Instructor Information and Office hours

Dr. Chung-Horng Lung
Office: Mackenzie 4434 Email: chlung@sce.carleton.ca
Office hours: TBD

Calendar Information

The course covers network routing, in-depth issues and technologies in traffic engineering, quality of service (QoS), and high-speed networks. The course addresses the following topics: basic routing, MPLS (Multiprotocol Label Switching) system components and architecture, constraint-based routing, traffic engineering, content delivery networks (CDNs), network monitoring and measurements, QoS, protection and restoration, virtual private networks, cross layer interworking, software-defined networking (SDN), segment routing, and special topics.

http://calendar.carleton.ca/grad/courses/SYSC/

Prerequisites

SYSC4602, SYSC5201/ELG6121, EACJ5607/ELG5374 Computer Communications, or equivalent

Course Objectives

The objective of the course is to introduce various network routing and traffic engineering technologies. Students will learn MPLS related topics in-depth (see Calendar Description). Modeling and analysis techniques for network traffic engineering will be introduced. Students will also be introduced advanced and emerging network technologies, e.g., Content Delivery Networks (CDNs), Software-defined Networking (SDN), Information-centric Networking (ICN), Segment Routing, Cloud Networking, etc. Students will also learn to conduct research through completing a course project, making an oral presentation and writing a technical report.

Learning Outcomes

After successful completion of the course, students will:

- Understand routing and traffic engineering with traditional IP.
- Understand MPLS system architecture and components, including RSVP-TE signaling protocol.
• Understand constraint-based routing and traffic engineering with MPLS.
• Understand applications of RSVP-TE and MPLS – load balancing, protection and restoration, virtual private networks (VPNs).
• Understand other network routing technologies and emerging approaches: CDNs, SDN, segment routing, ICN, and routing in datacenter networks.
• Be able to identify criteria to evaluate design alternatives for network routing and traffic engineering related technologies.
• Learn the basic skills to formulate and model traffic engineering objectives, and conduct research.
• Develop basic oral and written communications skills.

Textbooks (or other resources)

No single textbook was found to cover all the different topics discussed in this course. A number of technical papers will be used for the course and assignments. The following is a list of suggested references for general network switching and routing technologies.


Evaluation and Grading Scheme

• Assignments: 20%
• Class participation for discussions on (reading) assignments and presentation: 5%
• Project and Presentation: 50% (10% for presentation and 40% for report)
• Final Exam: 25%

The final examination is for evaluation purposes only and will not be returned to students. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available.

Week-by-Week breakdown (tentative)

1. Week 1: Overview of routing and MPLS components and architecture
   a. Review of traditional network routing technologies
b. Motivation of MPLS and MPLS framework

2. Week 2–3: Traffic Engineering
   a. Introduction to traffic engineering
   b. Green traffic engineering and communications
   c. Network monitoring and measurements
   d. Content delivery networks
   e. Software-defined networking

3. Week 4–5: Constraint-based routing
   a. Constraint-based shortest path first algorithm
   b. Label switched path calculation
   c. Signalling protocols
   d. Label switched path creation

4. Week 6: Quality of Service (QoS)
   a. QoS models for IP and MPLS
   b. QoS routing and traffic engineering for MPLS

5. Week 7–8: Protection and restoration
   a. Path protection and segment protection
   b. Link and node protection
   c. Protection and QoS
   d. Protection for multicast
   e. P-cycle
   f. Network coding

6. Week 9: Virtual private networks
   a. VPN models
   b. Layer 3 BGP/MPLS VPNs
   c. Layer 2 VPNs.

7. Week 10: Special topics: software-defined networking, segment routing, information-centric networking

8. Week 11–12: Project Presentations

**General Regulations**

**Student Responsibility:** It is the student's responsibility to remain informed of all rules, regulations and procedures required by their program and by the Faculty of Graduate and Postdoctoral Affairs. Ignorance of regulations will not be accepted as a justification for waiving such regulations and procedures.

**Academic Integrity:** Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: [https://carleton.ca/registrar/academic-integrity/](https://carleton.ca/registrar/academic-integrity/). This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

**Plagiarism:** Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.

**Deferred Term Work:** Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately
informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current *Graduate Calendar, Academic Regulations of the University, Section 9.3.*

**Academic Accommodation:** You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at [http://www.carleton.ca/equity/](http://www.carleton.ca/equity/). For an accommodation request, the processes are as follows:

- **Pregnancy or Religious obligation:** Please contact your instructor 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 see [https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

- **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](mailto: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](http://www.carleton.ca/pmc)) for the deadline to request accommodations for the formally-scheduled exam (*if applicable*).

- **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton’s Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: [https://carleton.ca/sexual-violence-support/](https://carleton.ca/sexual-violence-support/).

- **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor 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, see [https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf](https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf)
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Students from the University of Ottawa: You can request to have access to cuLearn: please see http://gradstudents.carleton.ca/forms-policies/