

**TERM:** Fall 2008

May 2008

**COURSE No:** TLEN 5400

**COURSE TITLE:** Network Design and Optimization

**INSTRUCTOR:** Gerald Mitchell  
Interdisciplinary Telecommunications Program  
University of Colorado  
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Boulder, CO 80309

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**CLASS DAYS/TIMES ON CAMPUS:** Tuesdays and Thursdays 8:00 – 9:15 AM

**REQUIRED TEXT:** Tentative - TBD

Digital Telephony, Third Edition, John Bellamy, 1991 and Telecommunication Sciences - Traffic Theory (instructor's notes), possibly Carrier Grade VoIP.

**Optional References:**

Queuing Theory for Telecommunications, John Daigle, 1992.  
Switching and Traffic Theory for Integrated Broadband Networks, Joseph Hui, 1990.  
Computer Networking, James F. Kurose, 2<sup>nd</sup> Ed. (3<sup>rd</sup> ?), 2003.

**PREREQUISITES:** TLEN 5310 & TLEN 5330 or equivalent with instructor's approval.

**COURSE OBJECTIVE:**

This course is designed to provide the student with a fundamental understanding of traditional traffic engineering concepts and an introduction to packet network analysis. It emphasizes the practical application of mathematical models for determining telecommunications equipment requirements and expected blocking and/or delay.

**COURSE DESCRIPTION:**

This course provides computational methods and analysis of determining equipment requirements for telecommunication systems. Topics include traffic theory, queuing theory, blocking, Erlang, Wilkinson, delay theories and computational procedures involving various traffic engineering algorithms and tables. The sizing of both traditional and VoIP networks will be covered.

**COURSE REQUIREMENTS:**

**Homework:** Homework assigned on Tuesday of each week, to be turned in Tuesday of the following week. Distant learning students have an additional week for homework and exams.

**Class Project:** Design a new nationwide long distance company to compete with the big interexchange carriers using VoIP and softswitch technology. There will be two hub cities and 12

nodes (cities) total. Your job is to size the softswitches, signaling links and the media channels using silence suppression. You'll also size one central office and one access tandem that feeds calls into your new company's system.

**EXAMINATIONS:** Midterm, Final Exam and Class Project

**CLASS ATTENDANCE:**

On-campus students, attendance is mandatory. Students are responsible for all material covered in class and in the instructor's notes.

**GRADING POLICY:**

Homework	30%
Midterm Exam	25%
Final Exam	35%
Class Project	10%

Please submit all homework and exams to Gerald Mitchell. CAETE (distance learning) students may send assignments to the above address, fax or via email (strongly encourage email!).

CAETE exams should be faxed or mailed to Gerald Mitchell. Make sure to put your **full name**, student number, University course number and assignment number on all returned homework and exams. Please put your name on each page. If you do not put your name on the paper in the **space provided** there will be a 10 point penalty. On exams, if you do not do your work on the paper provided there will be a 10 point penalty.

**!! Do not !!** send tests or homework to CAETE. This simply slows down the whole process.

Do not call or contact CAETE with questions about homework or exams, except for their distribution. Do call CAETE about distribution of materials and/or tapes/CDs or on-line lecture delivery. Do not both mail and also fax copies of the tests.

**EXAMINATIONS:**

Mid-term: 1 ½ hours	Time TBD.
Final: 2 ½ hours	Time TBD.

(all exams are **open book/open notes**)

## **STANDARD CU POLICY STATEMENTS**

### **Disability Services**

If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs may be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, and [www.Colorado.EDU/disabilityservices](http://www.Colorado.EDU/disabilityservices)

### **Conflicts with Religious Holidays**

Campus policy regarding religious observances requires that faculty make every effort to reasonably deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Notify me at least two weeks in advance of any conflict between a religious holiday and a class activity (especially exams). In the case of a conflict with an exam, I will reschedule the exam so as to resolve the conflict.

### **Classroom Behavior**

Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to such behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat all students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which they and their students express opinions. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

### **Discrimination and Sexual Harassment**

The University of Colorado at Boulder policy on Discrimination and Sexual Harassment (<http://www.colorado.edu/policies/discrimination.html>) applies to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at <http://www.colorado.edu/odh>

### **CU Boulder Honor Code**

All students of CU Boulder are responsible for knowing and adhering to the academic integrity policy of this institution, without exception. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council ([honor@colorado.edu](mailto:honor@colorado.edu); 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at <http://www.colorado.edu/policies/honor.html> and at <http://www.colorado.edu/academics/honorcode/>.

### **Policy for Attendance**

Attendance is a requirement for all in-class students. You will be allowed an excuse from attendance of any given class only if you seek and obtain prior approval from the professor. Your grade may be penalized as much as 5% per missed course (if unexcused).

**COURSE OUTLINE AND SCHEDULE: (tentative)**

TLEN 5400

WEEK	TOPIC
1	Introduction to Traffic Principles (forecasting) Calling Patterns & Traffic Characteristics (QOS) Engineering Economic Intervals (Growth – Cost)
2	Circuit Switched Networks Trunking - Erlang B Direct Trunk Groups (Possion Distributed Traffic) Blocked calls lost Blocked calls returning
3	High Usage Trunk Groups (Possion Distributed Traffic) Blocked calls cleared Alternate Routing & Non-random Traffic Intermediate Trunk groups (non-Possion Distributed Traffic) Blocked calls cleared Final Trunk groups (Possion and non-Possion Distributed Traffic) Blocked calls lost
4	Delay systems – Erlang C
5	Digital Switching Central Offices, Access Tandems and PBXs Time Division Switches
6	Single stage switches Multi-stage switches Blocking Switches & Non-Blocking Switches
7	Packet Switched Network IP Networks
8	RTP, RTCP, MPLS & Weighted Fair Queuing
9	Signaling System 7 Switches
10	Signaling links VoIP Systems
11	Softswitches Logical channels
12	Signaling links Media channels
13	Reliability, Availability & Redundancy
14	Data Networks Queuing Infinite Systems Finite Systems
15	Broadcast LANs ALOHA Slotted ALOHA Ethernet - CSMA & CSMA/CD