CARLETON UNIVERSITY

Department of Systems and Computer Engineering

SYSC 4700 Telecommunications Engineering Winter 2020

Course Outline (updated on Jan 12, 2020)

Instructor: Halim Yanikomeroglu
E-mail: halim@sce.carleton.ca
Office: MC 7032
Office Hour: Tuesdays and Thursdays, 2:30 – 3:00 pm

TAs: Rawan Alkurd ME 4390 rawanalkurd@cmail.carleton.ca
Qiao Lu ME 4390 qiaolu@cmail.carleton.ca

Lectures: Tuesdays & Thursdays, 1:05 – 2:25 pm Classroom: SA 304
Laboratory: Fridays: 08:35 am – 11:25 am Lab: ME 4390

Website: The cuLearn page will be maintained for the course.

Past website: http://www.sce.carleton.ca/courses/sysc-4700
The website contains past assignments, course notes.

Course Notes: Copies of lecture slides will be available at the cuLearn website. Refer to the attached lecture schedule (subject to change). Most lecture slides may not be available until just before the scheduled lecture.

Calendar Description:

Lectures: Three hours a week; laboratory/problem analysis: three hours alternate weeks.

Course Prerequisites: Fourth-year status; SYSC 3501 Communication Theory or SYSC 3503 Communication Theory II.

Students who have not satisfied the prerequisite for this course must either (a) withdraw from the course, (b) submit a prerequisite waiver through to the associate deans’ office (FED) or (c) will be deregistered from the course after the last day to register for courses in Winter 2020 term.

Course Objectives:
The modern telecommunications network is based on a broad spectrum of engineering principles for its design, evolution, operation and management. This course surveys these broad topics from a telecommunications industry perspective. We are fortunate in having a number of experts from the telecommunications industry, and the federal government, as well as from Carleton University to give the lectures.

The scope of this course is broader than almost any other course you have taken. The course aims to give you the big picture. The course may help in job interviews as well.

Assumed Knowledge:
Upon entry into the course, the students are expected to have knowledge of linear systems with input-output characterization (SYSC 3600/2500, SYSC 3501/3503), frequency domain analysis (SYSC 3600/2500), elementary digital communications (SYSC 3501/3503), and fundamentals of networking. Fourth-year status is a course prerequisite.
Learning Outcomes:
1. Ability to discuss the history of telecommunication especially the evolution from 1G to 5G and beyond.
2. Ability to understand different types of transmission media, their characteristics and bandwidth requirements for different technologies.
3. Ability to understand the link budget analysis, calculate the required transmission power for a given bandwidth and bit error rate.
4. Familiarity with different topics such as Voice over IP, patenting, cryptography, machine learning, cellular communication, telecommunication standards, wireless networks, packet networking, cloud computing, multiprotocol label switching (MPLS), software defined networks (SDN), etc.

Graduate Attributes (GA’s):
The three course learning outcomes listed above are used to develop competencies related to the Canadian Engineering Accreditation Board (CEAP) Graduate Attributes (GAs). In this course, we have identified three GAs with the following three indicators:

1.9.S → Communication networks (activities related to learning outcome 2 and 3)
8.4 → Knowledge of professional certification requirements (activities related to learning outcome 1 and 3)
12.2 → Knowledge of professional certification requirements (activities related to learning outcome 1 and 3)

Data obtained from the course group term project will be used to measure students’ progress towards indicators 1.9.S. Course case studies data will be used to map GA 8.4 and GA 12.2. Different sections of the course final exam will be used in part for Gas 8.4, 12.2 and fully for 1.9.S.

In addition, activities related to learning outcomes 1, 2, 3, and 4 are intended to prepare students to undertake learning activities that develop competence in GA 4 (design solutions for complex, open-ended engineering problems) in subsequent courses.

Text:
No textbook (refer to the course notes).

References:

Grading:
Bell Central Office and Global Network Management Centre tour: +/- 5%
Bell Mobility tour: +/- 5% (to be confirmed)
Term exam: 15% (Thursday, Feb 13)
Assignments: 5%
Project: 20%
Final Exam: 50%
If the Bell Mobility tour cannot be arranged, the weight of the term exam will be increased to 20%.

Term Exam:
Closed book (bring a calculator), scheduled on Thursday, February 13, during 1:05 – 2:25 pm; location: in-class (SA 304).

Final Exam:
The final examination is for evaluation purposes only and will not be returned to students. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available.

Note:
1. The instructor reserves the right to set the final exam (and deferred exam if necessary) to cover all the materials (i.e. lecture notes, handouts, tours, and reference materials) examined and covered in class and during project.
2. Students who miss the final exam may be granted permission to write a deferred examination. Section 2.5 of the Academic Regulations of the University applies in case of deferred final exam.

Labs:
Laboratories consist of a number of components:

a) Bell Central Office (CO) & Global Network Management Centre (GNMC) tour (mandatory). Sign-up sheets will be posted next to the instructor's office door on Thursday,
Jan 09, after the lecture:

Tour 1: Friday, Jan 17, 9:00-11:00 am  
Tour 2: Friday, Jan 24, 9:00-11:00 am  
Tour 3: Friday, Jan 31, 9:00-11:00 am  
Tour 4: Friday, Feb 07, 9:00-11:00 am  
Tour 5: Friday, Feb 14, 9:00-11:00 am  
Tour 6: Friday, Feb 21, 9:00-11:00 am  
Tour 7: Friday, Feb 28, 9:00-11:00 am

Location: 78 O’Connor Street (downtown; easily accessible by OC Transpo)

b) Bell Mobility tour (mandatory). (To be confirmed)

c) TA Office Hours: Fridays, 8:35 – 11:25 am, 4390 ME (lab time).

d) Group project meetings among students.

Laboratory and Assignments: This portion of the course consists of three major components:

1. (worth a total of 5%) About 3-4 assignments based on the lecture material. All assignments and reports will be handed in to designated assignment boxes in Mackenzie.

2. (worth 20%) A group project, in which you will work in groups of 3-4 to recommend solutions to an engineering problem in the form of a report. Project topic and further related information will be provided during the term. The best project will get an award (the best project award certificate).

3. (worth +5% or -5%) A tour of the Bell Central Office and Global Network Management Centre at 78 O’Connor St. A student not attending the tour gets -5%.

4. (worth +5% or -5%) A tour a Bell Mobility facility (TBD). A student not attending the tour gets -5%.

5. TA Office Hours are part of the lab system as well.

Every student should have a copy of our Health and Safety Manual. An electronic version of the manual can be found at: http://www.sce.carleton.ca/courses/health-and-safety.pdf

General Regulations

Attendance: Students are expected to attend all lectures and lab periods. The University requires students to have a conflict-free timetable. For more information, see the current Undergraduate Calendar, Academic Regulations of the University, Section 2.1.3, Course Selection and Registration and Section 2.1.7, Deregistration.

Health and Safety: Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: http://sce.carleton.ca/courses/health-and-safety.pdf

Deferred Term Work: Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current Undergraduate Calendar, Academic Regulations of the University, Section 4.4, Deferred Term Work.

Appeal of Grades: The processes for dealing with questions or concerns regarding grades assigned during the term and final grades is described in the Undergraduate Calendar, Academic Regulations of the
Academic Integrity: Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: https://carleton.ca/registrar/academic-integrity/ This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

Plagiarism: Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.

Academic Accommodation: You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at http://www.carleton.ca/equity/

For an accommodation request, the processes are as follows:

- **Pregnancy obligation**: Contact the instructor for any request for academic accommodation during the first two weeks of classes, or as soon as possible after the need for accommodation is known to exist. For more details, refer to https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf.

- **Religious obligation**: Contact the instructor for any request for academic accommodation during the first two weeks of classes, or as soon as possible after the need for accommodation is known to exist. For more details, refer to https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf.

- **Academic Accommodations for Students with Disabilities**: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult https://carleton.ca/pmc/students/dates-and-deadlines/ for the deadline to request accommodations for the formally-scheduled exam (if applicable).

- **Survivors of Sexual Violence**: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/.

- **Accommodation for Student Activities**: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, refer to https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf.

- **Absences**: Medical certificates for absences from tests, assignments, as well as the Bell tours, must be presented within one week after the test or assignment due date or tour date. Otherwise, the student will get zero from that component of the course.

**Copyright on Course Materials**: The materials created for this course (including the course outline and any slides, posted notes, labs, project, assignments, quizzes, exams and solutions) are intended for personal use and may not be reproduced or redistributed or posted on any web site without prior written permission from the author(s).
Central Office & GNMC and Bell Mobility Tours
Sign up for one of the possible visit times (the signup sheets will be posted on the wall next to 7032 MC starting on Jan. 9 after the lecture): Note that signup is first come-first served, and that no more than 11 students will be allowed to sign up for each visit. The Bell facilities must have a list of all visitors in advance of their visits. Therefore, no “last minute” visits will be allowed – you must sign up well in advance.

You are responsible for your own transportation to and from these facilities. The facilities have a high degree of security, and there are very strict rules and regulations regarding visits. See the rules on the next page of this document. If you arrive late or have to cancel, there is no guarantee that you can get on a later visit.

SYSC 4700 Course Instruction Personnel

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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<tbody>
<tr>
<td>Osama Aboul-Magd, PhD</td>
<td>Principal Engineer, Huawei Canada Research Centre</td>
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<td></td>
<td>Chair, IEEE 802.11ax Technical Group</td>
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<tr>
<td>Mohamed Ahmed</td>
<td>Cloud Infrastructure Engineer, CENGN</td>
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<tr>
<td>Andre Brandao, PhD</td>
<td>Project Leader, CRC (Communications Research Centre of Canada)</td>
</tr>
<tr>
<td>Yaser Eftekhari, PhD</td>
<td>Senior Software Architect, Irdeto</td>
</tr>
<tr>
<td>Matthias Falkner, PhD</td>
<td>Distinguished Technical Marketing Engineer, Cisco Systems Canada</td>
</tr>
<tr>
<td>Nathalie Guthrie</td>
<td>Director, HR, CENGN (Centre of Excellence in Next Generation Networks)</td>
</tr>
<tr>
<td>Tony Hutchinson</td>
<td>Cloud Architect, Mitel Networks</td>
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<tr>
<td>Paul Kloppenburg</td>
<td>Senior Strategic Architect, Avaya Networks</td>
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<tr>
<td>Jim MacFie</td>
<td>National Standards Officer, Microsoft Canada</td>
</tr>
<tr>
<td>Stephen Rayment</td>
<td>Vice President, Technology Solutions, Ericsson</td>
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<tr>
<td>Ted Reinhardt</td>
<td>Founder, Testpuddle Inc.</td>
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<tr>
<td>Tony Rybczynski</td>
<td>Director, Enterprise Networks, Nortel (retired)</td>
</tr>
<tr>
<td>Henry Starzynski</td>
<td>Manager, Global Network Management Centre, Bell Canada (retired)</td>
</tr>
<tr>
<td>Chuck Story</td>
<td>Director, DSL Architecture, Nokia Canada</td>
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<tr>
<td>Sherif Toulan</td>
<td>Technical Leader, Cisco Systems Canada (retired)</td>
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<tr>
<td>Halim Yanikomeroglu, PhD</td>
<td>Professor, Carleton University</td>
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SECURITY REGULATIONS for BELL CANADA CENTRAL OFFICE (78 O’Connor Street) and BELL MOBILITY (location: TBD) TOURS

ALL TOUR GROUPS MUST AGREE WITH THE FOLLOWING SECURITY BEFORE ENTERING THIS LOCATION

1. GROUP SIZE MUST NOT EXCEED 10 PEOPLE
2. ALL GROUPS MUST SUPPLY AN ATTENDEE LIST PRIOR TO ENTRY
3. ANYONE NOT ADHERING TO THE SCHEDULE WILL BE DENIED ACCESS
4. NO CAMERAS
5. NO FOOD OR BEVERAGES
6. NO BACKPACKS
7. IF YOU DO NOT HAVE A BELL ID, YOU MUST SIGN IN WITH SECURITY. CENTRAL OFFICE IS A VISABLE ID ZONE
8. THE ONLY TOURS SANCTIONED BY SECURITY ARE PREAUTHORISED BY THE DESIGNATED OPERATIONS TOUR TEAM
9. BELL IS REQUIRED BY LAW TO ADVISE YOU OF BUILDING EMERGENCY OPERATIONS PROCEDURES (EOP)
   A) ‘SLOW BELL’ FIRE ALARM WILL TERMINATE YOUR TOUR
   B) PROCEED IMMEDIATELY TO YOUR DESIGNATED EXIT AND EVACUATE AS DIRECTED BY YOUR TOUR LEADER OR BY THE BUILDING EMERGENCY CO-ORDINATOR
   C) KEEP TO THE RIGHT OF THE STAIRS
   D) WALK, DO NOT RUN
   E) DO NOT ENTER ANY OTHER FLOOR UNLESS ORDERED TO DO SO OVER THE PUBLIC ADDRESS SYSTEM
   F) DO NOT USE ELEVATOR

Typical Tour Components:
Power Room
Cable Vault
Main Distribution Frame
DMS
DSLAM
Transport Equipment
Fibre Management System
DS/DS1/DS3
X-connects
Fibre Multiplexers
Winter 2020 – Lecture Schedule [last update: 12 January 2020]

All lectures are in SA 304 (Southam Hall) and held during 1:05 – 2:25 pm

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<th>Topic</th>
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<td>Tue Jan 07</td>
<td>Introduction, Objectives</td>
<td>H. Yanikomeroglu</td>
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<td>ICT &amp; 5G Wireless</td>
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<tr>
<td>2</td>
<td>Thu Jan 09</td>
<td>History of Telecommunications</td>
<td>H. Starzynski</td>
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<td>Network Management</td>
<td>H. Starzynski</td>
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<tr>
<td>3</td>
<td>Tue Jan 14</td>
<td>Packet Networking</td>
<td>T. Rybczynski</td>
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<td>4</td>
<td>Thu Jan 16</td>
<td>Transmission of Information – I</td>
<td>H. Yanikomeroglu</td>
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<tr>
<td>5</td>
<td>Tue Jan 21</td>
<td>Transmission of Information – II</td>
<td>H. Yanikomeroglu</td>
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<td>6</td>
<td>Thu Jan 23</td>
<td>Global Telecommunications Standards</td>
<td>J. MacFie</td>
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<td>7</td>
<td>Tue Jan 28</td>
<td>Transmission Media – I</td>
<td>M. Yanikomeroglu</td>
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<td>8</td>
<td>Thu Jan 30</td>
<td>Transmission Media – II</td>
<td>M. Yanikomeroglu</td>
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<td>9</td>
<td>Tue Feb 04</td>
<td>Broadband Access Technologies – xDSL &amp; FTTx</td>
<td>C. Storry</td>
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<td>10</td>
<td>Thu Feb 06</td>
<td>Voice over IP</td>
<td>T. Hutchinson</td>
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<td>11</td>
<td>Tue Feb 11</td>
<td>Introduction to Data Analytics and Machine</td>
<td>A. Brandao</td>
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<td>Learning in Communications</td>
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<td>12</td>
<td>Thu Feb 13</td>
<td>Term Exam</td>
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<td>Winter Break (Feb 17–21)</td>
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<tr>
<td>13</td>
<td>Tue Feb 25</td>
<td>Cellular Communications &amp; Networks – I</td>
<td>H. Yanikomeroglu</td>
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<td>14</td>
<td>Thu Feb 27</td>
<td>Cellular Communications &amp; Networks – II</td>
<td>H. Yanikomeroglu</td>
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<td>15</td>
<td>Tue Mar 03</td>
<td>Wireless LAN / WiFi – I</td>
<td>S. Rayment</td>
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<td>16</td>
<td>Thu Mar 05</td>
<td>Wireless LAN / WiFi – II</td>
<td>O. Aboul-Magd</td>
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<tr>
<td>17</td>
<td>Tue Mar 10</td>
<td>Cryptography I – Introduction</td>
<td>Y. Eftekhari</td>
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<td>18</td>
<td>Thu Mar 12</td>
<td>Cryptography II – Advanced Topics</td>
<td>Y. Eftekhari</td>
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<td>19</td>
<td>Tue Mar 17</td>
<td>Cryptography III – Network Security</td>
<td>T. Reinhardt</td>
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<td>20</td>
<td>Thu Mar 19</td>
<td>Containers</td>
<td>M. Ahmed N. Guthrie</td>
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<td>21</td>
<td>Tue Mar 24</td>
<td>Multiprotocol Label Switching (MPLS) Services</td>
<td>S. Toulan</td>
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<td>22</td>
<td>Thu Mar 26</td>
<td>Internet Technology &amp; Cloud Computing Overviews</td>
<td>P. Kloppenburg</td>
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<tr>
<td>23</td>
<td>Tue Mar 31</td>
<td>Quantum Computing Non-Terrestrial Networks</td>
<td>A. Brandao H. Yanikomeroglu</td>
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<td>24</td>
<td>Thu Apr 02</td>
<td>Network Function Virtualization (NFV) Software Defined Networks (SDN)</td>
<td>M. Falkner</td>
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