



<b>Course Title: Building Science &amp; Technology I</b>			
Course Number	ARST 449 ~ EVDA 511		
Pre/Co-Requisites			
Instructor Name	Guy Gardner	Email	gegardne@ucalgary.ca
Office Location	CBDL main floor		
TA Name	Karan Sharma	TA Email	Karan.Sharma@ucalgary.ca
Class Dates	Winter 2020, T/TH		
Class Times	9:00am to 10:30am		
Class Location	PF2160		

### Course Information / Description of the Course

"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 the principles of building science and the properties of building materials 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 wall sections and building details the course will explore design principles for enhancing occupant comfort, lighting, acoustics, indoor environmental quality and energy performance.

### 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**. 9<sup>th</sup> 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.

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

## Course Learning Outcomes

### Objectives

1. Introduction to 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.

## Assessment Components

Assessment Method	Description	Weight	Aligned Course Learning Outcome
1. Acoustics Assignment		25%	2,3,4,6
2. Team Project: Building Performance Optimization		25%	1,2,3,4,5,6
3. In-Class Presentation		15%	1,2,3,4,5,6
4. In-class Quizzes		25%	1,2,3,4,5,6
5. Weekly Detail Presentation		10%	4,5
6. Wall section Assignment			

## Assessment and Evaluation Information

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. Work submitted late will lose 10% points per day at the discretion of the instructor.

Note: Students must submit and pass Assignment 2 in order to receive credit for the course.

**Registrar-scheduled Final Examination:** No

### Policy for Late Assignments

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.

### Grading Scale

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.

### (for Architecture courses only) CACB Student Performance Criteria

The following CACB Student Performance Criteria will be covered in this course at a primary level (other criteria will be covered at a secondary level):

**Primary:**

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

**Secondary:** A6. Human Behaviour; B3. Site Design; B4. Sustainable Design; B6. Life Safety Systems, etc.; C2. Building Systems Integration; C3. Technical Documentation

### Topic Areas & Detailed Class Schedule

Course Schedule Date	Topic	Assignments/Due Dates
January 14	<p><b>Introduction to building science,</b></p> <ul style="list-style-type: none"> <li>• course format and objectives , overview of syllabus and d2l, reading materials</li> <li>• Accessibility, safety and building regulations</li> <li>• Divide students into weekly detail presentation groups – 15 to 20 topics</li> <li>• ASSIGN: Acoustics Assignment.</li> </ul>	<p>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.</p>
January 16	<p><b>3: Acoustic Principles</b>            Sound intensity, transmission loss, absorption, insulation, reflection, reverberation, vibration, and ambient noise.</p> <p><i>Guest: Ian Bonsma Acoustic Engineer</i></p>	<p>Olin's 12 Sound Control. p.842-874-(889)            Olin's 9.7 Acoustical Treatment. p.717-730            Olin's 7.2.11 Sound Control. p.1024-1025            10 - Noise Transmission in Buildings.            41 - Sound and People</p>
January 21	<p><b>4: Acoustic Design Principles</b>            Design Considerations for Attenuation + Enhancement</p> <p>KS - Tutorial on Pachyderm</p>	<p>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 Transmission            240 - Sound Transmission - Windows.</p>
January 23	<p><b>2: Principles of Building Science</b></p>	<p>*48 - Requirements for Exterior Walls.            *30 - Water and Building Materials.</p>

	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	*56 - Thermal and Moisture Deform'n Bldg. *115 - Performance of Building Materials. *120 - Design and Service Life.
January 28	<b>5: -Environmental Conditions</b> Weather, Temperature, solar radiation, sol-air effects, wind, precipitation, snow loads, drifting, humidity, atmospheric, fire, toxins, pollutants. RADON, Ozone, CO, CO <sub>2</sub>	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
January 30	<b>-Impact of Water Intrusion</b> 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.
February 4	<b>-Water Vapor, condensation and freezing</b> -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.
February 6	<b>Comfort + human factors</b> 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.  <i>Alex Tansowny?</i>	*102 - Thermal Environment and Human Comfort. *199 - Air Ions and Human Comfort. *110 - Ventilation and Air Quality. *222 - Airtight Houses and CO Poisoning.

February 11	<b>Heat flow + Thermal Considerations</b> <i>Guest: Dr. Caroline Hachem</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.
February 13	KS – tutorial on Thermal bridging, therm, wufi  Energy modelling – sol, Kim, Jesse  <b>Quiz – psychrometrics and heat flow</b>  Acoustics assignment review and work periods -	
February 18	No classes – term break	
February 20	No classes – term break <b>Monday Feb 24<sup>th</sup> Acoustic Assignment Due (25%)</b>	
February 25	<b>Circular Economies and Building Science</b>  <i>Guests: Hayden Patullo and Kristen Forward</i>	In Class Readings In Class Readings
February 27	Guest Le Oscar Fleschas, <i>Passivehouse</i> <b>Air Flow and Stack effect</b> Wind pressure, wind tunnel effect, stack effect ecture TBD	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.
March 3	<b>Envelope Optimization</b>  - Building forensics pertaining to building envelopes, mechanisms for failure and remediation. Design strategies for durability and optimal performance. Fire and the building envelope. Fireproofing <i>Guest: David Leonard, Entuitive</i>  ASSIGN: Team Projects (Building failures).	In Class Readings
March 5	<i>Guest: David Silburne, GBT</i>  Drawing review - Quiz – building envelope , thermal bridge, etc	
March 10	SAPL block week – no classes	

March 12	SAPL block week – no classes	
March 17	<p><b>Wood</b></p> <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><b>Metal</b></p>	<p>Olin's 6.0 Wood. p.316-413</p> <p>*30 - Water and Building Materials.</p> <p>*85 - Some Basic Characteristics of Wood.</p> <p>*86 - Some Implications Properties of Wood.</p> <p>*111 - Decay of Wood.</p> <p>*115 - Performance of Building Materials.</p> <p>117 - Weathering of Organic Materials.</p> <p>124 - Biological Attack on Organic Materials.</p> <p>130 - Wetting and Drying of Porous Materials.</p> <p>*224 - Deterioration of Indoor Parking Garages.</p> <p>Olin's 5.0 Metals. p.248-312</p>
March 19	<p><b>Concrete</b></p> <p>Cements, mixtures, admixtures, joints, curing, precast, reinforcing, and corrosion.</p> <p><b>Glass Composites</b></p>	<p>Olin's 3.0 Concrete. p.68-147</p> <p>*15 - Concrete.</p> <p>*103 - Admixtures in Portland Cement Concrete.</p> <p>*116 - Durability of Concrete Under Winter Condition.</p> <p>136 - Concrete in Sulphate Environments.</p> <p>223 - Fibre reinforced Concrete.</p>
March 24	<p><b>Masonry</b></p> <p>Efflorescence, weep holes, flashings</p> <p><i>Guest: Mark Hagel, Alberta</i></p>	<p>Olin's 4.0 Masonry. p.152-243</p> <p>*2 - Efflorescence.</p> <p>6 - Rain Penetration of Walls of Unit Masonry.</p> <p>123 - Cold Weather Masonry Construction.</p> <p>131 - Coatings For Masonry Surfaces.</p> <p>138 - On Using Old Bricks in New Bldgs.</p> <p>169 - Bricks.</p> <p>*194 - Cleaning of Brickwork.</p>
March 26	<p><b>Wall Design</b></p> <p>Openings, kinetic energy, pressures, ventilation of cavities, rain screen principles, Cladding types, drainage, joints, capillary action, Stucco+ EIFS</p> <p><b>Roof Design Principles</b></p> <p>Insulation and waterproofing, Drainage, ice dams, roof cladding types, inverted roof membranes</p>	<p>Olin's 7.7 Siding. p.502-521</p> <p>Olin's 7.9.2 Wall Flashing. p.537-540</p> <p>*6 - Rain Penetration of Walls of Masonry Units</p> <p>*21 - Cavity Walls.</p> <p>97 - Look at Joint Performance.</p> <p>125 - Cladding Problems Due to Frame...</p> <p>*20 - Corrosion in Buildings.</p> <p>98 - Coatings for Exterior Metals.</p> <p>Olin's 7.6 Steep-Slope Roofing. p.458-502</p>

		<p>Olin's 7.8 Membrane Roofing Sys. p.521-5  roof membranes. 537  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.</p>
<p>March 31</p>	<p><b>Window + Door Design</b>  Code requirements, materials, energy transmissions, absorption, types, condensation, thermal breaks, and hardware</p> <p><b>Prefabricated construction techniques</b>  <i>Guest: Alex Tansowny</i></p> <p>Modular and Flat-pack off-site construction methods, Code requirements, transportation and on-site assembly considerations</p> <p>Green Building Tech?</p>	<p>Olin's 8.5 Glazed Curtain Wall p.583-615  Olin's 8.10 Glazing. p.615-633  *4 - Condensation on Inside Window  *5 - Condensation Panes of Dble  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>
<p>April 2</p>	<p><b>Energy Performance Optimization</b>  <i>Guest: John Souleles</i></p> <p>Passive and Active Solar Design, high performance building components and assemblies, Energy Modelling, Verification, Codes and Standards</p>	<p>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.</p>
<p>April 7</p>	<p>STUDENT PRESENTATIONS (10 minutes + 2min q+a)</p>	
<p>April 9</p>	<p>STUDENT PRESENTATIONS (10 minutes + 2min q+a)</p>	
<p>April 14</p>	<p>STUDENT PRESENTATIONS (10 minutes + 2min q+a)</p>	



## Media and Recording in Learning Environments

### Part 1

University Calendar: <https://www.ucalgary.ca/pubs/calendar/current/e-6.html>

Recording of lectures (other than audio recordings that are pre-arranged as part of an authorized accommodation) is not permitted.

Students may not record any portion of a lecture, class discussion or course-related learning activity without the prior and explicit written permission of the course instructor or authorization from Student Accessibility Services. For any other use, whether by duplication, transcription, publication, sale or transfer of recordings, written approval must be obtained from the instructor for the specific use proposed. Any use other than that described above constitutes academic misconduct and may result in suspension or expulsion.

### Part 2

The instructor may use media recordings to capture the delivery of a lecture.

The instructor will notify all students and guests in the class that the event is being recorded. If a student or guest wants to take steps to protect privacy, and does not want to be recorded, the instructor will provide the individual (s) with an alternative means of participating and asking questions (e.g., passing written notes with questions). Students cannot be penalized for choosing not to be recorded in situations where participation is part of the course. Students must be offered other ways of earning participation credit that do not involve recording.

Any video-recording would be intended to only capture the instructor and the front of the classroom. Students/other participants would not necessarily be visible on video recordings.

## Special Budgetary Requirements

nil

## University of Calgary Policies and Supports

### ACADEMIC ACCOMMODATION

Students seeking an accommodation based on disability or medical concerns should contact Student Accessibility Services; 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/](http://www.ucalgary.ca/access/). Students who require an accommodation in relation to their coursework based on a protected ground other than disability should communicate this need in writing to their Instructor. The full policy on Student Accommodations is available at <http://www.ucalgary.ca/policies/files/policies/student-accommodation-policy.pdf>.

### ACADEMIC MISCONDUCT

Plagiarism involves submitting or presenting work in a course as if it were the student's own work done expressly for that particular course when, in fact, it is not. Most commonly

plagiarism exists when: (a) the work submitted or presented was done, in whole or in part, by an individual other than the one submitting or presenting the work, (b) parts of the work are taken from another source without reference to the original author, (c) the whole work (e.g., an essay) is copied from another source, and/or, (d) a student submits or presents work in one course which has also been submitted in another course (although it may be completely original with that student) without the knowledge of or prior agreement of the instructor involved. While it is recognized that scholarly work often involves reference to the ideas, data and conclusions of other scholars, intellectual honesty requires that such references be explicitly and clearly noted. Plagiarism is an extremely serious academic offence. Any suspicion of plagiarism will be reported to the Dean, and dealt with as per the regulations in the University of Calgary Graduate Calendar.

For information on academic misconduct and its consequences, please see the University of Calgary Calendar at <http://www.ucalgary.ca/pubs/calendar/current/k.html>

#### **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](http://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.

#### **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.

**UNIVERSITY STUDENT APPEALS OFFICE:** If a student has a concern about the course, academic matter, or a grade that they have been assigned, they must first communicate this concern with the instructor. If the concern cannot be resolved with the instructor, the student can proceed with an academic appeal, which normally begins with the Faculty.

<https://ucalgary.ca/student-appeals/>

**More student support and resources (e.g. safety and wellness) can be found here:**

<https://www.ucalgary.ca/registrar/registration/course-outlines>