

## **CN8814: Network Mathematics and Simulations**

### **Calendar Description**

This course covers the probability theory, the cumulative distribution function (CDF) and probability density function (PDF) of random variables, the Markov chain, the Poisson process, and the queueing theory. This course also covers the traffic management and QoS techniques, which include classification and marking, differentiated services, various queueing disciplines, fragmentation and interleaving, traffic shaping and policing. The course project will involve the simulation and performance analysis of a computer network using OPNET.

### **Course Details**

#### Chapter 1: Probability theory (Lecture 1)

- Sample space event and probabilities Sample space, event, and probabilities
- Axioms of probability
- Conditional probability and independence
- Bayes' theorem

#### Chapter 2: Random variables (Lecture 2 & 3)

- Random variables
- CDF and PDF
- Continuous-type and Discrete-type random variables
- Statistics: mean and variance

#### Chapter 3: Stochastic Processes (Lecture 4)

- Stochastic processes
- Markov chain
- Poisson process

>> Applications of the above concepts in networking/communication will be highlighted whenever possible.

#### Chapter 4: Traffic management and QoS (Lecture 5, 6, 7)

- VoIP fundamentals
- Resource reservation protocol (RSVP)
- QoS marking and differentiated services
- Queueing disciplines
- Traffic shaping and policing

### Chapter 5: Queuing Theory (Lectures 8, 9 & 10)

- Basic model and notation
  - Little's law
  - Markovian systems
    - o M/M/1-queue
    - o M/M/m-queue
    - o M/M/1/K queue
- >> Application of queuing theory in networks

### **Assignments**

- Find the assignments in CN8814 course website (Notes folder)
- Although the assignments will not be collected, it is highly suggested that you do the problems by yourself.

### **References**

- Roy D. Yates, and David J. Goodman, Probability and Stochastic Processes, A Friendly Introduction for Electrical and Computer Engineers, 2nd Edition, Wiley Inc., 2004.
- Fundamentals of Queuing Theory, 4th Edition, John Wiley & Sons Inc., July 2008.
- Wendell Odom, Rus Healy, Naren Mehta, CCIE Routing and Switching Exam Certification Guide, 3rd Edition, Cisco Press, Oct. 2007. (Part IV: QoS)
- Scott Keagy Integrating Voice and Data Networks Cisco Press Oct. 2010

### **Evaluation**

Course Project:	20%
Lab Reports:	15%
Mid-term Test:	25% (2 hours, open book)
Final Examination:	40% (3 hours, open book)

Course Project (using OPNET): Applications of Queuing Systems to Traffic Management  
Labs: (1) Queuing Disciplines and (2) QoS for VoIP

Note: Lab and project work will be submitted through Turnitin.com. Late work will not be accepted and will receive zero credit.

### **Missed Classes and/or Evaluations**

Students are required to inform their instructors of any situation which arises during the semester which may have an adverse effect upon their academic performance, and must request any considerations and accommodations according to the relevant policies and well in advance. Failure to do so will jeopardize any academic appeals.

- *Medical certificates* – If a student misses the deadline for submitting an assignment, or the date of an exam or other evaluation component because of illness, he or she must submit a Ryerson Student Medical Certificate AND an Academic Consideration form within 3 working days of the missed date. Both documents are available at [www.ryerson.ca/senate/forms/medical.pdf](http://www.ryerson.ca/senate/forms/medical.pdf). If you are a full-time or part-time degree student, then you submit your forms to your own program department or school.
- *Religious observance* – If a student needs accommodation because of religious observance, he or she must submit a Request for Accommodation of Student Religious, Aboriginal and Spiritual Observance AND an Academic Consideration form within the first 2 weeks of the class or, for a final examination, within 2 weeks of the posting of the examination schedule. If the required absence occurs within the first 2 weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the required absence. Both documents are available at <http://www.ryerson.ca/senate/forms/reobservforminstr.pdf>. If you are a full-time or part-time degree student, then you submit the forms to your own program department or school.
- *Students with disabilities* – In order to facilitate the academic success and access of students with disabilities, they should register with the Access Centre <http://www.ryerson.ca/studentervices/accesscentre/index.html>. Before the first graded work is due, students should also inform their instructor through an “Accommodation Form for Professors” that they are registered with the Access Centre and what accommodations are required.

### **Academic Integrity and Plagiarism**

Ryerson’s Policy 60 (the *Student Code of Academic Conduct*) applies to all students at the University. The policy and its procedures are triggered in the event that there is a suspicion that a student has engaged in a form of academic misconduct.

Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism. Plagiarism is a serious academic offence and penalties can be severe. In any academic exercise, plagiarism occurs when one offers as one’s own work the words, data, ideas, arguments, calculations, designs or productions of another without appropriate attribution or when one allows one’s work to be copied.

All academic work must be submitted using the citation style approved by the instructor. The most common citation style is APA. Students may refer to the Ryerson Library for APA style guide references: <http://library.ryerson.ca/guides/toolbox/style/>

It is assumed that all examinations and work submitted for evaluation and course credit will be the product of individual effort, except in the case of group projects arranged for and approved by the course instructor. Submitting the same work to more than one course, without instructor approval, is also considered a form of plagiarism.

Students are advised that suspicions of academic misconduct may be referred to the Academic Integrity Office (AIO). Students who are charged with academic misconduct will have a Disciplinary Notation (DN) placed on their academic record (not on their transcript) and will be assigned one or more of the following penalties:

- A grade reduction for the plagiarized work
- A zero for the plagiarized work
- An F in the course
- More serious penalties up to and including expulsion from the University

For more detailed information on these issues, please refer to the full online text for the *Student Code of Academic Conduct* at <http://www.ryerson.ca/senate/policies/pol60-F2014.pdf> and the Academic Integrity Website at [www.ryerson.ca/ai](http://www.ryerson.ca/ai).

Students who do not want their work submitted to this plagiarism detection service must, by the end of the second week of class, consult with the instructor to make alternate arrangements.

Turnitin.com is a plagiarism prevention and detection service to which Ryerson subscribes. It is a tool to assist faculty members in determining the similarity between student work and the work of other students who have submitted papers to the site (at any university), internet sources, and a wide range of journals and other publications. While it does not contain all possible sources, it gives faculty some assurance that students' work is their own. No decisions are made by the service; it simply generates an "originality report". Faculty must evaluate that report to determine if something is plagiarized.

### **Important Resources Available at Ryerson**

Use the services of the University when you are having problems writing, editing or researching papers, or when you need help with course material:

- **The Library** (LIB 2<sup>nd</sup> floor) provides research workshops and individual assistance. Inquire at the Reference Desk or at [www.ryerson.ca/library/info/workshops.html](http://www.ryerson.ca/library/info/workshops.html)
- **The Writing Centre** (LIB 272- B) offers one-on-one tutorial help with writing and workshops [www.ryerson.ca/writingcentre/workshops.htm](http://www.ryerson.ca/writingcentre/workshops.htm)
- **Learning Success** (VIC B-15) offers individual sessions and workshops covering various aspects of researching, writing, and studying. You must book these directly through their website <http://www.ryerson.ca/studentervices/learningsuccess/>
- **English Language Support** (VIC B-17) offers workshops to improve overall communication skills [www.ryerson.ca/studentervices/els/](http://www.ryerson.ca/studentervices/els/)

**There is one general site where you may see and register for all of the workshops offered by all of these areas:** <http://www.ryerson.ca/academicintegrity/workshops.html>