. *Building Information Modelling for Dummies*. New York: Wiley. [\(eBook available through Novanet: 1 user\)](#)
- Rosenfeld, Walter. 1985. *The Practical Specifier*. New York: McGraw-Hill.

Hierarchy Theory

- Ahl, Valerie, and T. F. H. Allen. 1996. *Hierarchy Theory: A Vision, Vocabulary, and Epistemology*. New York: Columbia University Press.
- Koestler, Arthur. 1990. *The Ghost in the Machine*. London: Arkana.
- Pattee, Howard, ed. 1973. *Hierarchy Theory: The Challenge of Complex Systems*. New York: George Braziller.
- Simon, Herbert. 1990. *The Sciences of the Artificial*. Cambridge: MIT Press.

Whyte, Lancelot Law, Albert Wilson, and Donna Wilson. 1969. *Hierarchical Structures*. New York: American Elsevier.

Heterarchy and Homoarchy

Alexander, Christopher: *A City is Not A Tree*. <http://en.bp.ntu.edu.tw/wp-content/uploads/2011/12/06-Alexander-A-city-is-not-a-tree.pdf>

Bondarenko, D.M. 2007. What Is There in a Word? Heterarchy, Homoarchy and the Difference in Understanding Complexity in the Social Sciences and Complexity Studies. In K.A. Richardson and P. Cilliers eds. *Explorations in Complexity Thinking: Pre-Proceedings of the 3rd International Workshop on Complexity and Philosophy*. Mansfield, MA: ISCE Publishing.

McCulloch Warren. 1945. A Heterarchy of Values Determined by the Topology of Nervous Nets". *Bulletin of Mathematical Biophysics*. 7: 89–93,

General Systems Thinking

Emery, F.E. 1981. *Systems Thinking Selected Readings*. Harmondsworth: Penguin. [Internet Archive](#)

Klir, George J. 1969. *An Approach to General Systems Thinking*. New York: van Nostrand Reinhold.

Meadows, Donella. 2008. *Thinking in Systems*. White River Junction: Chelsea Green Publishing. [Internet Archive](#)

Weinberg, Gerald. 2001. *An Introduction to General Systems Thinking - Silver Anniversary Edition*. New York: Dorset House Publishing.

Ecology

Kormondy, Eugene. 1995. *Concepts of Ecology, 4th edition*. Upper Saddle River: Prentice Pearson Hall.

Meadows, Donella. 2008. *Thinking in Systems*. White River Junction: Chelsea Green Publishing. [Internet Archive](#)