CME 451.3 (3L-1P)
Transport Networks

Department of Electrical and Computer Engineering
Winter 2015

UNIVERSITY OF SASKATCHEWAN

Description: Topics include requirements of core and metropolitan telecommunications networks for the transport layer; physical layer technologies such as optical and electrical transmission, clock synchronization and receiver code alignment; protocols for transport networks including SONET, ATM, MPLS, Ethernet, IP, and RPR, physical and logical circuit switching, packet and cell switching, queuing and traffic management, and the design of network elements and the design of next-generation transport networks.

Prerequisites: EE 232 or CMPT 320.

Corequisites: None

Instructor:
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Lectures: Monday, Wednesday, Friday, 11:30 a.m. – 12:20 p.m., Room ENG 2C44

Tutorials: To be scheduled when needed

Laboratory: L02: Tuesday, alt. weeks, 8:30 a.m.–11:20 a.m., room 2C61 (starting January 20, 2015)

Website: Assignments, solutions, lab schedules, general course information, and announcements will be posted on the course website. Students are responsible for keeping up-to-date with the information on the course website.

General site: http://www.engr.usask.ca/classes/CME/451/
Blackboard Content: https://bblearn.usask.ca (login with your NSID)

Course Reference Numbers (CRNs): 31250 (lectures)
31251 (L02)

Textbooks: Krzysztof Iniewski, Carl McCrosky and Daniel Minoli, *Network Infrastructure and Architecture: Designing High-Availability Networks, 1st Ed.* (Wiley, 2008) (main text)

Behrouz Forouzan, *Data Communications and Networking*, 4th Ed. (McGraw Hill, 2007)

Office Hours: Students are welcome to drop by the instructor's office at any time for help with the course (open-door policy). Students may also schedule a specific, mutually convenient, time for a meeting, arranged via email or phone.

Reading List: none

Assessment: The methods of assessment and their respective weightings are given below:

Assignments (5 or 6)	18%
Labs (6)	12%
Midterm Exam	20%
Final Exam	50%

Final Grades: The final grades will be consistent with the "literal descriptors" specified in the university's grading system.

http://students.usask.ca/current/academics/grades/grading-system.php

For information regarding appeals of final grades or other academic matters, please consult the University Council document on academic appeals.

http://www.usask.ca/university_secretary/honesty/StudentAcademicAppeals.pdf

Course Content: The course uses content mainly from the textbooks. Approximate correspondences between topics and chapters (from the Iniewski textbook, unless otherwise noted) are indicated in the following.

1. Introduction to Networking (Chapter 1)
2. Fiber Optic Transmission (Chapter 2)
3. Wavelength Division Multiplexing (Chapter 3)
4. SONET (Chapter 4)
5. TCP/IP (Chapter 5; Forouzan: Chapter 23)
6. Protocol Stacks (Chapter 6)
7. VLSI for Networking (Chapter 7)
8. Physical Circuit Switching (Chapter 9)
9. TDM Switching (Chapter 10)
10. Introduction to Network Security (Forouzan: Chapters 30-31)

Assignments: There will be an assignment approximately every two weeks, based on the pace of the lecture content. Completed assignments must be submitted on the specified due date in the CME451 assignment box (second floor, across Room 2C94E). Late assignments will not be marked, and will be given a mark of zero.

Tutorials: No regularly scheduled tutorials for this class. However, when needed, tutorials will be arranged to cover specific topics, particularly to coincide with exams.

Quizzes: None

Exams: There will be one midterm exam and one final exam. All exams are closed textbook, with non-programmable calculator permitted.

Important Dates:

January 5, 2015	Course begins
April 8, 2015	Course ends

Student Conduct: Ethical behaviour is an important part of engineering practice. Each professional engineering association has a Code of Ethics, which its members are expected to follow. Since students are in the process of becoming Professional Engineers, it is expected that students will conduct themselves in an ethical manner.

The APEGS (Association of Professional Engineers and Geoscientists of Saskatchewan) Code of Ethics states that engineers shall "conduct themselves with fairness, courtesy and good faith towards clients, colleagues, employees and others; give credit where it is due and accept, as well as give, honest and fair professional criticism" (Section 20(e), The Engineering and Geoscience

Professions Regulatory Bylaws, 1997).

The first part of this statement discusses an engineer's relationships with his or her colleagues. One of the ways in which engineering students can demonstrate courtesy to their colleagues is by helping to maintain an atmosphere that is conducive to learning, and minimizing disruptions in class. This includes arriving on time for lectures, turning cell phones and other electronic devices off during lectures, not leaving or entering the class at inopportune times, and refraining from talking to others while the instructor is talking. However, if you have questions at any time during lectures, please feel free to ask (chances are very good that someone else may have the same question as you do).

For more information, please consult the University Council Guidelines for Academic Conduct.

http://www.usask.ca/university_secretary/council/reports_forms/reports/guide_conduct.php

Academic Honesty: The latter part of the above statement from the APEGS Code of Ethics discusses giving credit where it is due. At the University, this is addressed by university policies on academic integrity and academic misconduct. In this class, students are expected to submit their own individual work for academic credit, properly cite the work of others, and to follow the rules for examinations. Academic misconduct, plagiarism, and cheating will not be tolerated. Copying of assignments and lab reports is considered academic misconduct. Students are responsible for understanding the university's policies on academic integrity and academic misconduct. For more information, please consult the University Council Regulations on Student Academic Misconduct and the university's examination regulations.

http://www.usask.ca/university_secretary/honesty/StudentAcademicMisconduct.pdf
http://www.usask.ca/university_secretary/council/academiccourses.php

Safety: The APEGS Code of Ethics also states that Professional Engineers shall "hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace" (Section 20(a), The Engineering and Geoscience Professions Regulatory Bylaws, 1997).

Safety is taken very seriously by the Department of Electrical and Computer Engineering. Students are expected to work in a safe manner, follow all safety instructions, and use any personal protective equipment provided. Students failing to observe the safety rules in any laboratory will be asked to leave.

Laboratory Learning Outcomes:

Lab 1: Python Basics

Upon completion of this Lab the students should be able to:

- Demonstrate proficiency in the basic environment of Python programming, including: create a Python program, run it, and produce outputs.

Lab 2: Application-Layer Network Programming

Upon completion of this Lab the students should be able to:

- Write simple application-layer network programs, to retrieve information from a website and perform data analysis.

Lab 3: Socket Programming

Upon completion of this Lab the students should be able to:

- Explain the basics of socket programming for TCP connections in Python.
- Write Python programs to creating a socket, binding it to an IP address and port number, and sending and receiving HTTP packets.
- Create a simple web server and client using Python standard libraries.

Lab 4: Analyzing IP Packet Headers

Upon completion of this Lab the students should be able to:

- Explain the IPv4 packet structure and header format.
- Analyze the information in the headers of IP packets.
- Write Python script to parse headers into standard human-readable format.

Lab 5: IP Fragmentation and TCP Headers

Upon completion of this Lab the students should be able to:

- Analyze how IPv4 datagrams are fragmented while passing through different networks with different MTUs.
- Analyze the header format of TCP segments in order to understand how TCP accomplishes its goals.
- Write Python scripts to: (1) defragment IPv4 fragments; (2) parse TCP headers.

Lab 6: Error Detection

Upon completion of this Lab the students should be able to:

- Explain the principles of error detection in the TCP/IP suite.
- Perform and analyze error detection at the network and transport layers.
- Write Python programs to compute and validate the checksums in the IPv4 and UDP protocols.

Course Learning Outcomes:

Upon completing this course students will be able to:

1. Explain basic network concepts, including characterizing fundamental network topologies, transmission media and network equipment.
2. Describe and analyze fiber-optic transmission systems, with propagation and corresponding transmitters and receivers.
3. Explain the computational aspects and design of wavelength division multiplexing systems.
4. Explain the design and implementation requirements of SONET, including equipment and synchronization specifications.
5. Explain the rationale and design specifications of the TCP/IP suite and Protocol Stacks.
6. Explain the role of VLSI technologies in networking systems.
7. Describe and analyze switching networks based on physical switching and time division multiplexing.
8. Explain the role of cryptography for secure authentication and digital signatures in networks.
9. Perform hands-on network analysis and practical programming tasks, to complement the concepts taught throughout the course, specifically with the Python environment.

Attribute Mapping:

*Level of Performance**

Learning Outcome	Attribute**											
	A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**	**A11**	**A12**
1	1											
2	2	2	3									
3	2	2	3	3								
4	2	3	3	3								
5	2	3	3	3	2							
6	2	2										
7	2	3	3	2								
8	2	2	2	1								
9	2	2		3	2							

**Attributes:

A1 Knowledge base for engineering
A2 Problem analysis
A3 Investigation
A4 Design
A5 Use of engineering tools
A6 Individual and team work
A7 Communication skills
A8 Professionalism
A9 Impact of engineering on society and the environment
A10 Ethics and equity
A11 Economics and project management
A12 Life-long learning

*Levels of Performance:

1 - **Knowledge** of the skills/concepts/tools but not using them to solve problems.
2 - **Using** the skills/concepts/tools to solve directed problems. (*"Directed" indicates that students are told what tools to use.*)
3 - **Selecting** and using the skills/concepts/tools to solve non-directed, non-open-ended problems. (*Students have a number of S/C/T to choose from and need to decide which to employ. Problems will have a definite solution.*)
4 - **Applying** the appropriate skills/concepts/tools to solve open-ended problems. (*Students have a number of S/C/T to choose from and need to decide which to employ. Problems will have multiple solution paths leading to possibly more than one acceptable solution.*)

Accreditation Unit (AU) Mapping: (% of total class AU)

Math	Natural Science	Complementary Studies	Engineering Science	Engineering Design
-	-	-	29.7 AU (65%)	16.0 AU (35%)

Assessment Mapping:

Component	Weighting	Methods of Feedback***	Learning Outcomes Evaluated
Assignments	18%	S	1,2,3,4,5,6,7,8
Laboratory	12%	S	1,5,7,8,9
Midterm Exam	20%	S	1,2,3,4,5
Final Exam	50%	S	1,2,3,4,5,6,7,8,9

***Methods of Feedback:

F – *formative* (written comments and/or oral discussions)
S – *summative* (number grades)