Building Science & Technology I ***EVDA 511/ARST 449 H(3-0)***

Tang G. Lee, Course Manager ***Winter 2018***
lee@ucalgary.ca 403-220-6608
PFA-3194, hours by appointment

Teaching Assistant: David Matthew Schiwy Email: dmschiwy@ucalgary.ca
Classroom: T&R 9:30-10:50, room PF 2160

Introduction
Function of the building enclosure: demonstration of the behaviour of building elements and their sub-assemblies under differential temperature and pressure stresses; fundamentals of acoustics; nature and use of building materials; response of building materials to climatic cycles radiation, precipitation, heating and cooling. Credit for both EVDA 511 and Architectural Studies 449 will not be allowed.

This course is an introduction to building science principles and properties of materials. It will enable students to recognise factors which affect the performance of the building enclosure, and predict the probable service life of the assemblies.

The course stresses an understanding of building elements and their sub-assemblies under absolute and differential temperature and pressure stresses, and hygrometric condition. The course deals with functions of building enclosures, occupant comfort and building materials. Design principles for optimizing lighting, acoustics, indoor air quality and thermal comfort are presented in the form of case studies and best practices.

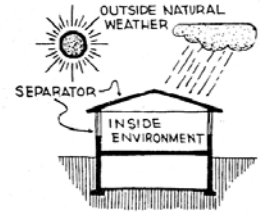
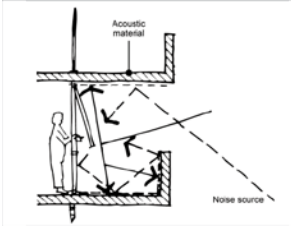
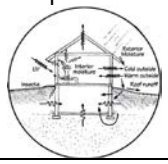
Also included are properties of building materials and their performance when subjected to cyclic conditions and stresses. Finally, specific parts of the building enclosure such as windows and roofs are analysed to determine its design principles.

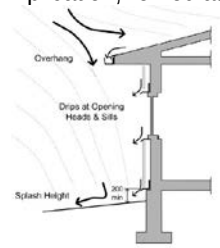
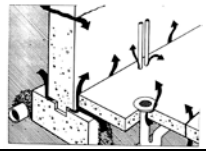
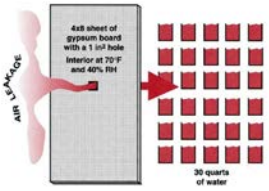
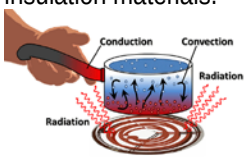
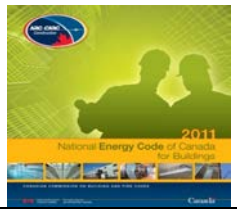
Objectives
1. Introduction to principles of building science and its importance to contemporary practice.
2. To acquire a basic understanding of building enclosures as environmental barriers.
3. To understand the behaviour of building elements and their assemblies under differential temperature and pressure stresses.
4. To acquire an understanding of the function, properties, costs, durability, availability and visual performance of materials.
5. To develop a capability to understand the responses of building materials to climatic cycles -- radiation, precipitation, heating and cooling through a systematic analysis of various assemblies in differing contexts.
6. To understand the implication of building regulations and codes governing the selection and arrangement of building materials.

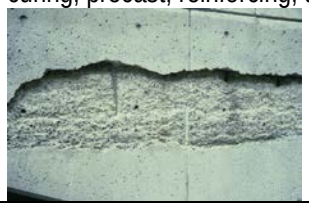
Teaching Approach
The course will be presented in the lecture mode, with extensive use of diagrams, illustrations and slides. The students must clearly understand the connection between building science principles and professional practice. Several case studies involving the diagnostics of building assemblies are presented to help illustrate these principles.

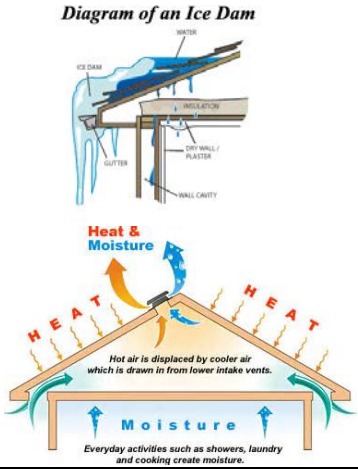
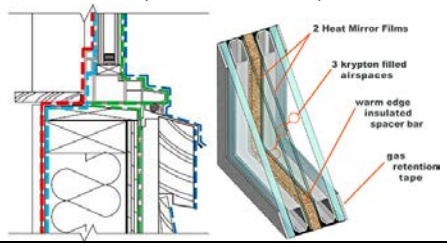
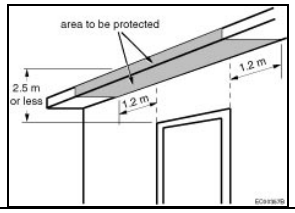
Students are expected to devote at least nine hours per week for readings and preparing the assignments.

Content: Topic Areas & Detailed Class Schedule

	COURSE SCHEDULE		
Class	**DATE**	**TOPIC**	**READINGS CBD ***
1	Jan 9	INTRODUCTION, BUILDING REGULATIONS The study of building science and technology, course format, objectives, reading materials; architectural practices and building regulations; and principles of building science. ASSIGN: Acoustics Assignment.	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.
2 & 3	Jan 11	FUNCTIONS OF THE BUILDING ENCLOSURE Building systems; role and definition of the designer, "performance"; design constraints; DESIGN AND SERVICE LIFE - DURABILITY Mechanisms to break down and decompose materials, controls of these mechanisms; matching material properties to function.	*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. 
4A & 4B	Jan 16 & Jan 18	ARCHITECTURAL ACOUSTICS 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 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.
5	Jan 23	ENVIRONMENTAL CONDITIONS Temperature, solar radiation, sol-air effects, wind, precipitation, humidity, atmospheric pollutants. COMFORT/ IAQ 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. 	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.

6	Jan 25	IMPACT OF WATER INTRUSION Design and workmanship failure; water staining, water damages, occupant health implication; remediation strategies. 	*102 - Thermal Environment and Human Comfort. *199 - Air Ions and Human Comfort. *110 - Ventilation and Air Quality. *222 - Airtight Houses and CO Poisoning. *247 - Control of Radon in Houses RADON MITIGATION 
7	Jan 30	AIR FLOW AND 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.
8	Feb 1	THERMAL CONSIDERATIONS AND HEAT FLOW 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.
9	Feb 6	ENERGY CODE OF CANADA FOR BUILDINGS 	*36 – Temp. Gradient thro Bldg. Envelopes *44 - Thermal Bridges in Buildings. 70 - Thermal Considerations in Roof Design. 105 - Heating and Cooling Requirements. *142 - Space Heating and Energy Conservation. 209 - Energy Conservation Exist'g Bldg.
10	Feb 8 & 13	WATER VAPOUR, CONDENSATION AND FREEZING Relative humidity, dewpoint, diffusion, vapour retardants, air barriers, psychometry, sublimation. 	Olin's 7.1 Moisture Crtl. p.427-443 *1 - Humidity in Canadian Buildings. *42 - Humidified Buildings. *57 - Vapour Diffusion and Condensation. *72 - Control of Air Leakage is Important. 83 - Indoor Swimming Pools. 175 - Vapour Barriers: What are they? effective? *231 - Moisture Problems in Houses.
	Feb 15	Mid-term review – Project collaboration	
-	Feb 18-23	Block/Reading Week – classes cancelled	
-	Feb 25	DUE: Acoustics @ midnight (25%)	

11	Feb 27	BUILDING ENVELOPE FAILURES Building forensics pertaining to building envelopes, mechanisms for failure and remediation. Design strategies for durability and optimal performance. ASSIGN: Team Projects (Building failures).	
12 13	Mar 1	PROPERTIES OF MATERIALS (WOOD) Dimensional changes, durability, strength seasoning, types of wood, decay, preservatives, fire protection, log enclosures, PWF  PROPERTIES OF MATERIALS (METALS)	Olin's 6.0 Wood. p.316-413 *30 - Water and Building Materials. *85 - Some Basic Characteristics of Wood. *86 - Some Implications Properties of Wood. *111 - Decay of Wood. *115 - Performance of Building Materials. 117 - Weathering of Organic Materials. 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
14	Mar 6	PROPERTIES OF MATERIALS (CONCRETE) Cements, mixtures, admixtures, joints, curing, precast, reinforcing, and corrosion. 	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.
15	Mar 8	PROPERTIES OF MATERIALS (MASONRY) Efflorescence, weep holes, flashings 	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.
16	Mar 13	WALL DESIGN PRINCIPLES Openings, kinetic energy, pressures, ventilation of cavities, rain screen principles, joints, capillary action, CLADDING Stucco, EIFS 	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.
17	Mar 15	ROOF DESIGN PRINCIPLES Drainage, ice dam, waterproofing, inverted	Olin's 7.6 Steep-Slope Roofing. p.458-502 Olin's 7.8 Membrane Roofing Sys. p.521-

		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 Wd 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.
18	Mar 20	WINDOW DESIGN PRINCIPLES AND SOLAR Code requirements, materials, energy transmissions, absorption, types, condensation, thermal breaks, and hardware 	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.
19	Mar 22	**FIRE AND THE BUILDING ENVELOPE** 	Olin's 7.12 Fireproofing. p.545-548 
20	Mar 27	STRUCTURALLY INSULATED PANEL (SIP) Code requirements, materials, thermal properties, fire-resistant, mould resistant, durability, thermal breaks, and MgO boards.	
	Mar 29, Apr 3, 5 & 10	Student Presentations (10%)	13 minutes + 2 minutes Q&A
14	Apr 12	EXAM REVIEW DUE: Building Failure Assignment @ midnight (30%)	(Apr. 12 last day classes)
15	Apr 17	EXAM (35%)	9:30-11:00 Rm. 2160

LEGEND *CBD = Essential readings (must read and understand).

Means of Evaluation

The EVDS standard grading scale will be used in all evaluations for this course.

1) Acoustics Assignment 25%
2) Team Project: Building Failures 30%

Class presentation 10%
3) Final Exam (Registrar-scheduled final exam) 35%
Total 100%

Final grades will be reported as letter grades, with the final grade calculated according to the 4-point range. All assignments will be evaluated by their letter grade equivalents as shown.

Registrar-scheduled Final Examination: Yes.

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
Faculty shall use the following methods for reporting grades and for determining final grades. Final grades shall be reported as letter grades, with the grade point value as per column 2. Final grades shall be calculated according to the 4-point range in column 3. Should faculty members evaluate any individual exams or assignments by percentage grades, the equivalents shown in column 4 shall be used.

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	

Notes:

- 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.

Readings
Canadian Building Digest, Institute for Research in Construction, National Research Council. Volumes 1-250. Free download from:
http://nparc.cisti-icist.nrc-cnrc.gc.ca/eng/search/?m=1&q=Canadian+Building+Digest&fc=%2Bgn%3Ais&fc=%2Bhte%3ACanadian+Building+Digest
(Type in i.e., CBD48 in "Search for")

Recommended book: 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.

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

Special Budgetary Requirements – Nil

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

Notes:

1. Written work, term assignments and other course related work may only be submitted by e-mail if prior permission to do so has been obtained from the course instructor. Submissions must come from an official University of Calgary (ucalgary) email account.
2. Academic Accommodations. Students who require 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 or the designated contact person in EVDS, Jennifer Taillefer (jtaillef@ucalgary.ca). Students who require an accommodation unrelated to their coursework or the requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Vice-Provost (Student Experience). For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/
3. Plagiarism - 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 (this includes having another impersonate the student or otherwise substituting the work of another for one's own in an examination or test),(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. It is recognized that clause (d) does not prevent a graduate student incorporating work previously done by him or her in a thesis. Any suspicion of plagiarism will be reported to the Dean, and dealt with as per the regulations in the University of Calgary Graduate Calendar.
4. Information regarding the Freedom of Information and Protection of Privacy Act (http://www.ucalgary.ca/secretariat/privacy) and how this impacts the receipt and delivery of course material
5. Emergency Evacuation/Assembly Points (http://www.ucalgary.ca/emergencyplan/assemblypoints)
6. Safewalk information (http://www.ucalgary.ca/security/safewalk)
7. Contact Info for: Student Union (http://www.su.ucalgary.ca/page/affordability-accessibility/contact); Graduate Student representative(http://www.ucalgary.ca/gsa/) and Student Ombudsman's Office (http://www.su.ucalgary.ca/page/quality-education/academic-services/student-rights).