

UNIVERSITY OF TORONTO  
FACULTY OF APPLIED SCIENCE AND ENGINEERING  
ELITE Master's Program

**APS1024H1F2018 Infrastructure Resilience Planning**

**Course Outline**

**Introduction**

Our world is changing. The trends in technology have fundamentally changed the way we live work and play. This has affected societal models and challenged familiar codes of practice and routines that we use to mitigate inherent risk. It has also caused a concentration of value in which the value of operations now far exceeds the value of the infrastructure that houses and enables it. Market expectation of corporation behavior has changed, with a greatly reduced tolerance of service interruption. Climate Change is a catalyst that through an increased frequency of extreme weather events has caused more frequent catastrophic losses that are amplified by the sheer amount that is exposed to loss. Insurance losses in Canada over the last 7 years have exceeded \$1Bn each year, save 2015, and the trend is climbing. The cost of loss now exceeds the capacity of governments to cover. We simply cannot afford catastrophic losses.

Everything that we create and do is for a purpose. We organize corporations, retain employees and contractors, build infrastructure, develop laws and codes of practice and conduct operations for a purpose. Protecting that purpose is much more than simply business continuity or infrastructure hardening, or even building redundant systems. It is about ensuring that the purpose continues to be delivered irrespective of whether a system component fails or some external event interrupts the supply chain. It comes down to understanding your operations, in context, and managing the inherent systems risk. The Infrastructure Resilience Planning course will explore the underlying principles of resilience planning and how it is efficiently applied today. We will discuss the concepts of all-hazards, safe-to-fail, intelligent resourcing, synergy between natural built and virtual infrastructure systems, equilibrium theory and current research into carrying capacity, rehabilitation, and protection and recovery investment balancing. We will also look at how it is being incorporated into codes of practice, engineering specifications and legislation.

In this course we will build upon your own experience and perspectives, to develop a core understanding of what resilience is, what it looks like and how to incorporate it into planning. You will investigate approaches to resilience planning in different jurisdictions, exploring how context and culture influence its practice. You will also conduct a project in small groups, in which you will investigate a real requirement and propose a resilience strategy from first principles. When you complete this course you will be able to direct resilience planning in engineering projects, conduct the analysis and develop and present strategy proposals. This course is recognized internationally by the Register of Security Engineers and Specialists.

## Course Designation

**APS1024 Infrastructure Resilience Planning**, starting Saturday, 15 September 2018. The course will be full days, from 09:00 to 17:00 with 30mins for lunch. It will run over four Saturdays in MY350 (TEAL). A foundation course of the CRCI that is recognised by the international Register of Security Engineers and Specialists;  
<http://www.crci.utoronto.ca/education/academic/infrastructure-courses>.

## Calendar:

15 Sep 18 Course introduction and administration.

We explore the purpose of infrastructure and the context in which it is used; how this context changes both operationally and in terms of wider hazard risk. We investigate the nature of resilience, how it differs from protection, and what it means for communities and business. We discuss the drivers of resilience, how it relates to sustainable economic development, and the concepts of ‘equilibrium’ and ‘carrying capacity’. We then focus on the primary tools, working from first principles, starting with location risk analysis, calculation plans, and mission analysis, before moving to more complex tools such as Intelligence Preparation of the Operating Environment, Demand & Dependency Management, and Resilience-Protection Investment Balance. We will look at how some of these tools are brought together to deliver specific frameworks for community or utility infrastructure resilience. We then deep dive into the theory and practice of Operational Resilience, All-Hazards and Recovery planning parameters. Issue Assignment and Project.

22 Sep 18 Review of Assignment.

We explore the concept of Security Integration at the Strategic, Operational and Technical levels, the application of All-Hazards and the  $\Phi_{\alpha}$  &  $\Phi_{\beta}$  trade-off and investment balance with resilience and recovery. We will look at security systems in capability terms and how technological change effects their value and efficacy specific to an operation.

Site Survey – assessing the operational resilience for a major international event – walk through / talk through with syndicate and open forum discussions of concept solutions.

29 Sep 18 Review Project Part 1 – Initial Desk Top Study.

We will continue looking into the capability requirements of various security and recovery systems, before exploring the concept, technology and practice of control systems. We now put all of the components together to build an operational resilience concept and plan, through a combination of lecture, syndicate work and open forum discussion.

13 Oct 18 Present Project – Concept Development Report.

We review the process of producing a Resilience Plan and what it means for operational and site assurance, how this affects value and even debt/equity ratios for capital investment.

Examination

## Evaluation

One assignment, representing 20% of the total course marks. Extract the necessary information and critically discuss. Keep asking ‘what does this mean in reality?’ to get to an impression of what is genuinely required and the effects that the stated policy and guidance have. Half of marks are for the correct description of the respective policies and associated structures, one tenth for extracting the issues that it raises and the remainder for your critical analysis of what it means.

**Discuss how current Canadian federal and provincial policies influence the delivery of effective national infrastructure resilience, compare and contrast with the equivalent in UK and US.**

If you are corresponding, use your country of residence as the subject and compare with the other two.

The project is in two parts, together representing 40% of the total course marks. This is a group research project that requires a first principles approach and critical assessment of the available information.

**1. Desk-Top Study.** If incomplete, half points will be given for a clear explanation of how each of the missing factors will be answered. A practised researcher will deliver the basic DTS in less than a day. It is highly likely to take you more than this. Do not fall into the trap of trying to research everything – stick to the operation in context.

**2. Concept Development Report.** Working as syndicates, you will build upon your DTS to devise a concept for how the client can enhance her confidence of operational survival.

A two-hour written examination comprising 3 essays selected from 10 possible titles. The final exam represents 40% of the total course marks. The examination will be closed book.

Each of the assignment, project and the final exam will be marked out of a possible 100 marks. The marks for each will be weighted according to the overall percentage of the course marks represented by that work and the whole aggregated for the final course mark / grade. Throughout, credit will be given for demonstrating a clear understanding of the concepts, principles and application over specific processes or formulae.

## Materials

You are expected to read “After the Flood: Exploring Operational Resilience” by Hay. This book was written specifically for this course, consolidating multiple references and concepts. This will provide you with useful references after the course. You should also read “The Edge of Disaster” by Flynn. You will likely wish to buy these two books.

You will find Lewis and MacAulay very useful references throughout and you may wish to rent these two books.

New and second-hand copies of the books are available from the University Bookstore on the corner of St George St and College St.

Address course questions and (correspondence) course work submissions to me at [alec.hay@utoronto.ca](mailto:alec.hay@utoronto.ca)