



Course Number	ARCH 508	Classroom	PF 2160/Zoom
Course Name	Building Science and Technology 1		
Pre/Co-Requisites	Admission to the Minor in Architectural Studies or the Master of Architecture Programs.		
Instructor	Guy Gardner	Office Hours/Location	by appointment
	Email: gegardne@ucalgary.ca		Phone: 403 471 0183
Class Dates	blended (Tuesdays 9:00AM - 10:30AM In Person, Fridays 9:00AM - 10:30AM Remote. COVID-19 NOTE: From January 10 until February 18 all classes will be conducted on-line. We should resume in-person classes after February 28. All dates and times listed in schedule below require attendance, regardless of modality.		
Instructor Email Policy	Please note that all course communications must occur through your @ucalgary email, and I will respond to emails sent via student's @ucalgary emails within 48 hours.		
Name and Email of Teaching Assistant(s)			

Course Description

"The importance of contemporary building science is often fully appreciated only after the occurrence of building performance problems, or worse, after failures, rather than at the planning and design stage of building projects" (Kesik, 2016).

Building Science and Technology 1 looks at how building physics and material properties can inform the design of buildings. It examines the elements that make up the building enclosure and the conditions affecting their performance. Through case study analysis and explorations of plans, sections and details, the course will explore design principles for enhancing occupant comfort, indoor environmental quality, lighting, acoustics, and energy performance.

<https://www.ucalgary.ca/pubs/calendar/current/architectural-studies.html#38564>)

Course Hours: 3 units;

Online Delivery (If applicable)

This course will take place **online** via Desire2Learn (D2L) and Zoom. Students are required to participate in the asynchronous learning tasks using the D2L learning environment and synchronous Zoom sessions. If unable to participate live due to unforeseen circumstances, inform the instructor in advance to work out an alternative participation activity (e.g., watch the recordings, submit a brief reflection, and actively contribute to the follow-up online discussion).

Course Learning Outcomes

Objectives

1. To introduce principles of building science and the properties of building materials
2. To acquire a basic understanding of the design of building envelope systems
3. To understand the impact of environmental conditions and occupant behaviour on building materials and assemblies
4. To learn to evaluate the condition of building components and identify opportunities to improve their performance.
5. To develop an ability to interpret and describe building assemblies through wall sections and details
6. To gain an understanding of the relationship between building science and technology and building regulations.

Learning Resources

Readings

Canadian Building Digest, Institute for Research in Construction, National Research Council. Volumes 1-250. Free download from:

<https://nrc-publications.canada.ca/eng/home/>

(Type in i.e., CBD48 in "Search for")

Recommended books:

Simmons, H.L., **Olin's Construction: Principles, materials, and methods**. 9th Ed. John Wiley & Sons, Inc. ~\$142.00 U/C bookstore or electronic copy. Might be cheaper to order from Amazon.com or the Used Bookstore. Also available in digital format through the UCalgary Library

Canadian Wood Frame House Construction. Canada Mortgage and Housing Corporation (CMHC). <http://chbanl.ca/wp-content/uploads/CMHC-Canadian-Wood-Frame-House-Construction.pdf>

Technology requirements (D2L etc.):

In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Broadband internet connection

Workshop Safety Training Requirement

If a course requires the use of the SAPL workshop, students must complete all online University of Calgary safety courses, the online Trajectory safety training course, as well as in-person workshop training and a grade of pass on the final evaluation project, to be granted access to the SAPL workshop. This training is offered once a year, around the start of the Fall term and has a completion deadline.

Additional Classroom Conduct and Related Information

Guidelines for Zoom Sessions in Online Classes

Students are expected to participate actively in all Zoom sessions and to turn on their webcam. Please join our class in a quiet space that will allow you to be fully present and engaged in the Zoom sessions. Students must behave in a professional manner during the session. Students, employees, and academic staff are also expected to demonstrate behaviour in class that promotes and maintains a positive and productive learning environment.

Assessment Components

Assessment Method	Description	Weight	Aligned Course Learning Outcome
1. Acoustics Assignment 2,3,4,6		25%	2,3,4,6
2. Team Project: Building Performance Optimization		30%	1,2,3,4,5,6
3. In-Class Presentation		10%	1,2,3,4,5,6
4. In-class Quizzes		25%	1,2,3,4,5,6
5. Weekly Detail Presentation		10%	4,5

Assessment and Evaluation Information

Attendance and Participation Expectations:

Students are required to participate in the asynchronous learning tasks using the D2L learning environment and synchronous Zoom sessions. If unable to participate live due to unforeseen circumstances, inform the instructor in advance to work out an alternative participation activity (e.g., watch the recordings, submit a brief reflection, and actively contribute to the follow-up online discussion).

Guidelines for Submitting Assignments:

Students will be evaluated individually for all assignments. In the case of group assignments, participants will be asked to describe their contribution to the assignment. Projects will be evaluated for completeness, quality and originality.

Assignments should be submitted to D2L Dropbox on or before the due date. Assignments submitted after the deadline will be penalized with the loss of a grade (e.g.: A- to B+). For late submission after one week but not more than 2 weeks late, the loss will be two grades, e.g.: A- to B. Assignments will not be accepted after 3 weeks.

Final Examinations:

N/A

Expectations for Writing (<https://www.ucalgary.ca/pubs/calendar/current/e-2.html>):

Criteria that must be met to pass: Note: Students must submit and pass Assignment 2 in order to receive credit for the course. Final grades will be reported as letter grades, with the final grade calculated according to the 4-point range. Assignment(s) will be evaluated by percentage grades, with their letter grade equivalents as shown.

Grading Scale

Grade	Grade Point Value	4-Point Range	Percent	Description
A+	4.00	4.00	95-100	Outstanding - evaluated by instructor
A	4.00	3.85-4.00	90-94.99	Excellent - superior performance showing comprehensive understanding of the subject matter
A-	3.70	3.50-3.84	85-89.99	Very good performance
B+	3.30	3.15-3.49	80-84.99	Good performance
B	3.00	2.85-3.14	75-79.99	Satisfactory performance
B-	2.70	2.50-2.84	70-74.99	Minimum pass for students in the Faculty of Graduate Studies
C+	2.30	2.15-2.49	65-69.99	All final grades below B- are indicative of failure at the graduate level and cannot be counted toward Faculty of Graduate Studies course requirements.
C	2.00	1.85-2.14	60-64.99	
C-	1.70	1.50-1.84	55-59.99	
D+	1.30	1.15-1.49	50-54.99	
D	1.00	0.50-1.14	45-49.99	
F	0.00	0-0.49	0-44.99	

A student who receives a "C+" or lower in any one course will be required to withdraw regardless of their grade point average (GPA) unless the program recommends otherwise. If the program permits the student to retake a failed course, the second grade will replace the initial grade in the calculation of the GPA, and both grades will appear on the transcript.

CACB Student Performance Criteria

The following CACB Student Performance Criteria will be covered in this course:

Primary:

B8. Environmental Systems, B9. Building Envelopes, B11. Building Materials,

Secondary: A6. Human Behaviour B4. Sustainable Design; C2. Building Systems

Integration; C3. Technical Documentation

Section 1: Fundamentals of Building Science		
Jan 12	Introduction to building science course format and objectives, overview of syllabus, d2l, reading materials Accessibility, safety and building regulations Form teams for weekly detail presentation groups – 15 to 20 topics ASSIGN: Acoustics Assignment (ASSG 1).	Olin's 1.3 Codes. p.16-23 *114 - Safety in Buildings. 135 - Consideration of the Physically Disabled. 200 - Building Technology and Its Use. 237 - The Regulation of Building Construction.
Jan 15	3: Acoustic Principles <i>Guest: Ian Bonsma Acoustic Engineer</i> Sound intensity, transmission loss, absorption, insulation, reflection, reverberation, vibration, and ambient noise.	Olin's 12 Sound Control. p.842-874-(889) Olin's 9.7 Acoustical Treatm't. p.717-730 Olin's 7.2.11 Sound Control. p.1024-1025 10 - Noise Transmission in Buildings. 41 - Sound and People
Jan 19	4: Acoustic Design Principles Design Considerations for Attenuation + Enhancement ZA/SB - Tutorial on Pachyderm	51 - Sound Insulation in Office Buildings. *92 - Room Acoustics - for Listening. 139 - Acoustical Design of Open-Planned Office 173 - Floor Vibrations. *232 - Vibrations in Buildings *236 - Introduction to Building Acoustics. 239 - Factors Affecting Sound Transm'n 240 - Sound Transmission - Windows.
Jan 22	QUIZ: ACOUSTICS 2: Principles of Building Science Understanding the functions and durability of the building enclosure as it relates to Indoor Environmental Quality, Human Factors, Ergonomics, Climate, Performance, Acoustics, Light, Thermal Considerations, Air Quality, Privacy + Safety	*48 - Requirements for Exterior Walls. *30 - Water and Building Materials. *56 - Thermal and Moisture Deform'n Bldg. *115 - Performance of Building Materials. *120 - Design and Service Life.
Jan 26	5: -Environmental Conditions Weather, Temperature, solar radiation, sol-air effects, wind, precipitation, snow loads, drifting, humidity, atmospheric, fire, toxins, pollutants. RADON, Ozone, CO, CO ₂	Olin's 16 HVAC. p.956-995 *14 - Weather and Building. 28 - Wind on Buildings. 37 - Snow Loads on Roofs. *47 - Extreme Temp. Outer Surfaces of Bldgs. 121 - Irradiation Effects on Organic Mtls. 122 - Radiation and other Weather Factors. 126 - Influence of Orientation on Ext.

		Cladding. 146 - Control of Snow Drifting about Bldgs. *155 - Joint Movement and Sealant Selection. 170 - Atmospheric Corrosion of Metals. *247 - Control of Radon in Houses
Jan 29	-Impact of Water Intrusion water intrusion, water vapor, – staining, occupant health implications, remediation strategies	Olin's 7.1 Moisture Ctrl. p.427-443 *1 - Humidity in Canadian Buildings. *42 - Humidified Buildings. *72 - Control of Air Leakage is Important. 83 - Indoor Swimming Pools.
Feb 2	-Water Vapor, condensation and freezing –relative humidity, dewpoint, diffusion, vapor retardants, air barriers, psychrometry, sublimation	*57 - Vapour Diffusion and Condensation. 175 - Vapour Barriers: What are they? effective? *231 - Moisture Problems in Houses.
Feb 5	Heat flow + Thermal Considerations <i>Guest: Mike Lasby, Morisson Herschfield</i> Modes of heat transfer, heating load, ground temperatures, thermal bridges, resistance, thermal gradient, heat loss calculations; insulation materials.	Olin's 7.3 Insulation. p.443-457 *16 - Thermal Insulation in Dwellings. *149 - Thermal Resistance of Building Insulation. 178 - Fire and Plastic Foam Insulation Materials 218 - Effects of Insulation on Fire Safety.
Feb 9	Air Flow and Stack effect Wind pressure, wind tunnel effect, stack effect	34 - Wind Pressures on Buildings. *104 - Stack Effects in Buildings. *107 - Stack Effects in Building Design. *174 - Ground Level Winds Around Tall Bldgs. 245 - Mechanical Ventilation and Air Pressure.
Feb 12	QUIZ: FUNDAMENTALS, WATER INTRUSION/WATER VAPOR Comfort + human factors IAQ, psychrometrics, Condition of thermal neutrality, temperature, air flow, radiation, humidity; comfort zones, variability with age and sex; adaptation, light, colour and noise, work and metabolism; conduction, convection evaporation and perspiration. Acoustics assignment review (time permitting)	*102 - Thermal Environment and Human Comfort. *199 - Air Ions and Human Comfort. *110 - Ventilation and Air Quality. *222 - Airtight Houses and CO Poisoning.
Feb 16	No classes – term break	
Feb 19	No classes – term break	
Section 2: Materials and Methods		
Feb 23	Glass/Composites <i>Guest: Laura Little – Goldray Glass</i>	Olin's 8.5 Glazed Curtain Wall p.583- 615 Olin's 8.10 Glazing. p.615-633 *30 - Water and Building Materials. *85 - Some Basic Characteristics of Wood. *86 - Some Implications Properties of Wood. *111 - Decay of Wood.
Feb 26	Wood / Metal	Olin's 6.0 Wood. p.316-413 *115 - Performance of Building Materials. 117 - Weathering of Organic Materials.

	<p>Dimensional changes, durability, strength seasoning, types of wood, decay, preservatives, fire protection, log enclosures, PWF, CLT, wood frame, Engineered floor and roof systems, SIP and panelized wall systems, FSC + SFI certification –</p> <p>Acoustic Assignment Due (25%)</p>	<p>124 - Biological Attack on Organic Materials. 130 - Wetting and Drying of Porous Materials. *224 - Deterioration of Indoor Parking Garages. Olin's 5.0 Metals. p.248-312</p>
Mar 2	<p>Concrete/ Masonry <i>Guest: Mark Hagel, AMA</i></p>	<p>Olin's 3.0 Concrete. p.68-147 *15 - Concrete. *103 - Admixtures in Portland Cement Concrete. *116 - Durability of Concrete Under Winter Condition. 136 - Concrete in Sulphate Environments. 223 - Fibre reinforced Concrete.</p>
Mar 5	<p>Envelope Optimization <i>Guest: David Leonard, Entuitive</i></p> <p>- Building forensics pertaining to building envelopes, mechanisms for failure and remediation. Design strategies for durability and optimal performance. Fire and the building envelope. Fireproofing</p> <p>ASSIGN: Team Projects (Building failures).</p>	<p>Olin's 4.0 Masonry. p.152-243 *2 - Efflorescence. 6 - Rain Penetration of Walls of Unit Masonry. 123 - Cold Weather Masonry Construction. 131 - Coatings For Masonry Surfaces. 138 - On Using Old Bricks in New Bldgs. 169 - Bricks. *194 - Cleaning of Brickwork.</p>
Mar 9	<p>Wall, Window + Door Design Code requirements, materials, energy transmissions, absorption, types, condensation, thermal breaks, and hardware</p>	<p>Olin's 7.7 Siding. p.502-521 Olin's 7.9.2 Wall Flashing. p.537-540 *6 - Rain Penetration of Walls of Masonry Units *21 - Cavity Walls. 97 - Look at Joint Performance 125 - Cladding Problems Due to Frame... *20 - Corrosion in Buildings. 98 - Coatings for Exterior Metals.</p> <p>*4 - Condensation on Inside Window *5 - Condensation Panes of Dble Windows 39 - Solar Heat Gain through Glass Walls. 46 - Factory-Sealed Double-Glazing Units. 55 - Glazing Design. 58 - Thermal Characteristics of Dble Windows. *60 - Characteristic of Window Glass. *101 - Reflective Glazing Units. 240 - Sound Transmission - Windows.</p>
Mar 12	<p>Roof Design Principles <i>Guest: Stephen Epp, RJC</i></p>	<p>Olin's 7.6 Steep-Slope Roofing. p.458-502 Olin's 7.8 Membrane Roofing Sys. p.521-5 roof membranes. 537</p>

	Insulation and waterproofing, Drainage, ice dams, roof cladding types, inverted roof membranes	Olin's 7.10 Metal Roofing. p.540-545 65 - Mineral Aggregate Roof Surfacing. 67 - Fundamentals of Roof Design. *73 - Moisture Considerations in Roof Design. *89 - Ice on Roofs. *99 - Application of Roof Design Principles. 112 - Designing Wood Roofs Prevent Decay. *150 - Protected-Membrane Roofs. *151 - Drainage from Roofs. 176 - Venting of Flat Roofs. 228 - Sliding Snow on Sloping Roofs. 235 - Single-ply Roofing Membranes.
Mar 16	SAPL block week – no classes	
Mar 19	SAPL block week – no classes	
Section 3: High Performance Design		
Mar 23	Energy modelling and the NECB <i>Guest: Ben Francis, Red Pelican Building Science</i>	NRCAN: Keeping the Heat In. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/housing/Keeping%20the%20Heat%20In_e%20.pdf
Mar 26	Circular Economies and Building Science <i>Guests: Hayden Patullo</i> Passivehouse Design Principles <i>Guest: Oscar Fleschas, Passivehouse</i>	Building A Circular Future Olin's 7.12 Fireproofing. p.545-548 *36 – Temp. Gradient thro Bldg. Envelopes 209 - Energy Conservation Exist'g Bldg. *142 - Space Heating and Energy Conservation.
Mar 30	Prefabricated construction techniques <i>Guest: Sol Aasland, ATCO structures</i> Modular and Flat-pack off-site construction methods, Code requirements, transportation and on-site assembly considerations	"Introduction" PREFAB ARCHITECTURE: A GUIDE TO MODULAR DESIGN AND CONSTRUCTION Ryan E. Smith
April 2	Good Friday, no classes	
April 6	STUDENT PRESENTATIONS (10 minutes + 2min q+a)	
April 9	STUDENT PRESENTATIONS (10 minutes + 2min q+a)	
April 13	STUDENT PRESENTATIONS (10 minutes + 2min q+a)	
April 15	Assignment 2 Report Due (30%)	

Guidelines for Zoom Sessions

Zoom is a video conferencing program that will allow us to meet at specific times for a “live” video conference, so that we can have the opportunity to meet each other virtually and discuss relevant course topics as a learning community.

To help ensure Zoom sessions are private, do not share the Zoom link or password with others, or on any social media platforms. Zoom links and passwords are only intended for students registered in the course. Zoom recordings and materials presented in Zoom, including any teaching materials, must not be shared, distributed or published without the instructor's permission.

The use of video conferencing programs relies on participants to act ethically, honestly and with integrity; and in accordance with the principles of fairness, good faith, and respect (as per the [Code of Conduct](#)). When entering Zoom or other video conferencing sessions (such as MS Teams), you play a role in helping create an effective, safe and respectful learning environment. Please be mindful of how your behaviour in these sessions may affect others. Participants are required to use names officially associated with their UCID (legal or preferred names listed in the Student Centre) when engaging in these activities.

Instructors/moderators can remove those whose names do not appear on class rosters. Non-compliance may be investigated under relevant University of Calgary conduct policies (e.g. [Student Non-Academic Misconduct Policy](#)). If participants have difficulties complying with this requirement, they should email the instructor of the class explaining why, so the instructor may consider whether to grant an exception, and on what terms. For more information on how to get the most out of your zoom sessions visit:

<https://elearn.ucalgary.ca/guidelines-for-zoom/>

If you are unable to attend a Zoom session, please contact your instructor in advance to arrange an alternative activity for the missed session (e.g., to review the recorded session). Please be prepared, as best as you are able, to join class in a quiet space that will allow you to be fully present and engaged in Zoom sessions. Students will be advised by their instructor when they are expected to turn on their webcam (for group work, presentations, etc.).

The instructor may record online Zoom class sessions for the purposes of supporting student learning in this class – such as making the recording available for review of the session or for students who miss a session. Students will be advised before the instructor initiates a recording of a Zoom session. These recordings will be used to support student learning only and will not be shared or used for any other purpose.

Special Budgetary Requirements

nil

University of Calgary Policies and Supports

COVID-19 PROCEDURE FOR SICK STUDENTS: <https://ucalgary.ca/risk/sites/default/files/Covid-19%20Folder/COVID-19-Procedure-for-Sick-Students.pdf>

ACADEMIC ACCOMMODATION

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The student accommodation policy can be found at: <https://www.ucalgary.ca/legal-services/university-policies-procedures/student-accommodation-policy>

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: <https://www.ucalgary.ca/legal-services/university-policies-procedures/accommodation-students-disabilities-procedure>

Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to their instructor (contact information on first page above).

SAS will process the request and issue letters of accommodation to instructors. For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/ .

ACADEMIC MISCONDUCT

Academic Misconduct refers to student behavior which compromises proper assessment of a student's academic activities and includes: cheating; fabrication; falsification; plagiarism; unauthorized assistance; failure to comply with an instructor's expectations regarding conduct required of students completing academic assessments in their courses; and failure to comply with exam regulations applied by the Registrar.

For information on the Student Academic Misconduct Policy and Procedure please visit:

<https://ucalgary.ca/policies/files/policies/student-academic-misconduct-policy.pdf>

<https://ucalgary.ca/policies/files/policies/student-academic-misconduct-procedure.pdf>

Additional information is available on the Academic Integrity Website

at <https://ucalgary.ca/student-services/student-success/learning/academic-integrity>.

COPYRIGHT LEGISLATION:

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (www.ucalgary.ca/policies/files/policies/acceptable-use-of-material-protected-by-copyright.pdf) and requirements of the copyright act (<https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html>) to ensure they are aware of the consequences of unauthorised sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy (<https://www.ucalgary.ca/pubs/calendar/current/k.html>).

INSTRUCTOR INTELLECTUAL PROPERTY

Course materials created by instructors (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the instructor. These materials may NOT be reproduced, redistributed or copied without the explicit consent of the instructor. The posting of course materials to third party websites such as note-sharing sites without permission is prohibited. Sharing of extracts of these course

materials with other students enrolled in the course at the same time may be allowed under fair dealing.

FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY

Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary.

SEXUAL VIOLENCE POLICY

The University recognizes that all members of the University Community should be able to learn, work, teach and live in an environment where they are free from harassment, discrimination, and violence. The University of Calgary's sexual violence policy guides us in how we respond to incidents of sexual violence, including supports available to those who have experienced or witnessed sexual violence, or those who are alleged to have committed sexual violence. It provides clear response procedures and timelines, defines complex concepts, and addresses incidents that occur off-campus in certain circumstances. Please see the policy available at <https://www.ucalgary.ca/policies/files/policies/sexual-violence-policy.pdf>

UNIVERSITY STUDENT APPEALS OFFICE: If a student has a concern about a grade that they have received, they should refer to Section I of the Undergraduate Calendar (<https://www.ucalgary.ca/pubs/calendar/current/i-3.html>) which describes how to have a grade reappraised.

OTHER IMPORTANT INFORMATION

Please visit the Registrar's website at:

<https://www.ucalgary.ca/registrar/registration/course-outlines> for additional important information on the following:

- Wellness and Mental Health Resources
- Student Success
- Student Ombuds Office
- Student Union (SU) Information
- Graduate Students' Association (GSA) Information
- Emergency Evacuation/Assembly Points
- Safewalk