COURSE SYLLABUS
CMPT 434: COMPUTER NETWORKS

Catalogue Description
The principles and practice of computer networking, focusing on the Internet and its structure, protocols, and applications. Topics include network applications and programming, reliable data transfer, flow and congestion control, routing, multimedia networking, local area networks, security, and network management.

Prerequisite: CMPT 332.
Students with credit for CMPT 424 may not take this course for credit.

Class Time & Location: M W F, 9:30-10:20, Agriculture 2E25 when in-person (default delivery mode) and otherwise via Zoom. (The Zoom meeting invitation will be posted on Canvas. Zoom sessions will be recorded and posted.)

Website: Canvas

Instructor Information
Instructor: Derek Eager
Contact: Email: eager@cs.usask.ca
Feel free to email me at any time. I am usually able to respond to emails received during the day (9:00 am to 5:00 pm) on weekdays (Monday to Friday) within a few hours, depending on other commitments. Emails received during the evening may not be responded to until the following morning.

Course Overview and Objectives
This course provides a comprehensive survey of the design and organization of computer networks. After beginning with some background on the fundamentals of data communication and communication infrastructures, and on socket programming, the course will largely follow a bottom-up approach, covering protocols for reliable data transfer, multiple access protocols, layer 2 networks, routing, congestion control, quality of service, and transport layer protocols, before finally looking at some important applications and the cross-cutting issues of network security. The principles we discuss will be made concrete through study of existing systems, most notably the Internet and its structure, protocols, and applications.

Assignments will involve both programming (specifically, socket programming using C on Linux) and non-programming problems. There will also be a group project that can take the form of either a critical survey of a current issue in networking research, or an implementation.

After completing this course, students should be able to:
• Define and describe the layered structure of a typical networking architecture.
• Design and potentially implement network protocols.
• Describe the components of network addressing in IPv4 and IPv6 and how addresses are used in routing and forwarding.
• Implement applications using reliable and unreliable socket communication.
• Compare and contrast the various approaches to multiple-access communication channels.
• Describe the organization of wireless networks and the support for mobile users.
• Implement, simulate, and/or evaluate methods of congestion control with respect to issues of performance and fairness.
• Compare and contrast how frames/packets are delivered between hosts and switches/routers at the data link and network layers.
• Evaluate the need for and effectiveness of error detection/correction mechanisms in different network contexts.
• Determine the role and appropriate use of encryption and decryption algorithms in network applications.
• Describe the purpose of different message types in application layer protocols.
• Compare and contrast different approaches to quality of service in networks carrying time-sensitive data.

**Student Evaluation**

There will be three equally-weighted assignments, involving both programming (specifically, socket programming using C on Linux) and non-programming problems. **Tentative** due dates for the assignments are January 31st, February 28th, and March 21st. There will also be a group project that can take the form of a critical survey of a current issue in networking research or an implementation or experimental study of some kind, with tentative due dates for the project proposal of February 7th and final project submission of April 8th. Due dates are strict – if an extension is required for some special reason (e.g. medical), the instructor must be contacted as soon as feasible. A midterm exam will be held during our scheduled class time (9:30-10:20 am) on Wednesday March 9th (COVID permitting, the exam will be in-person, in-class). A three-hour final exam will be held during a time slot that will be assigned in the University final exam schedule. COVID permitting, the midterm exam and the final exam will be in-person, closed book, with no electronic devices permitted.

**Grading Scheme**

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<tbody>
<tr>
<td>Assignments (3)</td>
<td>25</td>
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<tr>
<td>Project</td>
<td>15</td>
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<tr>
<td>Midterm Exam</td>
<td>20</td>
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<tr>
<td>Final Exam</td>
<td>40</td>
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<td><strong>Total</strong></td>
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**Final Exam Scheduling:**

The Registrar schedules all final examinations, including deferred and supplemental examinations. Students are advised not to make travel arrangements for the exam period until the official exam schedule has been posted.

*Note: All students must be properly registered in order to participate in and receive credit for this course.*

**Textbook Information**

Lecture notes will be posted, as well as links to various on-line resources. There is no required textbook, but the following books are recommended references:


**Lecture Schedule (all timings approximate)**

1. **Background (1.5 weeks)**
   - Transmission media, limits on achievable data rate, digital modulation, communication infrastructures, socket programming.

2. **Basics of Point-to-Point Data Transfer (1 week)**
   - Protocols for reliable data transfer, error detection and correction, point-to-point data transfer at the link layer, end-to-end argument.
3. Multiple Access Protocols and Layer 2 Networks (1.5 weeks)
   Classes of multiple access protocols, Ethernet, link layer switching, 802.11, Bluetooth, IoT.

4. Network Layer (3 weeks)
   Datagram vs. virtual circuit networks, routing, congestion control, quality of service, network layer
   addressing in the Internet, IP, routing in the Internet, Software Defined Networking.

5. Transport Layer (1.5 weeks)
   Internet transport protocols, TCP connection establishment and release, data transfer in TCP, TCP
   congestion control, current problem areas with conventional TCP, new protocols.

6. Application Layer (1.5 weeks)
   DNS, email, the Web, streaming media, content delivery, P2P, blockchain.

7. Network Security (1.5 weeks)
   Cryptography, digital signatures, message digests, public key management, authentication, security in the
   Internet, social issues.

University of Saskatchewan Grading System (for undergraduate courses)

Exceptional (90-100) A superior performance with consistent evidence of
   • a comprehensive, incisive grasp of the subject matter;
   • an ability to make insightful critical evaluation of the material given;
   • an exceptional capacity for original, creative and/or logical thinking;
   • an excellent ability to organize, to analyze, to synthesize, to integrate ideas, and to express thoughts
     fluently.

Excellent (80-90) An excellent performance with strong evidence of
   • a comprehensive grasp of the subject matter;
   • an ability to make sound critical evaluation of the material given;
   • a very good capacity for original, creative and/or logical thinking;
   • an excellent ability to organize, to analyze, to synthesize, to integrate ideas, and to express thoughts
     fluently.

Good (70-79) A good performance with evidence of
   • a substantial knowledge of the subject matter;
   • a good understanding of the relevant issues and a good familiarity with the relevant literature and
     techniques;
   • some capacity for original, creative and/or logical thinking;
   • a good ability to organize, to analyze and to examine the subject material in a critical and constructive
     manner.

Satisfactory (60-69) A generally satisfactory and intellectually adequate performance with evidence of
   • an acceptable basic grasp of the subject material;
• a fair understanding of the relevant issues;
• a general familiarity with the relevant literature and techniques;
• an ability to develop solutions to moderately difficult problems related to the subject material;
• a moderate ability to examine the material in a critical and analytical manner.

**Minimal Pass (50-59)** A barely acceptable performance with evidence of

• a familiarity with the subject material;
• some evidence that analytical skills have been developed;
• some understanding of relevant issues;
• some familiarity with the relevant literature and techniques;
• attempts to solve moderately difficult problems related to the subject material and to examine the material in a critical and analytical manner which are only partially successful.

**Failure <50** An unacceptable performance

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**Important guidelines for this term**

During this term it is important that we undertake in-person elements of this class safely. In order to do this the university has developed a set of expectations and safety protocols that all students must adhere to if they are to engage in in-person activity.

**Throughout the term:**

- **Protect the pack:** Right now, the impact of student choices and activities when not on campus cannot be separated from time spent on campus. In order to “protect the pack”, the university is asking all students who are doing in-person work to be mindful and do whatever possible to lower the risk that you will contract COVID-19 and bring it onto campus.

- **Know what is required and expected of you:** One of the critical lessons learned in dealing with COVID-19 is knowing that situations can change and we must be flexible and ready to adjust our safety protocols. The university has created [a web page](https://covid19.usask.ca/about/safety.php#Expectations) where all up-to-date information around returning to campus is listed. **You are responsible** for regularly checking the health and safety guidelines [https://covid19.usask.ca/about/safety.php#Expectations](https://covid19.usask.ca/about/safety.php#Expectations) and knowing what is expected of you throughout the term.

- **Follow all guidance:** Students are expected to follow all guidance provided by the University’s Pandemic Recovery/Response Team (PRT), College/Department, professors, lab instructors, TAs, and any other staff member involved in the in-person academic program activities (e.g., Protective Services, Safety Resources).

- **Key channels of communication:** If there is a need for the class to pause meeting in-person for a period of time you will be notified. If this occurs, you will be provided with detailed information on the course Canvas site on what you will need to do in place of the in-person class sessions.
Policies

Recording of Lectures
Students may record in-person lectures if desired. For those classes held using Zoom, the instructor will be posting recordings of lectures. These recordings are protected by copyright. Do not download, copy, or share recordings without the explicit permission of the instructor.

For questions about recording and use of sessions in which you have participated, including any concerns related to your privacy, please contact your instructor. More information on class recordings can be found in the Academic Courses Policy [https://policies.usask.ca/policies/academic-affairs/academic-courses.php#5ClassRecordings](https://policies.usask.ca/policies/academic-affairs/academic-courses.php#5ClassRecordings).

Late Assignments/Project
Due dates are strict – if an extension is required for some special reason (e.g. medical) the instructor must be contacted as soon as possible.

Missed Assignments/Project
Students who do not submit anything for an assignment or the project by the due date (possibly as extended by the instructor) will receive a grade of zero for it.

Missed Examinations
1. Students who miss an exam should contact the instructor as soon as possible. If it is known in advance that an exam will be missed, the instructor should be contacted before the exam.

2. "If a student is absent from a final examination due to an extenuating circumstance, they may be eligible to apply for a deferred exam. Students in the College of Arts and Science must contact the Undergraduate Student Office within three business days of the missed exam to be considered." [http://artsandscience.usask.ca/undergraduate/advising/strategies.php](http://artsandscience.usask.ca/undergraduate/advising/strategies.php)

Incomplete Course Work and Final Grades
"When a student has not completed the required class work, which includes any assignment or examination including the final examination, by the time of submission of the final grades, they may be granted an extension to permit completion of an assignment, or granted a deferred examination in the case of absence from a final examination.

Extensions past the final examination date for the completion of assignments must be approved by the Department Head, or Dean in non-departmentalized Colleges, and may exceed thirty days only in unusual circumstances. The student must apply to the instructor for such an extension and furnish satisfactory reasons for the deficiency. Deferred final examinations are granted as per College policy.

In the interim, the instructor will submit a computed percentage grade for the class which factors in the incomplete class work as a zero, along with a grade comment of INF (Incomplete Failure) if a failing grade.

In the case where the student has a passing percentage grade but the instructor has indicated in the class syllabus that failure to complete the required class work will result in failure in the class, a final grade of 49% will be submitted along with a grade comment of INF (Incomplete Failure).

If an extension is granted and the required assignment is submitted within the allotted time, or if a deferred examination is granted and written in the case of absence from the final examination, the instructor will submit a revised assigned final percentage grade. The grade change will replace the previous grade and any grade comment of INF (Incomplete Failure) will be removed.

A student can pass a class on the basis of work completed in the class provided that any incomplete class work has not been deemed mandatory by the instructor in the class syllabus as per College regulations for achieving
a passing grade.” (https://policies.usask.ca/policies/academic-affairs/academic-courses.php)

For policies governing examinations and grading, students are referred to the Assessment of Students section of the University policy “Academic Courses Policy on Class Delivery, Examinations, and Assessment of Student Learning” (https://policies.usask.ca/policies/academic-affairs/academic-courses.php)

Copyright

Course materials are provided to you based on your registration in a class, and anything created by your professors and instructors is their intellectual property, unless materials are designated as open education resources. This includes exams, PowerPoint/PDF slides and other course notes. Additionally, other copyright-protected materials created by textbook publishers and authors may be provided to you based on license terms and educational exceptions in the Canadian Copyright Act (see http://laws-lois.justice.gc.ca/eng/acts/C-42/index.html).

Before you copy or distribute others’ copyright-protected materials, please ensure that your use of the materials is covered under the University’s Fair Dealing Copyright Guidelines available at https://library.usask.ca/copyright/general-information/fair-dealing-guidelines.php. For example, posting others’ copyright-protected materials on the open web is not covered under the University’s Fair Dealing Copyright Guidelines, and doing so requires permission from the copyright holder.

For more information about copyright, please visit https://library.usask.ca/copyright/index.php where there is information for students available at https://library.usask.ca/copyright/students/rights.php, or contact the University's Copyright Coordinator at copyright.coordinator@usask.ca or 306-9668817.

Integrity

The University of Saskatchewan is committed to the highest standards of academic integrity (https://academic-integrity.usask.ca/). Academic misconduct is a serious matter and can result in grade penalties, suspension, and expulsion. Students are expected to act with academic integrity. Students are encouraged to complete the Academic Integrity Tutorial to understand the fundamental values of academic integrity and how to be a responsible scholar and member of the USask community (tutorial link: https://libguides.usask.ca/AcademicIntegrityTutorial). Students can access campus resources that support development of study skills, time and stress management, and ethical writing practices important for maintaining academic integrity and avoiding academic misconduct.

Students are expected to be familiar with the academic misconduct regulations (https://governance.usask.ca/student-conduct-appeals/academic-misconduct.php#About).

- Definitions appear in Section II of the academic misconduct regulations.
- The academic misconduct regulations apply regardless of type of assessment or presence of supervision during assessment completion.
- Students are advised to ask for clarification as to the specific expectations and rules for assessments in all of their courses.
- Students are urged to avoid any behaviour that could result in suspicions of cheating, plagiarism, misrepresentation of facts. Students should note that posting copyrighted course materials (e.g., notes, questions, assignments or exams) to third party websites or services or other forum or media without permission is an academic or non-academic misconduct offense.

Non-academic offenses are dealt with under the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals.

Access and Equity Services (AES) for Students

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to
register with Access and Equity Services (AES) if they have not already done so. Students who suspect they may have disabilities should contact AES for advice and referrals at any time. Those students who are registered with AES with mental health disabilities and who anticipate that they may have responses to certain course materials or topics, should discuss course content with their instructors prior to course add / drop dates. In order to access AES programs and supports, students must follow AES policy and procedures. For more information or advice, visit https://students.usask.ca/health/centres/access-equity-services.php, or contact AES at 306-966-7273 or aes@usask.ca.

Students registered with AES may request alternative arrangements for mid-term and final examinations. Students must arrange such accommodations through AES by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by AES.

Student Supports

Student Learning Services

Student Learning Services (SLS) offers assistance to U of S undergrad and graduate students. For information on specific services, please see the SLS web site https://library.usask.ca/studentlearning/.

Teaching, Learning and Student Experience

The Teaching, Learning and Student Experience Unit (TLSE) focuses on providing developmental and support services and programs to students and the university community. For more information, see https://students.usask.ca.

Financial Support

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact Student Central (https://students.usask.ca/student-central.php).

College Supports

Students in Arts & Science are encouraged to contact the Undergraduate Student Office and/or the Trish Monture Centre for Success with any questions on how to choose a major; understand program requirements; choose courses; develop strategies to improve grades; understand university policies and procedures; overcome personal barriers; initiate pre-career inquiries; and identify career planning resources. Contact information is available at: (http://artsandscience.usask.ca/undergraduate/advising/)

Aboriginal Students’ Centre

The Aboriginal Students’ Centre (ASC) is dedicated to supporting Aboriginal student academic and personal success. The centre offers personal, social, cultural and some academic supports to Métis, First Nations, and Inuit students. The centre is also dedicated to intercultural education, bringing Aboriginal and non-Aboriginal students together to learn from, with and about one another in a respectful, inclusive and safe environment. Students are encouraged to visit the ASC’s Facebook page (https://www.facebook.com/aboriginalstudentscentre/) to learn more.

International Student and Study Abroad Centre

The International Student and Study Abroad Centre (ISSAC) supports student success in their international education experiences at the U of S and abroad. ISSAC is here to assist all international undergraduate, graduate, exchange and English as a Second Language students and their families in their transition to the U of S and Saskatoon. ISSAC offers advising and support on all matters that affect international students and their families and on all matters related to studying abroad. Please visit https://students.usask.ca for more information.
Land Acknowledgement

I would like to acknowledge that the Saskatoon campus of the University of Saskatchewan is on Treaty Six Territory and the Homeland of the Métis. We pay our respect to the First Nation and Métis ancestors of this place and reaffirm our relationship with one another. I would also like to recognize that some may be attending this course from other traditional Indigenous lands. I ask that you take a moment to make your own Land Acknowledgement to the peoples of those lands. In doing so, we are actively participating in reconciliation as we navigate our time in this course, learning and supporting each other.