Description: Computer networks and data communication are the fastest growing technologies in our culture today. This is especially true when we are experiencing every year new social networking applications appears and have become quickly very popular. People use the Internet more and more every day. They use the Internet from the time they get up in the morning to the moment they lie down for bed. Therefore, specialists are needed to develop and control the Internet applications or the network applications connected to the Internet.

This course is designed to help students understand the concepts of computer networks in general and the Internet and networks applications in particular. Although the main goal of the course is to teach the concepts of Internet and network applications, it is designed to teach these concepts through the following three dimensions:

- **Technology**: To provide students a technical foundation in data communications and network technology. Topics include: multimedia networking, mobile and wireless data communications, client-server and p2p network applications, software defined network, quality of services, and network security protocols.

- **Configuration**: Students will gain hands-on experience in Cisco labs, using state-of-the-art technologies such as NetLab and VMware server. Laboratory activities include creating, installing, configuring and maintaining Cisco-based network systems.

- **Implementation**: The course is designed to extend students’ knowledge and practice in design of computer networks applications by focusing on network programming in the context of network protocol implementation (e.g., TCP, UDP, ICMP, RTP, RTSP, and non-standard protocols). Assignments require students to develop GUI and/or Web based client-server and peer-to-peer applications.

Instructor: Dr. Abdelkader Ouda, Ph.D., P.Eng.
TEB 359, 519-661-2111 ext. 81299, aouda@uwo.ca
Consultation hours: Thursday, 10:30 am – 12:30 pm.

Academic Calendar Copy: This course examines and introduces advanced concepts in computer network and data communications. Topics include mobile and wireless data communications, multimedia networking, network management, distributed computing and clusters, and peer to peer network applications.

Contact Hours: 3 lecture hours per week and 2 laboratory hours per week.

Prerequisites: ECE 4436 A/B.
Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

**CEAB Academic Units:** Engineering Science 75%, Engineering Design 25%.


**Other References:** Course notes and supplementary material will be available at the Course Web site.

### General Learning Objectives (CEAB Graduate Attributes)

<table>
<thead>
<tr>
<th>Knowledge Base</th>
<th>Use of Engineering Tools</th>
<th>Impact on Society and the Environment</th>
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<tbody>
<tr>
<td>Problem Analysis</td>
<td>2/3</td>
<td>Individual and Team Work</td>
</tr>
<tr>
<td>Investigation</td>
<td></td>
<td>Communication Skills</td>
</tr>
<tr>
<td>Design</td>
<td>2/2</td>
<td>Professionalism</td>
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</tbody>
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Notation: $x/y$, where $x$ is the cognitive level (1: Remember, 2: Understand, 3: Apply) at which the attribute is assessed and $y$ is the academic level (1: Beginner, 2: Intermediate, 3: Advanced) at which the attribute is assessed.

### Topics and Specific Learning Objectives

1. **Wireless and Mobile Networks:**
   
   At the end of this section, students will be able to:
   
   a. Describe the general issues behind wireless LANs and be able to compare it to that in wired networks.
   b. Describe the major characteristics of the wireless networks and the way access is controlled in these types of networks.
   c. Explain the Bluetooth technology as a personal area network (PAN), including the architecture, the addressing mechanism, and the packet format.
   d. Explain the WiMAX, and the services provided by this network.
   e. Explain cellular telephone networks, and the general operations of these networks.

2. **Network Programming:**
   
   At the end of this section, students will be able to:
   
   a. Discuss network programming with object-oriented programming languages like C# and Java in addition to scripting languages and frameworks like JavaScript, Node.js, Express.js, and Ember.js that they bring to network programming.
   b. Design and develop original programs that demonstrate key concepts of network programming. This is an essential component of the course assignments.
c. Apply socket programming and Graphical User Interface (GUI) in network applications that provide significant network capability as required to fulfill assignment objectives and deliverables.

3. Multimedia Networking:
At the end of this section, students will be able to:
   a. Understand the general idea behind compression. This includes both lossless and lossy compression.
   b. Define the elements of multimedia: text, image, video, and audio, and then understand how these elements are represented, encoded, and compressed.
   c. Explain the features and characteristics of the multimedia categories in the Internet: streaming stored audio/video, streaming live audio/video, and real-time interactive audio/video.
   d. Understand the real-time interactive protocols RTP and RTSP.
   e. Understand the signalling and the voice over IP protocols: SIP and H.323.

4. Peer-to-Peer networks:
At the end of this section, students will be able to:
   a. Explain the peer-to-peer paradigm, including the general idea behind P2P networks, and the distributed hash table (DHT) as a mathematical concept for routing in a P2P network.
   b. Understand and describe Chord as one of the P2P networks that uses DHT, including the identifier space, finger tables.
   c. Understand and describe Pastry, another DHT-based P2P network, including the usage of the routing tables and leaf sets to answer queries.
   d. Understand and describe Kademlia, another DHT-based P2P network, including the XOR identifications and operations.
   e. Understand BitTorrent, a popular P2P network used for file sharing.

5. The Internet of Things (IoT):
At the end of this section, students will be able to:
   a. Explain the scope of the Internet of Things.
   b. List and describe the five principle components of the IoT-enabled things.
   c. Compare different types of IoT reference models.
   d. Examine the open source and commercial implementations of the IoT.

6. Software Defined Network:
At the end of this section, students will be able to:
   a. List and explain the key requirements for an SDN architecture.
   b. Understand the concept of an OpenFlow logical network device.
   c. Understand the basic elements of the OpenFlow protocol.
   d. Compare centralized and distributed SDN controller architectures.
   e. Explain the role of BGP in an SDN network.

7. Network Security Protocols:
At the end of this section, students will be able to:
   a. Understand generic security protocols in order to better understand the fundamental issues involved in the design of real-world security protocols.
   b. Understand several real-world security protocols including SSL, IPSec, and Kerberos.
   c. Distinguish different ways to authenticate and establish a session key over a network.
d. Explain how to achieve perfect forward secrecy, and the benefits (and potential drawbacks) of using timestamps.

**Evaluation**

<table>
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<tr>
<th>Course Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Homework Assignments. (written and programming assignments)</td>
<td>20%</td>
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<tr>
<td>Laboratory works. (configuring Cisco devices)</td>
<td>15%</td>
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<tr>
<td>Midterm Exam</td>
<td>15%</td>
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<tr>
<td>Final Examination</td>
<td>50%</td>
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To obtain a passing grade in the course, a mark of 50% or more must be achieved on the following course components: the midterm and final examination, the homework assignments, and the laboratory works. Any component mark < 50% will result in a final course grade of 48% or less. The midterm exam information will be announced in the course website (OWL). The final examination is a closed book for two hours and will be taken during the regular examination period.

**Late Submission Policy:** Assignments and laboratories works will be penalized by 4% of the available marks per day for late submission. Assignments submitted more than 3 days late will not be accepted.

**Assignment Submission Locker:** located on the second floor of TEB.

**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:** All classes, laboratories, and tutorials are mandatory unless otherwise stated. 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.

**Absence Due to Illness or Other Circumstances:** Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled”). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.
For more information concerning medical accommodations, see the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

**Cheating and Plagiarism:** Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on 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).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

**Use of Electronic Devices:** Students may use laptops, tablet computers, or smart phones only to access the course OWL site during lectures and tutorials. Use of nonprogrammable calculators only is permitted during quizzes and examinations. No other electronic devices may be used at any time during lectures, tutorials, or examinations.

**Policy on Repeating All Components of a Course:** Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

**Internet and Electronic Mail:** Students are responsible for regularly checking their Western e-mail and the course web site (https://owl.uwo.ca/portal/) and making themselves aware of any information that is posted about the course.

**Accessibility:** Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

**Support Services:** Office of the Registrar, http://www.registrar.uwo.ca/  
Student Development Centre, http://www.sdc.uwo.ca/
Students who are in emotional/mental distress should refer to Mental Health @ Western, [http://www.health.uwo.ca/mental_health/](http://www.health.uwo.ca/mental_health/), for a complete list of options about how to obtain help.