# ECE610 : Broadband Communication Networks
# Winter 2020

**Instructor:** *Prof. Ravi R. Mazumdar*, [redacted] tel: Ext 7444, e-mail: mazum@uwaterloo.ca

**Lecture Schedule:** [redacted]
Note there will be no lecture on Tuesday Jan 21, 2020.
**Course website:** LEARN/ ECE610

**Office hours:** When not busy in my office or by appointment (please send me an e-mail to set up an appointment).

**Pre-requisite:** Undergraduate probability.

**Aims:**

This is an introductory graduate course on broadband communication networks. The aim of the course is to present the main facets of broadband communication networks i.e. the issues of performance, network design, and protocols. The emphasis in the course will be on modeling and the use of analysis to gain insights for understanding the functioning of networks. The course will emphasize the basic building blocks of communication networks: how they are organized, the various functionalities that are needed for reliable communication between two entities, how to measure performance, and finally how to control and optimize them to obtain good utilization of resources and provide some performance guarantees.

## Course Outline

1. Introduction to broadband networks: wireline and wireless
2. Networking functional elements: Multiplexing. Switching, Routing, Network management
3. Current networks: Network infrastructure, architecture, circuit switched, packet switched, ATM, internet, wireless networks.
4. Circuit-switching: Network performance and source characterization. Introduction to loss models. Erlang formula. Multi-rate circuit switching, Kaufman-Roberts recursion, Overflow process, loss networks. Erlang fixed point formula
5. Packet switching: Modeling. Introduction to queueing theory. Delay estimation. Traffic models. Statistical multiplexing and effective bandwidths
6. Stream sessions: Deterministic network analysis. Introduction to network calculus. Leaky buckets. Weighted Fair Queueinq Scheduling.
7. Routing in networks. Shortest path. Dijkstra's algorithm and Bellman-Ford, routing metrics. Distance Vector protocols, Link state protocols. Maxflow-mincut theorem. Internet routing protocols. Exterior Gateway protocols.

8. Congestion control: Rate-based control for elastic traffic. Window based schemes. TCP and rate control. Admission control

9. Introduction to wireless networks. Multiple access. Aloha, Slotted-aloha. CSMA/CA and WLANs. IEEE 802.11 protocol. Saturation throughput and other performance issues such as stability.

10. Emerging networking scenarios. Cloud computing and load balancing. Redudancy schemes eg. Google Bigtable.

**TEXT AND REFERENCES**

**Text:**

D. Bertsekas and R. Gallager; Data Networks, 2nd Edition, Prentice-Hall, 1992, ISBN 0-13-200916-1

It is recommended that you buy this excellent book. There will be additional material that will be covered and relevant pointers and notes will be given out.

In addition the following books also cover the material to varying degrees:

**References**

1. A. Kumar, D. Manjunath, and J. Kuri: *Communication Networking: An analytical approach*, Morgan-Kaufman (Elsevier), 2004, ISBN 0-12-428751-4 (This is an excellent book that takes a more modern but analytical take on the material. Also highly useful as a reference.)

2. J. Walrand and P. Varaiya, *High Performance Communication Networks*, 2nd ed., Morgan Kaufmann, San Francisco, 2000.

3. K. W. Ross: *Multiservice Loss Models for Broadband Telecommunication Networks (Telecommunication Networks and Computer Systems)*, Springer-Verlag, 1995. (Circuit-switching)

Class notes will be made available from time to time.

## Course Evaluation

- Problem sets will be handed out. The onus is on you all to attempt them. Solutions will be posted on the course website.

- There will be one or two simulation projects that will count for 10% of the grade.

- There will 1 midterm examination that will count for 40% of the grade. The final examination will count for 50%

- This course will involve reading on your own. It is imperative that you obtain a copy of the text. It will be a very good investment especially for those of you with interests in networking.
- Dishonesty in projects will be dealt with harshly.

**This is a basic course and of interest to all students who wish to specialize in communications and networking.**

## Academic Dishonesty

The ECE faculty expect every student to practice honourable and ethical behavior both inside and outside the classroom. Any actions that might unfairly improve a student's score on graded work or examinations will be considered cheating and will not be tolerated. Examples of cheating include (but are not limited to):

- Sharing results or other information during an examination.
- Bringing forbidden material or devices to an examination.
- Working on an exam before or after the official time allowed.
- Requesting a re-grade of answers or work that has been altered.
- Representing as your own work anything that is the result of the work of someone else or material taken from elsewhere (**particularly the web**) without proper attribution.

**Dishonesty during an exam or on a project will result in a failing grade for the entire course**.