

**COMP ENG 4DK4**  
**Computer Communication Networks**

**COURSE OUTLINE**

Please refer to course website for updated information.

**COURSE DESCRIPTION**

This course introduces the design and operation of modern packet-switched computer networks such as the Internet. A variety of important material is covered, including techniques for automatic error control, shared media access control in wired and wireless networks, and the design and performance of the Internet. The course discusses the design of these systems including those factors that affect their performance. The laboratory component introduces discrete-event simulation of computer networks using the C programming language. The simulations are used to characterize the performance of various network related systems.

**PRE-REQUISITES AND ANTI-REQUISITES**

Pre-requisite(s): ELEC ENG 3TQ4 or ELEC ENG 3TQ3

Anti-requisite(s): COMP SCI 4C03

**SCHEDULE and MODE OF DELIVERY**

Lecture: Monday, Wednesday & Thursday 10:30am – 11:20am, MDCL 1105

Tutorial: Tuesday 5:30pm – 6:20pm, BSB B136

Lab: There are no scheduled lab sessions. Lab work starts from week 2. All labs are C-based programming that students can do on their own laptop or PC.

**INSTRUCTOR**

Dr. Dongmei Zhao

E-mail: dzhao@mcmaster.ca

Office: ITB-A323

Phone: 905-525-9140 ext. 27126

Office Hours: see course website for details

**TEACHING ASSISTANTS**

Names, contact information and office hours are provided on the course website.

**COURSE WEBSITE/S**

<http://avenue.mcmaster.ca>

**COURSE OBJECTIVES**

By the end of this course, students should be able to demonstrate their competency and be knowledgeable on the following subjects and topics:

Message Switching: Telegraphy and long-distance communications, optical telegraphy, electronic telegraphy, message switching properties;

Circuit Switching: The telephone network, central switching, analog voice switching, crossbar switches, blocking vs non-blocking, multistage switches, digital voice transmission, digital voice switching, the time-slot-interchanger (TSI), time-division switching, time-multiplexed space-division switching, digital switching using TSIs and TMSs, circuit switching for computer traffic, properties of circuit switching, circuit switch timing;

Packet Switched Networks: Circuit vs packet switching, datagram and virtual circuit packet switching, layered protocol architecture, the Open Systems Interconnection (OSI) Reference Model, connection vs connection-less services and protocols;

Error Control Protocols: Forward error correction, ARQ, sliding window protocols, selective repeat protocols. SR protocol performance over error-free and noisy channels, GO-BACK-N protocols, performance of GO-BACK-N, the use of ARQ protocols at the transport layer, TCP.

Multi-access Communication and Local Area Networks: Media access control, TDMA, FDMA and CDMA, random access networks, ALOHA (slotted and unslotted), throughput analysis, stability considerations, control algorithms for stability, CSMA, performance analysis, Local Area Networks (LANs), IEEE 802 standard LANs, CSMA/CD, Ethernet, capacity limitations, token ring networks, performance of ring networks, bridging.

Network Layer Communications and the Internet: Routing algorithms, shortest path routing, Bellman-Ford Distance Vector routing, RIP, link state routing, OSPF, hierarchical routing, Internet routing, address structure, subnetting, ARP.

Wireless Networking (time permitting): Wireless propagation, cellular network design, cellular geometry and interference-limited channel assignment, mobility management in cellular networks, wireless media access, hidden and exposed CSMA stations, IEEE 802.11 wireless LAN.

Communication Network Simulation: Discrete-event simulation, simulation using the Simlib library, application to various networking systems.

**ASSUMED KNOWLEDGE**

Good knowledge of course material from ELEC ENG 3TQ3 or ELEC ENG 3TQ4

### COURSE MATERIALS

Required Texts:

Communication Networks (Second Edition), A. Leon-Garcia and I. Widjaja, McGraw-Hill, 2004.

Lab tools:

Personal computer or laptop with a C compiler.

Calculator:

Only the McMaster Standard Calculator (Casio fx-991 MS or MS Plus) is permitted in tests and examinations. This is available at the Campus Store.

Other:

Lecture notes

### COURSE OVERVIEW (SUBJECT TO MINOR CHANGES)

Week	Topic	Readings
1	Introduction to Communication Networks	Text Chs. 1, 3, lecture notes
1	Message Switching	Text Ch. 2, lecture notes
2	Circuit Switching	Text Ch. 4, lecture notes
3	Packet Switched Networks	Text Ch. 2, lecture notes
5	Error Control Protocols	Text Ch. 5, lecture notes
8	Multi-access Communication and Local Area Networks	Text Ch. 6, lecture notes
10	Network Layer Communications and the Internet	Text Ch. 7, 8, lecture notes
12	Wireless Networking	Lecture notes
1,2,3	Discrete Event Simulation	Lecture notes

A more detailed timeline is available on the course website.

At certain points in the course, it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

### LABORATORY OVERVIEW

**Labs are NOT held during the first week of term.**

**Lab Topic**

1	Performance of Single Server Queueing Systems
2	Packet Switched Network and Integrated Voice Performance
3	Call Blocking in Circuit Switched Networks
4	The ALOHA Media Access Control Protocol

**5 Scheduling for Mobile Cloud Computation Offloading**

**ASSESSMENT**

Component	Weight
Labs (5)	25%
Quizzes (10)	10%
Mid-term Exam (1)	0% or 20% *
Final Exam (1)	65% or 45% *
Total	100 %

**Grading and Evaluation Policies**

- There are five (5) labs, ten (10) quizzes, one (1) mid-term exam, and one (1) final exam to be evaluated in this course.
- A passing grade for the final exam is required in order to pass the course.
- Use of books, notes, other copied materials, computers or cell phones are not allowed during exams.
- \*20% of the mark is taken as the best of the midterm and final exam.
- No make-up midterm test is granted. Weight of a missed midterm test is transferred to the final exam.
- Quizzes are open-book and done on Avenue-to-Learn. No make-up quizzes are granted. A zero mark is given for a quiz that is not completed before the deadline.

**ACADEMIC INTEGRITY**

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

### **AUTHENTICITY / PLAGIARISM DETECTION**

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to [www.mcmaster.ca/academicintegrity](http://www.mcmaster.ca/academicintegrity).

### **COURSES WITH AN ON-LINE ELEMENT**

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

### **COPYRIGHT AND RECORDING**

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, including lectures by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

### **CONDUCT EXPECTATIONS**

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online. It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

### **ACADEMIC ACCOMMODATIONS**

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or [sas@mcmaster.ca](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University’s Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations.

Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

### **REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK**

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

### **EXTREME CIRCUMSTANCES**

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

<b>ACCREDITATION LEARNING OUTCOMES</b>
--

Note: The *Learning Outcomes* defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of the accreditation process for the program and will not be taken into consideration in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit: <http://www.engineerscanada.ca>.

Outcomes	Indicators	Measurement Method(s)
<p><b>Constructs effective oral or written arguments as appropriate to the circumstances:</b></p> <p>Summarize the operation, properties, and performance, of message switched networks.</p> <p>Understand the functioning of circuit switched networks including a quantitative understanding of their blocking performance behaviour.</p> <p>The tradeoffs between circuit and packet switched network operation and an understanding of layered protocol design used in packet switched networks.</p>	7.3	Final exam
<p><b>Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions:</b></p> <p>Understand the use and performance of common packet switched error control methods, i.e., automatic repeat request (ARQ) protocols.</p> <p>Understand the operation and performance of media access control in packet switched networks with shared channels, e.g., static channelization, random access, and reservation protocols.</p>	2.2	Final exam
<p><b>Selects appropriately from relevant knowledge base to plan appropriate data collection methods and analysis strategies:</b></p> <p>Examining performance of the ALOHA-family protocols, including throughput and delay as input traffic load changes;</p> <p>Understand the stability issue of the protocols;</p>	3.1	Lab 4

Obtain skills of adjusting and fine-tuning simulation parameters.

**Determines and employs applicable standards and codes of practice.**

4.6

Final exam

Working knowledge of IP routing in the Internet, i.e., address structure, subnetting, ARP.

[www.eng.mcmaster.ca/ece](http://www.eng.mcmaster.ca/ece)

## Electrical and Computer Engineering Lab Safety

### Information for Laboratory Safety and Important Contacts

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory and online <https://hr.mcmaster.ca/app/uploads/2019/07/2019-McMaster-Lab-Manual.pdf>

### General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following whether conducting lab work at school or at home:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe condition.
6. The location and correct use of all available safety equipment should be known.



7. Potential hazards and appropriate safety precautions should be determined, and sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.
9. Personal ergonomics should be practiced when conducting lab work. <https://bit.ly/3fOE71E>
10. Current University health and safety issues, and protocol should be known.  
<https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/>

## Location of Safety Equipment

### Fire Extinguisher

On walls in halls outside of labs

### First Aid Kit

ITB A111, or dial "88" after 4:30 p.m.

### Telephone

On the wall of every lab near the door

### Fire Alarm Pulls

Near all building exit doors on all floors

## Who to Contact

**Emergency Medical / Security:** On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.

**Non-Emergency Accident or Incident:** Immediately inform the TA on duty or Course Instructor.

**University Security (Enquiries / Non-Emergency):** Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

**See TA or Instructor:** For problems with heat, ventilation, fire extinguishers, or immediate repairs

**Environmental & Occupational Health Support Services (EOHSS):** For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

**ECE Specific Instructional Laboratory Concerns:** For non-emergency questions specific to the ECE laboratories, please contact 24103.

## In Case of a Fire (On Campus Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not

attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.

6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

## Clothing on Fire

**Do not use a fire extinguisher on people**

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

## Equipment Failure or Hazard

**Failure of equipment may be indicative of a safety hazard - You must report all incidents.**

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In power labs, press wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

## Protocol For Safe Laboratory Practice

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

## Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer- ITB 147	<a href="mailto:steve@mail.ece.mcmaster.ca">steve@mail.ece.mcmaster.ca</a>
ECE Chair	Mohamed Makr- ITB A111	<a href="mailto:mbakr@mcmaster.ca">mbakr@mcmaster.ca</a>
ECE Administrator	Kerri Hastings- ITB A111	<a href="mailto:hastings@mcmaster.ca">hastings@mcmaster.ca</a>
ECE Course Instructor	Please contact your specific course instructor directly	