CARLETON UNIVERSITY
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
FIRE BEHAVIOUR OF MATERIALS – CIVE 5615
COURSE OUTLINE

The objective of this course is to introduce students to the scientific aspects of material behaviour during a fire. Materials to be covered include liquids, plastics, fibres, concrete, steel, and wood. On completion of this course, participants will have an in-depth understanding of material specifications, standards, and international fire codes.
Prerequisite: bachelor degree in one of the following: Engineering, Science, Architecture Studies, Industrial Design

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TOPICS

Fundamentals of the Fire Hazards of Materials

Performance-Based Building Fire Safety approach, Fundamentals of Combustion, Flammability Limits for Gases and Vapors, Burning Rate of Liquids, Flame Spread Behaviours of Fluids, Properties Associated with Ignition, Vaporization, Flammability, and Combustion. Solids, Piloted Ignition, Sustained Burning, Critical Heat Flux, Ignition Temperatures, Modes of Flame Spread on Solid Materials, Heat Release Rate, Smoke Production, Gross and Net Heat of Combustion, Enclosure Effects.

Materials Specifications, Standards, and Testing

Materials Characteristics, Burning Behaviour of Materials, Flame Spread, Fire Growth, Standard Test Methods for the Assessment of Burning Behaviour of Materials, Acceptance Criteria, Parameters Used for Ranking the Products

Plastics and Rubber

Polymeric Materials, Fire Behaviour of Plastics, Thermoplastics, Thermosets, the Burning Process, Glass Transition Temperature, Charring, Ignition, Heat Release Rate

Flame Retardants for Plastics

Mechanisms of Flame Retardancy, Evolution of Smoke, Classes of Commercial Flame Retardants, Polymer Families, Selection of Flame Retardant, Effect of Flame-Retardant Systems, Mechanism of Flame Retardancy in Nanocomposites.

Fibres and Fabrics

The Role of Fabrics in Fire Protection, Fibres and Their Properties, Flammability of Fabrics, Protective Clothing and Furnishings, Thermal Performance Tests.

Structural Materials (Steel)

Construction Materials, Development of Fire Resistance Testing, Standard Fire Resistance Tests, Failure Criteria, Reaction of Structural Materials to Fire, Structural Fire Response. Steel at Elevated Temperatures, Thermal Properties, Metallurgical Changes, Stress-strain, Ultimate and Yield Strengths, Strength, Young's Modulus of Elasticity, Residual Modulus of Elasticity, Application of Fire Protection

Structural Materials (Concrete)

Property Variations, Thermal Properties of Concrete at Elevated Temperatures (Light/Normal Weight, High-Strength, Fiber-Reinforced), Compressive Strength Retention, Modulus of Elasticity, Development of Fire Resistance Testing, Protection of Structural Materials from Fires, Role of Concrete Cover.

Structural Materials (Wood and Wood Products)

Wood as a Construction Material, Physical and Chemical Characteristics, Reaction to Fire, Thermal and Mechanical Properties, Thermal Decomposition and Pyrolysis, Density & Mass Loss, Dimensional Changes Due to Drying, Steam Softening, Charring Rate, Modulus of Elasticity, Tensile/Compressive, Bending Strength, Fire-Retardant Treatments, Gypsum Board

COURSE FORMAT

- Lectures: Three hours a week
- Midterm (25%) + 1 Literature Review Paper 25% (Paper 15% + Presentation 10%)
- Final Examination (50%)

REFRENCES:

- Harper, C.A., "Handbook of Building Materials for Fire Protection" ISBN13: 9780071388917, ISBN10: 0071388915
- SFPE Handbook of Fire Protection Engineering, ISBN: 0877654514, ISBN13: 978-0-87765-451-3
- Buchanan, A.H., "Structural Design for Fire Safety" ISBN: 978-0-471-89060-7
- National Fire Code of Canada 2015

Academic Integrity

All work submitted for evaluation must be the result of the students' individual effort, unless it is a group assignment. Cheating of any kind will constitute a serious instructional offense subject to sanctions that may include failure in the course, suspension from your degree program, and potentially expulsion from the university. Please consult the university undergraduate calendar for definitions and penalties at http://www2.carleton.ca/studentaffairs/academic-integrity/

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: http://www.carleton.ca/equity/

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: http://www.carleton.ca/equity/

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your ***Letter of Accommodation*** at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*). **Requests made within two weeks will be reviewed on a case-by-case basis.** After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) for the deadline to request accommodations for the formally-scheduled exam (*if applicable*).

NOTE TO JOB SEEKERS AND GRADUATE STUDENTS

I can serve as a reference for you in your job search. The requirement for getting a reference letter is to achieve a minimum grade of 'A+' in the course. Letters of reference will be sent directly to employers or under signed seal to you.

Modified: September 26, 2017