Western University
Faculty of Engineering
*Department of Electrical and Computer Engineering*

## ECE 9303: Networking: Principles, Protocols and Architectures
### COURSE OUTLINE 2023-2024

**DESCRIPTION:** This course introduces the fundamental concepts of communication networks. Specifically, it is concerned with network architectures and protocols. The objective of the course is to allow students to develop a thorough understanding of the architectures of networks and the basic principles that allow the transmission of data over the networks.

**ENROLLMENT RESTRICTIONS**
Enrollment in this course is restricted to graduate students in M.Eng. Communications and Signal Processing, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

**COURSE FORMAT**
In person (face-to-face)

**TOPICS AND LEARNING OBJECTIVES**

| Topic # | Description | Learning Activities | Tentative Timeline |
|---|---|---|---|
| **1.** | **Introduction to Computer Networks and the Internet** <br> At the end of this section, students will be able to: <br> a. Demonstrate an understanding of the Internet. <br> b. Demonstrate knowledge of the Network Edge. <br> c. Demonstrate knowledge of the Network Core. <br> d. Demonstrate knowledge of the Network Access and Physical Media. <br> e. Demonstrate an understanding of ISPs and Internet Backbones. <br> f. Demonstrate an understanding of Delay and Loss in Packet-Switched Networks. <br> g. Demonstrate an understanding of Protocol Layers and Their Service Models. | • Lectures <br> • Additional reading material | Week 1-2 |

| Topic # | Description | Learning Activities | Tentative Timeline |
|---|---|---|---|
| 2. | **Application Layer Protocols**<br>At the end of this section, students will be able to:<br>  a. Demonstrate an understanding of the Principles of Application Layer Protocols.<br>  b. Demonstrate an understanding of the Web, HTTP, FTP, DNS, and DNS-The Internet's Directory Service protocols.<br>  c. Understand and apply Socket Programming with TCP.<br>  d. Understand and apply Socket Programming with UDP.<br>  e. Design and build a Simple Web Server.<br>  f. Demonstrate an understanding of Content Distribution | • Lectures<br>• Assignments/Labs<br>• Practice Problems<br>• Examination | Week 2-3 |
| 3. | **Transport Layer Services**<br>At the end of this section, students will be able to:<br>  a. Demonstrate an understanding of Transport-Layer Services.<br>  b. Demonstrate an understanding of Multiplexing and De-multiplexing.<br>  c. Demonstrate an understanding of Connectionless Transport: UDP.<br>  d. Demonstrate an understanding of the Principles of Reliable Data Transfer.<br>  e. Build and apply the Principles of Reliable Data Transfer.<br>  f. Demonstrate an understanding of Connection-Oriented Transport: TCP.<br>  g. Design and apply the Principles of Congestion Control.<br>  h. Demonstrate an understanding of TCP Congestion Control | • Lectures<br>• Practice Problems<br>• Assignments/Labs<br>• Examination<br>• Additional reading material | Week 4-5 |
| 4. | **Networking Layer & Routing Protocols**<br>At the end of this section, students will be able to:<br>  a. Demonstrate an understanding of Network Service Model.<br>  b. Build and apply the Routing Principles.<br>  c. Demonstrate an understanding of Hierarchical Routing.<br>  d. Demonstrate an understanding of The Internet Protocol.<br>  e. Demonstrate an understanding of Routing and the Internet. | • Lectures<br>• Practice problems<br>• Assignments/Labs<br>• Examination<br>• Additional reading material | Week 6-7 |

| Topic # | Description | Learning Activities | Tentative Timeline |
|---------|-------------|---------------------|--------------------|
|  | f. Demonstrate an understanding of what's Inside a Router.<br>g. Demonstrate an understanding of IPv6.<br>h. Demonstrate an understanding of Multicast Routing.<br>i. Demonstrate an understanding of Mobility and the Network Layer<br>j. Software Defined Networking (SDN)<br>k. Simple Network Management Protocol (SNMP) |  |  |
| 5. | **Link Layer Services and Protocols**<br>At the end of this section, students will be able to:<br>a. Demonstrate an understanding of Data Link Layer Services.<br>b. Demonstrate an understanding of Multiple Access Protocols.<br>c. Demonstrate an understanding of LAN Addresses and ARP.<br>d. Demonstrate an understanding of Ethernet.<br>e. Demonstrate an understanding of Hubs, Bridges and Switches functionalities.<br>f. Design and build Local Area Networks.<br>g. Design and build Wireless Local Area Networks<br>h. Demonstrate an understanding of PPP: The Point-to-Point Protocol.<br>i. Data Centre Networking | • Lectures<br>• Additional reading material<br>• Practice Problems<br>• Assignments/Labs<br>• Examination | Week 10 |
| 6. | **Cloud Networking Principles**<br>At the end of this section, students will be able to:<br>a. Demonstrate an understanding of data center network stack specifics<br>b. Demonstrate an understanding of management and sharing of network infrastructure in cloud data centers.<br>c. Demonstrate an understanding of inter-data center WAN connectivity | • Lectures<br>• Additional reading material<br>• Practice Problems<br>• Assignments/Labs<br>• Examination | Week 10-11 |
| 7. | **Wireless Communications & Mobility**<br>At the end of this section, students will be able to:<br>a. Demonstrate an understanding of Wireless communications and Mobility.<br>b. Build and design of Wi-fi networks. | • Lectures<br>• Additional reading material<br>• Practice Problems<br>• Assignments/Labs<br>• Examination | Week 12 |

**SPECIFC LEARNING OUTCOMES**

| Degree Level Expectation | Weight | Assessment Tools | Outcomes |
|---|---|---|---|
| **Depth and breadth of knowledge** | 35% | • Assignments/Labs<br>• Examinations | • Understanding of advanced concepts and theories related to network architectures and protocols<br>• Understanding of computational and/or empirical methodologies to solve related problems |
| **Research & scholarship** | 15% | • Assignments/Labs | • Ability to conduct critical evaluation of current network architectures<br>• Ability to conduct coherent and thorough analyses of complex network problems using established techniques/principles and judgment |
| **Application of knowledge** | 30% | • Assignments/Labs<br>• Examinations | • Ability to apply knowledge in a rational way to analyze a particular problem<br>• Ability to use coherent approach to design a particular engineering system using appropriate tools |
| **Professional capacity / autonomy** | 10% | • Assignments/Labs | • Awareness of academic integrity<br>• Ability to implement established procedures and practices in the coursework<br>• Defends own ideas and conclusions<br>• Integrates reflection into his/her learning process |
| **Communication skills** | 0% | | |
| **Awareness of limits of knowledge** | 10% | • Examinations | • Awareness of the need of assumptions in complex scientific analyses and their consequences<br>• Understanding of the difference between theoretical and empirical approaches<br>• Ability to acknowledge analytical limitation due to complexity of practical problems |

**ASSESSMENTS**

| Assessment Type | Material Covered | Tentative Due Date | Weight |
|---|---|---|---|
| Assignments/Labs (3 to 4) | Topics 1-7 | Every 2 or 3 weeks (average) | 30% |
| Midterm Exam | Topics 1-4 | Around Week 7 or 8 | 30% |
| Final Exam | Topics 1-7 | Final Exams Period | 40% |

**Activities in which collaboration is permitted:**
- N/A

**Activities in which students must work alone (collaboration is not permitted):**
- Assignments/Labs
- Midterm Exam
- Final Exam

## REQUIRED TEXTBOOK

- James F. Kurose & Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson, 7th Edition, ISBN-10: 0133594149 , 2016.

## OPTIONAL COURSE READINGS

- Andrew S. Tanenbaum and David J. Wetherall, Computer Networks (5th Edition), Prentice Hall, 2010
- W. Stallings, Data and Computer Communications, Prentice Hall, 2002.
- Leon-Garcia and I. Widjaja, Communication Networks: Fundamental Concepts and Key Architectures, McGraw-Hill, 2000.

## CHEATING, PLAGIARISM/ACADEMIC OFFENCES

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations.  Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence at the following website: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

## CONDUCT

Students are expected to follow proper etiquette to maintain an appropriate and respectful academic environment.  Any student who, in the opinion of the instructor, is not appropriately participating in course activities and/or is not following the rules and responsibilities associated with the course activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

## HEALTH/WELLNESS SERVICES

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services to help you achieve optimum health and engage in healthy living while pursuing your graduate

degree. Information regarding health- and wellness-related services available to students may be found at http://www.health.uwo.ca/.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Faculty of Engineering has a Student Wellness Counsellor. To schedule an appointment with the counsellor, contact Kristen Edwards (khunt29@uwo.ca) via confidential email and you will be contacted by our intake office within 48 hours to schedule an appointment.

Students who are in emotional/mental distress should refer to Mental Health@Western: http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.


**SICKNESS**
Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

Students who are not able to meet certain academic responsibilities due to medical, compassionate or other legitimate reason(s), could request for academic consideration. The Graduate Academic Accommodation Policy and Procedure details are available at:
https://www.eng.uwo.ca/graduate/current-students/academic-support-and-accommodations/index.html

**ACCESSIBLE EDUCATION WESTERN (AEW)**
Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program. Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW): http://academicsupport.uwo.ca/accessible_education/index.html

AEW is a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.