**DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING**

**AISE 4430A – Introduction to Computer Networking, Security and IoT Systems**

**Course Outline 2025-26**

## COURSE DESCRIPTION:

This course introduces the fundamental concepts of communication networks, network security, and Internet of Things (IoT) network systems. The objective of the course is to allow students to develop a thorough understanding of the architecture of networks, IoT network system protocols (e.g., WiFi, LoRA, and Zigbee) and security.

## ACADEMIC CALENDAR:

https://www.westerncalendar.uwo.ca/Courses.cfm?CourseAcadCalendarID=MAIN_030977_1&SelectedCalendar=Live&ArchiveID=

Principles of computer networking architecture/layers and protocols, IoT network systems, protocols, security, and connections to cloud services with an emphasis on the ability to interface and collect data from things and move them securely through the internet to process in public and private data centers.

## PRE OR COREQUISITES:

Engineering Science 1036A/B or Computer Science 1026A/B.

## ANTIREQUISITES:

ECE 4436A.

## CEAB ACADEMIC UNITS:

Engineering Science 75%, Engineering Design 25%.

## CONTACT HOURS:

| | |
|---|---|
| **LECTURE:** | 3hrs per week |
| **LABORATORY:** | 3hrs per week |

## REQUIRED TEXT:

- James F. Kurose & Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson, 8th Edition, ISBN-13: 9780135928615, 2020.
- Qusay F. Hassan, Internet of Things A to Z: Technologies and Applications, Wiley-IEEE Press, ISBN: 978-1-119-45674-2, 2018.

**RECOMMENDED REFERENCES:**

- IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, 1st edition Published by Cisco Press, 2017.
- 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.

**RECOMMENDED SOFTWARE:**

- **Mininet** is a network emulator that allows you to create a virtual network on a single machine, complete with hosts, switches, routers, and links. It's widely used for testing and developing OpenFlow-based SDN (Software-Defined Networking) applications in a scalable and flexible environment. It can be downloaded from https://mininet.org/
- **Wireshark** is a network protocol analyzer that captures and displays data packets in real-time. It allows users to inspect the details of network traffic for troubleshooting, analysis, and development. It can be downloaded from https://www.wireshark.org/
- **Oracle VirtualBox or Docker** will be used to run Mininet and Wireshark in a simulation environment. This allows students to create and manage isolated virtual networks for testing and analysis. VirtualBox provides full-fledged virtual machines, while Docker offers lightweight containers. Both enable efficient setup and testing of network configurations and traffic monitoring in a controlled environment.

**GENERAL LEARNING OBJECTIVES (CEAB GRADUATE ATTRIBUTES):**

| | | | | | |
|---|---|---|---|---|---|
| **Knowledge Base** | I | **Engineering Tools** | A | **Impact on Society** | |
| **Problem Analysis** | D | **Individual & Team Work** | | **Ethics and Equity** | |
| **Investigation** | | **Communication** | | **Economics and Project Management** | |
| **Design** | D | **Professionalism** | | **Life-Long Learning** | |

Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).
Rating: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e. g. no review).

**COURSE MATERIALS:**

Weekly content and guides for the laboratories will be available on the course OWL Brightspace site. The material for this course will be taught in both lectures and labs; therefore, it is imperative that you attend each lecture and lab.

**COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES:**

The following table summarizes the course learning outcomes along with CEAB GAIs where the GAIs in bold indicate ones to be measured and reported annually.

| **Course Topics and Specific Learning Outcomes** | **CEAB Graduate Attributes Indicators** |
|---|---|
| **1. Computer Networks and the Internet** | |
| At the end of this section, students will be able to: | |
| **a.** Demonstrate an understanding of the Internet | **Taught but not assessed** |
| **b.** Demonstrate knowledge of the Network Edge. | |
| **c.** Demonstrate knowledge of the Network Core. | |
| **d.** Demonstrate knowledge of the Network Access and Physical Media | |
| **e.** Demonstrate an understanding of ISPs and Internet Backbones. | **KB1 KB2 PA2** |
| **f.** Demonstrate an understanding of Delay and Loss in Packet-Switched Networks. | |
| **g.** Demonstrate an understanding of Protocol Layers and Their Service Models. | **KB1 KB2** |
| **2. Application Layer** | |
| At the end of this section, students will be able to: | |
| **a.** Demonstrate an understanding of the Principles of Application Layer Protocols. | **PA2 PA3** |
| **b.** Demonstrate an understanding of the Web, HTTP, FTP, DNS, and DNS-The Internet's Directory Service protocols. | **PA4** |
| **c.** Understand and apply Socket Programming with TCP. | **PA3 ET2 ET 3** |
| **d.** Understand and apply Socket Programming with UDP. | **PA3 ET2 ET 3** |
| **3. Transport Layer** | |
| At the end of this section, students will be able to: | |
| **a.** Demonstrate an understanding of Transport-Layer Services. | **PA3 PA4** |
| **b.** Demonstrate an understanding of Multiplexing and De-multiplexing. | **PA3 PA4** |
| **c.** Demonstrate an understanding of Connectionless Transport: UDP. | |
| **d.** Demonstrate an understanding of the Principles of Reliable Data Transfer. | **PA3 PA4** |
| **e.** Build and apply the Principles of Reliable Data Transfer. | **D2 D3 ET2** |
| **f.** Demonstrate an understanding of Connection-Oriented Transport: TCP. | **PA2 PA3** |
| **g.** Design and apply the Principles of Congestion Control. | **D3 ET2 ET3** |
| **h.** Demonstrate an understanding of TCP Congestion Control. | **PA3 PA4** |
| **4. Networking Layer & Routing** | |
| At the end of this section, students will be able to: | |

| | |
|---|---|
| **a.** Demonstrate an understanding of Network Service Model. | **PA2 PA3** |
| **b.** Build and apply the Routing Principles. | **D2 D3 ET3** |
| **c.** Demonstrate an understanding of Hierarchical Routing. | **PA3 PA4** |
| **d.** Demonstrate an understanding of The Internet Protocol. | **PA3 PA4** |
| **e.** Demonstrate an understanding of Routing and the Internet. | **PA3 PA4** |
| **f.** Demonstrate an understanding of what's Inside a Router. | **PA3 PA4** |
| **g.** Demonstrate an understanding of IPv6. | **PA3 PA4** |
| **h.** Demonstrate an understanding of Multicast Routing. | **PA3 PA4** |
| **i.** Demonstrate an understanding of Mobility and the Network Layer. | **PA3 PA4** |
| **j.** Software Defined Networking (SDN). | **PA3 PA4** |
| **k.** Simple Network Management Protocol (SNMP). | |
| **5. Link Layer** | |
| At the end of this section, students will be able to: | |
| **a.** Demonstrate an understanding of Data Link Layer Services. | **PA3 PA4** |
| **b.** Demonstrate an understanding of Multiple Access Protocols. | **PA3 PA4** |
| **c.** Demonstrate an understanding of LAN Addresses and ARP. | **PA3 PA4** |
| **d.** Demonstrate an understanding of Ethernet. | **PA3 PA4** |
| **e.** Demonstrate an understanding of Hubs, Bridges and Switches functionalities. | **PA3 PA4** |
| **f.** Demonstrate an understanding of PPP: The Point-to-Point Protocol. | **PA3 PA4** |
| **g.** Data Centre Networking. | |
| **6. Network Security** | |
| At the end of this section, students will be able to: | |
| **a.** Understand the general requirements of the network security protocols. | **PA1** |
| **b.** Understand several real-world security protocols including SSL, IPSec and Kerberos. | **PA2** |
| **c.** Distinguish different ways to authenticate and establish a session key over a network. | **PA2 PA3** |
| **d.** Explain how to achieve perfect forward secrecy and the benefits (and potential drawbacks) of using timestamps. | **PA2 PA3** |
| **7. IoT Systems and Security** | |
| At the end of this section, students will be able to: | |
| **a.** Explain the scope of the Internet of Things. | **PA1** |
| **b.** Understand IoT network traffic and Web services. | **PA1, PA2** |
| **c.** Understand IoT technologies including Wi-Fi, Bluetooth Low Energy, Zigbee, and LoRa. | **PA1, PA2** |
| **d.** Understand the general IoT security attacks. | **PA1, PA2, ET2** |

**EVALUATION:**

| Name | % Worth | CEAB GAs ASSESSED |
|---|---|---|
| Individual Lab Oral Exams (3) | 30% | **KB4 PA2 PA3 D2 D3 ET2 ET3** |
| Midterm Exam/Quizzes | 30% | **KB4 I1 PA2 PA3 D2 D3 ET2 ET3** |
| Final Exam | 40% | **KB4 I1 PA2 PA3 D2 D3 ET2 ET3** |

Marks will be assigned on the basis of method of analysis and presentation, correctness of solution, clarity and neatness.

For this course, the following assessment has been designated as requiring supporting documentation:

- Final Exam, due during the final examination period

**COURSE POLICIES:**

**Laboratory:**
There will be three laboratory assignments, each spanning roughly three weeks and carrying equal weight toward the final grade. Laboratory work may be programming-based, and the Python programming language will be used. Instead of submitting written lab reports, each assignment will conclude with an individual oral exam.

- Every student will be assigned a specific time slot during their enrolled lab session for the oral exam.
- Attendance at the scheduled oral exam time is mandatory. **A missed exam will result in a grade of zero**, unless formal academic consideration is approved in advance or appropriate documentation is provided for an emergency.
- Students who receive approved academic consideration must contact the TA and instructor **within 24 hours** of the missed exam to arrange a make-up.

**Self-Reported Absence:**
No weight-shifting is allowed for self-reported absence; missed work will be due after a covered period.

**Midterm/Quizzes Test:**
There will be one midterm test or three quizzes, which will be a closed-book exam (no reference materials allowed) and will last for two hours for midterm and hour for each quiz. Only non-programmable calculators are permitted. If a student misses the test, the test will not be rescheduled. Instead, the weight of the test will be added to the final exam, making the final exam worth up to 70% of the overall grade. If no valid justification is provided for missing the midterm, the student will receive a mark of zero for the test.

**Final Examination:**
Please note that the final exam is considered to be central to the learning objectives for this course. Accordingly, students seeking academic consideration for this assessment must provide formal supporting documentation. Students who are granted academic consideration for this assessment will be provided with the following opportunity to make up this work: The final examination will take place during the regular examination period. It will be two hours long, closed book, and only non-programmable calculators are allowed.

**Use of English:**
In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

**Attendance:**
Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.