Graduate Course

Outlines

Electrical and Computer Engineering

Ryerson University

September, 2014

Table of contents

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8102: Signal Detection Theory

Prerequisites EE8103

Course Web Page

Compulsory Texts:
1. Signal Detection and Estimation, 2nd edition, Mourad Barkat, Artech House, Inc.
2. Lecture notes from Dr. Soosan Beheshti.

Calendar Description
Classical and statistical detection theory, multiple hypotheses, composite hypotheses, sequential analysis. Classical estimation theory. Representation of random processes. Detection of signals (white and coloured noise, signals with unknown parameters). Estimation of signal parameters. Linear filtering theory, estimation of continuous waveforms. Wiener and Kalman filtering.

Learning Objectives
At the end of this course, the successful student will have a solid understanding of hypothesis testing, Bayesian estimators, parametric estimation, MAP and ML estimators. In addition, the student will have in-depth knowledge of related filtering methods such as Kalman filter and Wiener Filter. The student will be able to evaluate an estimation problem and design the proper estimators accordingly.

Course Organization 3 hours of lecture per week for 13 weeks

Course Evaluation

Midterm exam	20%
Quiz	10%
Problem Set	10%
Course Project	30%
Final exam	30%
Total	100%

Examinations

Midterm examination is a 1.5-hour, closed-book examination that covers all the lectures up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination that covers all the course material.

Project Format

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- Appendices
- Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1-2	Random vectors and random process review	6
3	Gaussian Random vectors	3
4	Decision Theory, Hypothesis Testing	3
5	Parameter Estimation, ML and Bayes' Estimations	3
6-7	Parameter Estimation, Best Linear Unbiased Estimator (Blue)	6
8-9	Stochastic Processes and Systems	6
10	Wiener Filters	3
11	Kalman Filters	3
12	Signal Representation	3
13	Matched filters, Kernels	3

Project

Project	Detailed Description	Week
	Students are required to choose a recently research papers in IEEE Transactions or highly cited Journal which is on the topic of detection and estimation. The project is on thorough and critical analysis of the paper.	5-13

	Throughout the project students evaluate the advantages and disadvantages of the selected work and are encouraged to modify, further design or find other applications for the reviewed paper. In addition to the written project, students must have a 10min presentation.	

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf

Accom. of Student Relig., Abor. and Spir. Observance,
http://www.ryerson.ca/senate/policies/pol150.pdf
Est. of Stud. Email Accts for Official Univ. Commun.,
http://www.ryerson.ca/senate/policies/pol157.pdf

9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8103: Random Processes

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8103/

Compulsory Texts:

1. R.D. Yates and D. J. Goodman, *Probability and Stochastic Processes, a Friendly Introduction for Electrical and Computer Engineering*, Second Edition, John Wiley & Sons, 2004.
2. S. M. Ross, *Introduction to Probability Models*, Eighth Edition, Academic Press, 2003.
3. Lecture notes from Dr. Lian Zhao.

Reference Texts:

1. A. Papoulis and S. U. Pillai, *Probability, Random Variables and Stochastic Proceses*, McGraw Hill, 2002.

Calendar Description

Probability theory: mathematical model, conditional probabilities, random variables, pdf, transformation of random variables, conditional densities, statistical averages. Random processes concept; ensemble, stationarity, ergodicity, correlation and covariance, power spectral density, calculation and measurement of ACF and PSD, Gaussian random processes, noise. Transmission of random processes through linear systems: time-invariant systems, multiple terminals, Gaussian processes, non-stationary processes.

Learning Objectives

At the end of this course, the successful student will have a solid understanding of the methods for statically analysis of random variables and random processes, a good understanding of probability density functions, cumulative distribution functions, typical distributions, mean, variance, characteristic functions, moment generation functions, correlations and covariance, etc. In addition, the student will have in-depth knowledge of conditional probabilities, expectation on condition, Bayes theorem. The student will also be able to solve problems in random processes, such as markov chains and poisson processes.

Course Organization 3 hours of lecture per week for 13 weeks

Course Evaluation

Quizs	20%
Midterm exam	30%
Final exam	50%
Total	100%

Examinations Quizs are 0.5-hour, closed-book examinations that covers all the lecture materials up to the week of the specific examination.

Midterm examination is a 3-hour, closed-book examination that covers all the lecture materials up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination that covers all the course materials.

Course Content

Week	Detailed Description	Hours
1-2	Introduction, set theory, three axioms, Bayes' theorem, law of total probability	6
3-4	Random variables, pdf, cdf, special distributions, binomial random variable approximations	6
5-7	Statistics of RVs: mean, variance, characteristic functions, moment generation functions, correlation and covariance, function of RVs.	9
8-10	Conditional Probabilities: conditional probabilities, conditional cdf and pdf, expectation on condition, independence.	9
11-13	Random Processes: concept, correlation and covariance, markov chains, Poisson processes	9

Note: Schedule of lectures is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on

the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course

3. Student who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
4. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
5. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.

Name of Instructor		Signature of Instructor		Date	
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

EE 8104 Adaptive Signal Processing

Instructor

Sridhar (Sri) Krishnan, Ph.D., P.Eng.
T 247 Eric Palin Hall
T) 416.979.5000 X 6086
F) 416.979.5280

E) krishnan@ee.ryerson.ca
W) www.ee.ryerson.ca/~krishnan/ee8104.html

Lecture hours: Mondays, 6pm to 9pm
Office hours: Tuesdays, 2pm to 5pm

Calender Description

The course begins with a brief review of linear signals and systems. Adaptive filter algorithms such as least mean squares (LMS), recursive least squares (RLS), and recursive least squares lattice (RLSL) will be covered. Linear prediction theory, autoregressive modeling, and spectral estimation will also be discussed. The course will briefly cover advanced adaptive signal analysis techniques based on time-frequency and wavelet transforms. 1 Credit

Course Details

1. **Fundamentals of Digital Signal Processing**

    - Discrete-time signals and systems
    - Z-transform
    - Discrete Fourier Transform (FFT)
    - FIR, IIR filters

2. **Adaptive Filter Algorithms**

    - Stochastic Processes
    - Least Mean Squares (LMS)
    - Recursive Least Squares (RLS)
    - Recursive Least Sqaures Lattice (RLSL)

3. **Signal Modeling**

    - Linear Prediction Theory
    - Autoregressive Modeling, Pole-Zero Modeling
    - Adaptive Signal Models

4. **Spectral Estimation**

    - Parametric Spectral Estimation
    - Non-parametric Spectral Estimation

5. **Advanced Topics**

    - Adaptive Time-frequency Analysis
    - Adaptive Wavelet Analysis

Course Evaluation

- Two Quizzes: 20%
  (Feb 9, March 8)

- Final Exam (will be determined later): 35%

- Project: 25%

- 3 Computer Assignments: 15%

- Class Participation: 5%

Recommended Books

- Manolakis, Ingle, and Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing", McGraw Hill, 2000.

- Proakis and Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", 3e, Prentice Hall, 1996.

- Haykin, "Adaptive Filter Theory", 4e, Prentice Hall, 2002.

Recommended Journals

(Use IEEE Xplore to access these journals)

- IEEE Transactions on Signal Processing
- IEEE Signal Processing Letters
- IEEE Transactions on Image Processing
- IEEE Transactions on Multimedia
- IEEE Trans on Circuits and Systems Part II: Analog and Digital Signal Processing
- IEEE Transactions on Speech and Audio Processing, Signal Processing (EURASIP),
- IEE Proceedings: Vision, Image, and Signal Processing.

Policy on Report Writing

"Students agree that by taking this course all required papers may be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All submitted documents will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. Use of the Turnitin.com service is subject to the terms of user agreement posted on the Tunritin.com site"

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8105: Digital Signal Processing I (F2014)

Prerequisites None

Course Web Page The course will be administered through Ryerson University Blackboard System

Compulsory Texts: J.G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, fourth edition, Pearson Education Inc./ Pearson Prentice Hall, Upper Saddle River, New Jersey, 2007.

Reference Texts:

1. S.K. Mitra, Digital Signal Processing: A Computer-Based Approach, third edition, McGraw-Hill Inc., New York, 2005.S. Henzler, *Time-to-Digital Converters*, Springer, 2010
2. E.C. Ifeachor and B.W. Jervis, Digital Signal Processing: A Practical Approach, second edition, Prentice-Hall Inc., Essex, 2002.

Calendar Description The course provides an introductory treatment of the theory and principles of digital signal processing (DSP), with suitable supporting work in linear system concepts and digital filter design. More specifically, the course deals with the following topics: general concepts of digital signal processing, continuous-time system analysis, Fourier analysis and sampled-data signals, discrete-time system analysis, discrete-time systems, finite and infinite impulse response digital filter design, discrete and fast Fourier transforms, and general properties of the discrete Fourier transform.

Learning Objectives At the end of this course, the successful student will be able to:

1. Analyze, design, and implement simple DSP systems for various applications.
2. Acquire required background for the advanced DSP II (EE8111) and related courses.
3. Better equip them with required DSP knowledge to pursue research in signal processing related areas.

Course Organization 3 hours of lecture per week for 12 weeks

Course Evaluation

Computer Assignments	15%
Course Project	25%
Midterm exam	25%
Final exam	35%
Total	100%

Examinations

Midterm examination is a 2 hour, closed-book examination that covers all the lecture and assignment materials up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination that covers all the course material and assignment materials.

Project

The course project is a major report on a topic that is related to digital signal processing theory and its applications. The project report should include a literature survey, theoretical analysis, performance analysis and applications. Whenever applicable, simulation and implementation results should accompany the theoretical analysis presented in the report. The simulation studies can be conducted in any environment of the student's choice; however students may find it easier to use a simulation tool such as Matlab/Simulink. The report topic should ideally be related to the student's interest/research area. All students need to consult, discuss and obtain approval about their project topic from the course instructors before proceeding with their projects. The important timeline for the project are as follows.

- Week 1 to Week 5: consultation and preliminary discussions to identify the project.
- Week 6: project proposal due date
- Week 11/12 (TBD): Final project report due date.

Further information about the project will be made available as required

Course Content

Week	Detailed Description	Hours
1	Introduction and Background	3
2	Discrete-Time Signals and Systems	3
3	Discrete-Time Signals and Systems/ z-Transform	3
4	Frequency-Domain Analysis of LTI Systems	3
5	Frequency-Domain Analysis of LTI Systems	3
6	DFT/DCT/MDCT/FFT	3
7	DFT/DCT/MDCT/FFT	3
8	Design of Digital Filters (1hr) (Mid-term 2 hours)	3
9	Design of Digital Filters	3
10	Design of Digital Filters	3
11	Additional Advanced Topics	3
12	Additional Advanced Topics	3

Important Notes

All course related information, announcements and material are available from Ryerson's BlackBoard system at:

http://my.ryerson.ca/

The administration of this course will be in accordance with the terms, conditions, regulations and policies contained in the Ryerson Calendar and Department of Electrical and Computer Engineering Student Handbook. For links to most relevant academic policies please refer to the departmental website and the University WEB pages at:

http://www.ryerson.ca/graduate/currentstudents/academicmatters/policies.html

http://www.ryerson.ca/senate/policies/

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.

2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.

3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format.

4. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

5. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

6. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.

7. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final

examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.

8. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.

9. Students are required to adhere to all relevant University policies.

10. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.

11. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.

12. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.

13. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.

14. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8107: Digital Communication

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8107/

Compulsory Texts:
1. 1. John G. Proakis, Digital Communications (5th Edition), McGraw-Hill, 2007.
2. Optional Lecture notes from Dr. A. Anpalagan and published scientific papers.

Reference Texts:
1. Simon Haykin, Communications Systems, 3rd edition, Wiley, 1994.
2. B.P. Lathi, Modern Digital and Analog Communication Systems, Oxford Press, 1998.

Calendar Description
The class is intended to introduce the student to the concepts and theory of digital communications. The concepts of information, channel capacity, error probability, intersymbol interference, pulse shaping and spectrum shaping and optimum filtering are discussed. Digital multiplexing and bit stuffing, encoding, scrambling, equalization and synchronization problems are studied. Regenerative repeaters, M-ary signaling systems, basic modulation techniques - ASK, PSK and FSK; and performance characteristics of digital transmission systems are considered.

Course Organization
3 hours of lecture per week for 12 weeks

Course Evaluation

Midterm test	= 30 %
Exam	= 40%
Assignments	= 10%
Project	= 20%
Total	= 100%

Examinations
Midterm examination is a 2-hour, closed-book examination that covers all the lecture materials up to the week of mid-term examination.
Final examination is a 3-hour open-book examination that covers all the course material.

Project
Each student will do a project and submit a report at the end of the semester. Project proposal has to be approved by the instructor within 3 weeks from the first class. The project can include one or more of the following:

- critical review of a major article (e.g, from journal papers or magazines)
- evaluation of two methods proposed in two different papers
- further development/analysis of an existing approach/idea
- novel approach/technique, analysis or algorithm

Course Content

	Detailed Description	Approximate Hours
1	Review of Fundamental Concepts: introduction to digital communication, probability theory, random processes, autocorrelation and power spectrum density, complex signals and systems, signal space representation, Fourier analysis of signals and systems	6
2	Source Entropy and Channel Capacity: entropy, source coding, rate distortion, channel capacity and coding	9
3	Digital Modulation Techniques: ASK, PSK, FSK, constellations, power spectra, pulse shaping, precoding	9
4	Signal and Receiver Design with Performance Analysis: AWGN channel, band-limited channel, optimum receiver structure, error probability, inter-symbol interference, signal design, performance characterization and analysis of digital communication systems	9
5	Emerging Communication Systems and Techniques: OFDM, MIMO, Cognitive Radio	3

Remarks: SGS policy on course management always prevails.

Name of Instructor		Signature of Instructor		Date	
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8108: Multimedia Processing and Communications

Prerequisites	None
Course Web Page	http://www.ee.ryerson.ca/~courses/ee8108/
Compulsory Texts:	1. Lecture notes from Dr. Ling Guan and published scientific papers.
Reference Texts:	1. L. Guan, Y, He and S.Y. Kung (Editors), *Multimedia Image and Video Processing*, 2nd Edition, 828 pages, CRC Press, March 2012.
Calendar Description	This course will touch some of the fundamental issues in media processing and applications. It will start with a quick look at the standards which set the baseline work for multimedia, such as MPEG-4 and MPEG-7. It will then present to the class the latest and the most important issues in multimedia, including indexing and retrieval, media coding, media transmission, human-computer interface, image and speech processing for multimedia, wireless multimedia, and more. Examples, demonstrations, and applications will also be provided.
Learning Objectives	At the end of this course, the successful students will have a solid understanding of multimedia standards, information organization and search in multimedia database, transmission of video and multimedia data over wire/wireless and cloud communication infrastructures, interaction with multimedia via various human-computer interaction techniques. Through the course project, which is research in nature, the students will gain in-depth knowledge on literature review, search for research topics, methodology design and implementation, testing and evaluation, and project planning and management, thus getting prepared for high quality research in multimedia domain and beyond.
Course Organization	3 hours of lecture per week for 11 weeks

Course Evaluation	Quiz 1	20%
	Quiz 2	20%
	Project presentation	10%
	Project report	50%
	Total	**100%**

Quezzes

Quiz 1 is a one hour, open-book test that covers the material up to the lecture taught in the week before the quiz.

Quiz 2 is a one hour, open-book test that covers all the course material, with emphasis on that taught after Quiz 1.

Project

Students are required to work on a technical topic, either chosen by yourselves in consultation with the instructor, or provided by the instructor. Students are encouraged to choose their own topics. The topics of your projects could be one of the following:

- ❑ comparison of two or more methods found in the literature
- ❑ further development/analysis of an existing method/idea
- ❑ novel approach/technique, analysis or algorithm

Projects of pure literature reviews in nature are not acceptable. Students are required to demonstrate that the system and/or algorithm designed works at the presentation time. The students are encouraged to work in a team of two students.

The project report must contain Background studies - An extensive background study of the research is required with a literature review, and must be prepared in a single-column double-space format, and must contain the followings:

- ❑ Title page - Title of the project, authors' name, and course name.
- ❑ Abstract - Abstract of the project report.
- ❑ Table of contents - list of chapters, sections, and subsections of the project report.
- ❑ List of figures - list of all figures in the project report.
- ❑ List of tables - list of all tables in the project report.
- ❑ Main body of the project report - All figures and tables must be embedded in the main body of the report and numbered.
- ❑ References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Multimedia* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- ❑ Appendices
- ❑ Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1	Introduction to multimedia and MPEG standards	3
2	Statistical pattern recognition and neural networks	3
3-4	Multimodal information fusion	6
5-6	Multimedia indexing and retrieval	6
7-8	Human signature recognition	6
9-10	Multimedia transmission	6
11	Extra material	3

Project

	Detailed Description	**Week**
Proposal	Students are required to identify a topic in multimedia processing and communications, in consultation with the instructor and submit a proposal to the instructor	7
Presentation	Students must demonstrate the design in work to the instructor and class during project presentation.	13
Project	Projects should make an extensive use of the knowledge acquired from the course. Projects must be research-oriented. It can be hardware based or software based. For software projects, there is no restrictions on programming languages. Students are encouraged to work in groups of two.	

Note: Schedule of lectures is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. The project report must have a cover page. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a quiz or the project presentation, with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format.
4. Medical or Compassionate documents for the missing of a quiz or presentation must be submitted within 3 working days of the quiz or presentation. Students are responsible for notifying the instructor that they will be missing a quiz or exam as soon as possible.
5. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question. In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive

accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.

6. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
7. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
8. Project reports handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
9. Students found to have plagiarized *any* portion of their project report will receive a grade of ZERO on the *complete* project. This will automatically lead to a failing grade.

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8109: Wireless Communications

Prerequisites	None
Course Web Page	Blackboard. My.ryerson.ca
Compulsory Texts:	Lecture notes from Dr. Xiao-Ping Zhang and published scientific papers.
Reference Texts:	T. S. Rappaport, Wireless Communications: Principles and Practice, 2nd Edition, Prentice Hall, 2002.
Calendar Description	This class provides an overview of wireless communications systems and fundamental analysis and design techniques. The class introduces cellular system, channel characterization for propagation losses, fading, and interference. Coding, modulation, and advanced transceiver design issues are examined. Modern mobile wireless communication system applications are reviewed.
Learning Objectives	At the end of this course, the successful student will have a solid understanding of wireless communications systems and fundamental analysis and design techniques. The students will get a good overview and understanding on the state-of-the-art development in wireless communications systems. In addition, the students will learn the basic research and presentation skills through guided self-study of high quality research papers and related class discussions.
Course Organization	3 hours of lecture per week for 12 weeks 2 hours of project work per week for 12 weeks
Course Evaluation	Project and presentations 50% Final exam 50% Total 100%
	To achieve a passing grade, student must pass both the theory and project components.
Examinations and project	Midterm presentation is a research presentation on one or more selected journal papers (most on IEEE Transactions).

Final project and presentation include (a) a full research presentation on one or more selected journal papers including simulations; and (b) a research report on the research study and simulations in IEEE paper format.

Final examination is a closed-book examination that covers all the course materials.

Course Content

Week	Detailed Description	Hours
1-2	Introductions on history and state-of-the-art of wireless communication systems and networks	6
3-5	Radio Propagation, large scale path loss and channel modeling	9
6	Channel modeling and basic estimation methods	3
7	Midterm presentation	3
8	Multipath and fading channels: modeling and channel properties	3
9	Cellular structures and trunking	3
10-11	Advanced Modulation in wireless systems and spread spectrum, channel diversity techniques and multiple access	6
12	Final presentation	3

Note: Schedule of lectures is tentative and for reference only. There will be changes to be communicated.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8111: Digital Signal Processing II

Prerequisites	Digital signal processing I (Graduate level course preferred.) Good mathematical and matlab skills
Course Web Page	Blackboard. My.ryerson.ca
Compulsory Texts:	Lecture notes from Dr. Xiao-Ping Zhang and published scientific papers.
Reference Texts:	No specific texts. But any texts related to the topics can be referenced.
Calendar Description	This course covers signal processing topics such as short-time Fourier Transform, discrete cosine transform, principal component analysis, continuous and discrete wavelet transforms, multirate filterbanks, independent component analysis, and quadratic time-frequency distributions. Applications of the above techniques in denoising, data compression, feature extraction, and source localization will also be discussed.
Learning Objectives	At the end of this course, the successful student will have a solid conceptual understanding of digital signal processing (DSP) and mathematical transforms used in DSP. Students specially will master all types of time-frequency, time-scale and filterbanks transforms and be able to identify appropriate mathematical tools for DSP applications. Also, the students will get a good overview and understanding on the state-of-the-art development in advanced DSP research, such as signal processing for Finance. In addition, the students will learn the advanced research and presentation skills through guided self-study of high quality DSP research papers and related class discussions.
Course Organization	3 hours of lecture per week for 12 weeks 2 hours of project work per week for 12 weeks

Course Evaluation

Midterm presentation	30%	
Final project and presentation		40%
Final exam	30%	
Total	100%	

To achieve a passing grade, student must pass both the theory and project components.

Examinations and project

Midterm presentation is a research presentation on one or more selected journal papers (most on IEEE Transactions).

Final project and presentation include (a) a research presentation on one or more selected journal papers including simulations; and (b) a research report on the research study and simulations in IEEE paper format.

Final examination is a closed-book examination that covers all the course materials.

Course Content

Week	Detailed Description	Hours
1	A new look of DSP and Fourier transforms	3
2-4	Time-frequency transforms	9
4-6	Time-scale transforms	9
7	Midterm presentation	3
8-9	Discrete wavelet transforms, multiresolution analysis, multirate filter banks and signal processing	6
11	Various DSP applications and other topics	3
12	Final presentation	3

Note: Schedule of lectures is tentative and for reference only. There will be changes to be communicated. Note that additional advanced state-of-the-art topics such as graphical models in a seminar format may be added as needed.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term or equivalent (e.g. presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of

the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

EE 8114: Optical Communications and Networks

Projects, Formatting, Drawing, Study Material and Problems Reference Sources,

Prerequisites: Electrical engineering background with good understanding in digital and analog communications

Instructor: Xavier N. Fernando, Office: ENG-437, Phone: 416-979-5000 ext. 6077, E-mail: fernando at ryerson.ca, Counseling: Fridays 1-3 PM or by appointment

Lecture Hours: Mondays 6.00 PM - 9.00 PM at room VIC 101

Objective: The objective of the course is to provide a comprehensive understanding of optical communication systems and networks. The course starts with basics of light waves and their propagation, and single/multimode optical fibers. Then move to broadband (light emitting diode) and narrowband (laser diodes) optical sources and their modulation; PIN and Avalanche photo detectors and other elements of optical systems. We will study basic optical networks then using a design approach to point-to-point fiber links, star, bus and ring topologies. Multiple access techniques such as WDM (Wavelength Division Multiplexing) and SCM (Sub Carrier Multiplexing) also will be covered. Synchronous Optical Networks (SONET) will be covered to good extend. Passive Optical Networks (PON) widely used in fiber-to-the-home (FTTH) schemes and emerging radio over fiber (ROF) networks that bridge the optical and wireless networks will also be covered.

Teaching Method: Main form of information delivery will be through lectures. However, students have to frequently visit the course site to check for the course announcements, postings and to participate in the e-mail discussions.

Evaluation:

Mid term examination	20 % (October 21)
Final examination	35 %
Quizzes (2 - surprise)	10 %
Project Proposal	5 % (Due September 30) , **Click here for Project Proposal Form**
Project Presentation	10 % - Should match the proposal
Term paper	20 % - Publishable quality gets bonus

Term Paper: Each student will write a term paper. This will give the students a chance to explore a topic of their interest in detail. The project will involve with some additional background reading, and suggesting a better solution to a typical optical communications problem. Verification of results can be done by mathematical proof or by computer simulation or by experiment. A formal paper should be submitted to the course instructor and a visual presentation should be made.

Marking Scheme for the Paper

Abstract	Not more than 200 words, should precisely describe what is done	4 %
Introduction	A brief outline and motivation of the problem under investigation	3 %
Theory	Theoretical definition of the problem and your derivations (if any)	3 %
The Work	What has actually been done in the paper, details of the simulation, analysis or experiment	3 %
Results and Discussions	Significance and the application of the results	3 %
Reference	A properly formatted list of all the references	2 %
Formatting	Adhere to the specified format	2 %

The term paper should confirm the following format. There will be a penalty for not adhering to the format guidelines.

Plagiarism: Reproducing other's work or idea without proper citation is defined as *plagiarism*. If your work found to have plagiarized material, you will get zero marks for the work. If the offence is serious, then it may be reported to the academic council as an academic misconduct.

Note: Significant portion of research is studying what others have done. Then an attempt is made enhance the work by adding more. Therefore, a well-written paper should clearly mention relevant previous work and clarify what is done new.

References: There is no text book for the course, we will use given course notes, articles from journals and conferences, power point presentation slides etc.

US Department of Commerce Institute for Telecommunications Sciences Glossary Search Engine

Good site for long lasting high power LED related articles

http://lasers.jpl.nasa.gov/index.html

http://www.lascomm.com/tutorial.htm

White Papers by Corning ;

In-depth - very technical - Fiber optic write up

WDM basics (Wavelength Division Multiplexing)

DWDM basics (Dense Wavelength Division Multiplexing)

Fiber Optics Training Provider

Various publications from IEEE, Society of Photonics and Instrumentation Engineers (SPIE) and Lasers and Electro Optic Society (LEOS)

Gerd Keiser, 'Optical Fiber Communications' third edition, McGraw-Hill (2000)

Jeff Hecht, 'Understanding Fiber Optics' 5/e, Prentice Hall (2006)

John Senior, `Optical Fiber Communications' second edition, Prentice Hall (1999)

S. O. Kasap, 'Optoelectronics and Photonics: principles and practices' Prentice Hall (2001)

Joseph C. Palais, 'Fiber Optic Communication' fourth edition, Prentice Hall (1998)

IEEE and OSA, `Journal of Lightwave Technology'

IEEE LEOS, `Photonics Technology Letters'

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8120: Applied Optimization Techniques and Algorithms

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8120/

Compulsory Texts:

1. Published scientific papers as assigned per course project.
2. C. J. Floudas and P. M. Pardalos (Eds,), Encyclopedia of Optimization, *Springer US*, ISBN (Print): 978-0-387-74758-3, ISBN (Online): 978-0-387-74759-0. To access, go to http://www.ryerson.ca/library. Click Catalogue. Type "Encyclopedia of Optimization."

Reference Texts:

1. S. C. Chapra & R. P. Canale, Numerical Methods for Engineers with Software and Programming Applications, 4th edition, *McGrawHill*, ISBN: 0-07-243193-8.

Calendar Description

This course covers the following topics: Linear and nonlinear programming, unconstrained optimization techniques such as gradient techniques (steepest descent, conjugate gradient, Newton-Raphson) and constrained optimization techniques such as Lagrange multiplier, quadratic and dynamic programming, least square techniques, integer and mixed-integer programming. NP-complete problems: branch-and-bound as well as heuristic algorithms, graph colouring, partitioning, and maximum matching. Bounds, variable priorities, special ordered sets and search algorithms (random search, binary search, genetic algorithms, and tabu search). Optimization algorithms in Electrical and Computer Engineering areas will be discussed in depth.

Learning Objectives

This is a core course where students learn to formulate optimization problem for a given application. These applications range from green technology, signal processing, to image processing and system/circuit designs. Examples are: Net-zero community, smart systems, wireless sensor networks, and image processing. At the end of this course, the successful student will have a solid understanding of traditional optimization algorithms during the class sessions. Students will get numerous one-on-one meetings to learn and apply new optimization algorithms.

Course Organization

3 hours of lecture per week for 13 weeks

Meeting one-on-one is an integral part of this course. Students are encouraged to meet and discuss challenges they face during selection, study, and implementation of the course projects. On average, half an hour per course project per week.

Course Evaluation

Midterm Project Report and Presentation	15%
Final Project Report and Presentation	45%
Final Exam	40%
Bonus (Outstanding Achievements in Projects)	5%
Total	100%

To achieve a passing grade, student must implement a selected paper and pass the exam.

Reports will be checked by turnitin.com software. Similarity factors must be below 5%. Higher similarity factors would be penalized proportionally.

Examinations

Midterm Project Presentation is 20 min per person. The midterm course project report must adhere to structures discussed in-class.

Final Project Presentation is 20 min per person. The final course project report must be in the form of an IEEE conference paper.

Final examination is a 3-hour closed-book examination that covers all the course material.

Project

Students are required to select a course project at the beginning of the class. The project must contain an element of optimization as explained. Initially, each student is required to find 6 papers given the specifications by the instructor. Students, then, study these papers and discuss their understanding of the materials during in-person meetings. A small literature review of the topic of interest is handed in as midterm course project report. Students are required to implement one paper among the six papers, and authenticate the results reported by the authors of the selected paper. A final course project report is required to show the discrepancies and also the strength of the selected research paper. Students are encouraged to further advance the knowledge in the area of interest by modifying the platform they have already created in a simulation environment. A general report may follow the items noted below. Final course project should be in the form of an IEEE conference paper.

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be

embedded in the main body of the report and numbered.

- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- Appendices
- Index - list of key words and their page number in the project report.

Course Content (Fall 2014)

Week	Detailed Description	Hours
1-2	General description of Optimization problems, and project selections	6
3	Genetic Algorithm, Simulated Annealing, Tabu Search, Other Evolutionary Algorithms	3
4	Solution of Linear and Nonlinear Systems of Equations	3
5-6	Unconstrained Optimization Techniques: Gradient Techniques (Steepest Descent, Conjugate Gradient, Newton-Raphson)	6
7-8	Midterm Presentations	6
9	Constrained Optimization Techniques (Lagrange Multipliers)	3
10-11	Simplex Technique, Linear/Nonlinear Programming Integer/Dynamic Programming	6
12	Modern Optimization Techniques, Graph Theory	6
13	Final Presentations	3

Note: Schedule of lectures is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of

the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

EE 8121
Wireless Networks
Winter 2014

M. Jaseemuddin
Handout #1
Date: 15/01/2014

Course Information Sheet

Objective: This is an advanced course that deals with the impact of wireless medium on the network design. It focuses on four major areas of Wireless Networks (WN): (1) Designs of different Wireless Networks including their integration; (2) Medium Access Control for WN; (3) Routing in WN including routing for ad hoc and sensor networks; and (4) TCP design for WN. A discussion on the impact of current major developments of physical layer on wireless networking is included to introduce the students with the emerging areas of research.

Outline: *Introduction:* Short History of wireless communications and its Applications.
Wireless Transmission: Signal Propagation, Channel Models, Multiplexing, Spread Spectrum (FH and DSS), 802.11 FH PHY and DS PHY.
Cellular Networks: Frequency Reuse, Handover, GSM+GPRS, UMTS, LTE and WiMAX.
Multihop Wireless Networks: Mesh, Ad-Hoc and Sensor Networks.
Medium Access Control: Motivation for a specialized MAC; Contention and non-contention MAC (examples: 802.11, Bluetooth and 802.16 MAC); MAC design for ad hoc and sensor networks.
Routing: Routing for multi-hop (ad hoc, mesh and sensor) networks, power efficient routing, interference-aware routing
TCP: congestion control due to wireless channel, mobility, and asymmetry in uplinks and downlinks; methods of discriminating congestion related and channel-error related packets losses.
Advanced Topics: Integration of wireless networks, Smart Antenna, Co-operative Communication, and Cross-layer Design.

Instructor: Muhammad Jaseemuddin
Email: jaseem@ee.ryerson.ca, Phone: 979-5000x6073, office: ENG470
Office hours: Monday 1:00-2:00pm

Lectures: Wednesday 2:00pm – 5:00pm@EPH229

Prerequisites: COE865/EE8216 or Equivalent

Text: J. Schiller, *Mobile Communications*, Second Edition, Addison-Wesley, 2003. (Recommended)

Reference: T. Rappaport, *Wireless Communications – Principles and Practice*, Second Edition, Prentice Hall.
William Stallings, *Wireless Communications and Networks*, Prentice Hall.
K. Pahlavan and P. Krishnamurthy, *Principles of Wireless Networks – A Unified Approach*, Prentice Hall.
S. Haykin and M. Moher, *Modern Wireless Communications*, Prentice Hall, 2005.

Grading: Based on the following weights

Paper Reviews	10%
Assignments	15%
Project	40%
Two Quizzes	10%
Final Examination	25%

Policies:

1. Textbook does not cover all the topics. Reading list contains list of papers that can be consulted for specific topics.
2. Please use emails for communicating your needs. I discourage phone calls unless it is an absolute necessity. I won't be able to answer your questions through email, please use office hours for that purpose.
3. Check Blackboard for course related information.
4. Please make yourself aware of relevant university policies, such as regarding cheating and plagiarism, academic consideration etc (http://www.ryerson.ca/senate/policies/).
5. Project marks breakdown and deadlines are as follows:

Project proposal (5%)	due **February 5th**
Interim Report (5%)	due **March 5th**
Project report (20%)	due **April 9th**
Presentation (10%)	schedule will be posted on the web

6. Report will be marked based on the following criterion:
   - Introduction
   - Problem Definition: Statement, Motivation
   - Project Details: Analytical, Originality, Clarity, Writing style, Enough details
   - Conclusion: Summary, Conclusive Remarks, Future work
7. Project should show originality through creative thinking and analysis.
8. Make yourself familiar with the resources available at Ryerson Library (www.library.ryerson.ca), especially browse *IEEE explore* for accessing papers on-line.
9. You can use www.google.com and CiteSeer (http://citeseer.nj.nec.com/cs) for citation lookup.
10. Quiz dates will be announced one week in advance.

Department of Electrical and Computer Engineering
Ryerson University

EE 8122: OPTOELECTRONIC DECVICES

Course Contents:
This one-semester course offers a comprehensive overview of optical properties of semiconductors devices. The course begins with the transmission properties of electromagnetic wave in different media. This introduction is followed by the devices that generate light: light-emitting diodes (LEDs) and laser diodes (LDs). Topics also include optical spectra and transitions, spontaneous and stimulated emission, population inversion, carrier and optical confinements in heterostructures, etc. Some of the most popular devices such as LCD, CCD, DVD and LED will be discussed. The last part is the semiconductor photodetectors such as photoconductors, photodiodes and avalanche photodiodes.

Based on the acquired knowledge of photonics, students will be required to submit a written engineering design project (see the description on a separate page).

Course hours: 3 Lecture hours per week

1. **Text book:** S.O. Kasap, Optoelectronics and Photonics, Prentice Hall, 2011, 2nd edition.

References:
1. Ammon Yariv and Pochi Yeh, Photonics, Oxford University Press, 2007.

Course Evaluation:
Chapter 2 Assignment: mode calculations 5%
Mid-term test (Oct. 24, 2013) .....…....25 %
Design Project (due with final exam).....20 %
Final Examination (Dec. 2013).....….....50 %
Total: …100 %
Tests are closed-book tests, only calculators and one 8½x11 home-made formula sheet is allowed.

Note 1: Course written materials will be assessed not only by on their technical or academic merit, but also on the communication skills of the author as exhibited through these written materials.

Note 2: A faculty/course evaluation survey will be conducted in EE81222 class in late Nov. 2013.

Detailed Course Outline: Lecture Hours (36)

1.0 Wave Optics (8 hrs)
- 1.1 Light propagation in homogeneous medium
- 1.2 Light Reflection and transmission:
- 1.3 Fresnel's equations
- 1.4 Optical Resonators
- 1.5 Temporal and spatial coherence
- 1.6 Diffraction

2.0 Waveguides and Optic Fibers (8 hrs)
- 2.1 Planar dielectric slab waveguide
- 2.2 Step index fiber
- 2.3 Dispersion in single mode fibers
- 2.4 The graded index optical fiber
- 2.5 Light absorption and scattering

3.0 Semiconductor Science and Light Emitting Diodes (6 hrs)
- 3.1 Semiconductor concepts and energy bands
- 3.2 pn junction principle

3.3 Light emitting diodes (LEDs)
3.4 LED characteristics

4.0 Semiconductor Lasers (5hrs)
4.1 Stimulated emission and photon amplification
4.2 Optical amplifiers
4.3 Laser oscillation conditions
4.4 Principle of the laser diode (LD)
4.5 Single frequency solid state lasers

(4 hrs)
5.1 Liquid crystal display (LCD)
5.2 Charge-coupled-devices (CCD)
5.3 Integrated optical modulators
5.4 CD and DVD

6.0 Semiconductor Photon Detectors (5 hrs)
6.1 Principle of the pn Junction Photodiode
6.2 Photoconductors
6.3 Photodiodes
6.4 Avalanche Photodiodes
6.5 Noise in Photodetectors

5.0 Examples of optoelectronic devices

ENGINEERING DESIGN PROJECTS: OPTOELECTRONIC DECVICES (ELE 8122)

Based on the acquired knowledge of optoelectronics principles, students are expected to do their own research in the field of optoelectronic devices and submit a written engineering design project at the time of the final examination. The paper should to be written in a standard scientific publication form (including abstract) and contain 8 - 10 pages of relevant information needed to construct an optoelectronic device. You can choose one topic from those listed in course outline, modify it, or create your own project based on the principles of optoelectronics (i.e., it should employ light in the visible, near IR, or UV region). Standard electronic devices (amplifiers, power sources, ADCs, etc.) may be presented in a block diagram form only, however, light sources, opto-electronic and photonic components should be described fully, i.e., detailed diagrams, specifications, functional ranges, and dimensions, including the theoretical equations and supporting calculations of the expected performance. Think of the project as of your own proposal to obtain a patent for a photonic device.

SUGGESTED TOPICS:

(1) Erbium-doped fiber Amplifier.
(2) Optical Add-Drop devices for fiber optic communication.
(3) Multiplexing and de-Multiplexing wavelength in fiber optic communication.
(4) Optical switching.
(5) Optical storage and retrieval of information.
(6) Liquid crystal display (LCD)
(7) Light emitting diode and high power LEDs
(8) White Light LEDs
(9) Digital versatile disk (DVD)
(10) Charge-coupled-devices (CCD).
(11) An instrument determining the position and speed of distant moving objects.
(12) A coding device that could code and decode visual information, such as a photograph.
(13) A wireless power transfer system.
(14) A device that could easily determine the coherence (quality) of any light source.
(15) A precision optical spectrum analyzer

NOTE: Projects will be judged by the creativity and feasibility. All projects must be strictly individual and original.

Professor X. Gu
Office: EPH-400C
Telephone: (416) 979-5000 ext. 4151
E-Mail: xgu@ee.ryerson.ca

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science

Department of Electrical and Computer Engineering

Course Outline (W2014)

EE8202: Digital Image Processing I

Instructor Prof. Javad Alirezaie
Office: ENG452
Phone: (416) 979-5000 ext 6092, Email: javad@ee.ryerson.ca
URL: **http://www.ee.ryerson.ca/~javad**

Prerequisites N/A, (note: knowledge of Signals and Systems I & II or similar courses from an undergraduate program is required)

Course Web Page **https://my.ryerson.ca/(Blackboard)**

Compulsory Texts: ***Digital Image Processing*, Gonzalez and Woods, Prentice Hall, Third edition, 2008**

Reference Texts: Digital Image Processing by Kenneth R. Castleman

Calendar Description

This course starts with the introduction to digital image fundamentals, imaging geometry, and image storage formats. Simple spatial domain techniques as well as spatial frequency domain methods and digital filter design for image enhancement and restoration are discussed. Low-level image segmentation and feature extraction concepts will also be introduced. Special topics in application of image processing including remote sensing, medical imaging, etc. will be presented.

Course Organization 3 hours of lecture per week for 13 weeks.

Course Evaluation

Mini course projects (i.e. 5 Lab projects)	25%
Main Course Project	30%
Final exam	45%
Total	100%

Examinations Final exam, during exam period, 3 hours, closed book, a formula sheet is allowed (covers all the course material).

Course Outline:

1. Introduction and overview
2. 2D Linear Systems
3. The Discrete Fourier Transform
4. Point Operations and Contrast Enhancement
5. Local Operations
6. Discrete Gradient and Laplacian Operators
7. Global Operators: Linear Fitters
8. High Frequency Emphasis Filters
9. Homomorphic, Density Domain Filters
10. Implementation issues
11. Image Restoration: Random Processes
12. Optimal Restoration: Wiener Filter
13. Wiener Deconvolution and Extensions
14. Algebraic Restoration
15. Constrain Optimization
16. Discrete Systems Review, Adaptive Filters (Course notes)
17. Adaptive Filters for Image Smoothing
18. Local Statistics and Locally Optimal Filters

MAJOR PAPER AND COURSE PROJECT PRESENTATION

Each project combines two separate components: a written component, and an oral component. It is an individual project, marks will be awarded out of 35 marks as per following schedule:

- Reference summaries: **5 Marks**
- Final project report. Week 12, 13. **15 Marks**
- Final oral and presentation. Week 12, 13. **10 Marks**

PAPER (COURSE PROJECT)

Write a 6 page paper (double column, IEEE style) on **Segmentation and Classification** of *Digital Images; applications in multimedia image processing, biomedical imaging and remote sensing etc… are acceptable*. The paper should be based primarily on journal articles, but information from one or two textbooks can be included. Material in the paper must be properly referenced.

The course project includes in the following steps:

- Select an application to the related topic (***Segmentation and Classification)*** and compile a list of references (3 reference papers is appropriate). Receive the approval of course instructor on the selected topics. TOPIC AND REFERENCE LIST DUE BY: **TBA.**

- Write one page summary of each reference; the summaries can be done in point form. SUMMARIES ARE DUE BY: **TBA.**

- Write the full paper and prepare your oral presentation, PAPER DUE BY: **TBA**

*Please note, directly copying text from a reference (text book, journal paper, conference paper or on-line paper) is not acceptable (this is a form of plagiarism and is considered **academic dishonesty)**. In your paper, text must not be copied verbatim; figures and tables may be used but must be properly referenced.*

PRESENTATION

Prepare a presentation on the topic covered in your paper. The presentation should be about 15 - minutes long and will be presented in class, with 2-3 minutes for questions.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
4. Students are required to adhere to all relevant University policies including:
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance, http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun., http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 20% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8205: Embedded Computer Systems

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8205/

Compulsory Texts:

1. *M. Wolf*, Computer as Components: Principles of Embedded Computing System Design, 3rd Edition, Morgan Kaufman Publishers 2012, ISBN 978-0-12-388436-7
2. *Daniel W. Lewis,* Fundamental of Embedded Software with the ARM Cotex M3, 2nd Edition, Pearson 2013, ISBN 978-0-13-291654-7

Reference Texts:

1. *Z. Navabi,* Embedded Core Design with FPGAs, McGraw Hill 2007, ISBN 978-0-07-147481-8 or ISBN 0-07-147481-1
2. SystemC: From the Ground Up, 2nd Edition, D.C. Black, J Donovan, B. Bunton, A. Keist, Springer 2010, ISBN 978-0-387-69958-5.
3. *Alan Burns and Andy Wellings*, Real-time Systems and Programming Languages, Addison-Wesley 2001, ISBN 0 201 72988 1

The instructor will identify some relevant e-books and review articles.

Calendar Description

This course focuses on the design and implementation of software for embedded systems. High performance embedded system and safety critical embedded system architecture will be introduced, Fault-tolerant and reliable embedded system design techniques are also highlighted. The main topics to be covered include embedded computer organization, hardware/software codesign of embedded systems, CAD tools for hardware/software codesign, system on chip, advance concepts of real-time operating systems and real-time scheduling. The course introduces the technologies used in the design of embedded systems such as processor cores, embedded system specification languages, and software tools for hardware/software co-verification and system partitioning. The application of embedded systems for emerging networking and medical devices will also be covered.

Learning Objectives

At the end of this course, the students will also attain the background knowledge required for understanding embedded systems, system on chip technology and real-time operating system. The successful student will have a solid understanding of embedded system organization, embedded processors, CPU soft-cores and other IPs, multitasking, real-time scheduling, priority inversion and fault-tolerant embedded systems. After passing this course, the students will be able to grasp the main principles of real-time embedded systems, hardware-software codesign and embedded software design.

Course Organization

3 hours of lecture per week for 12 weeks

Course Evaluation

Lab Projects	20%
Course Project	40%
Final exam	40%
Total	100%

Examinations

Final examination is a 2-3 hour closed-book examination that covers all the course and lab-project materials.

Project

Details and Selection

Please choose a topic from any one of the following areas for your project. The project topics include but not limited to the following areas:

1. Case study and review of a specific embedded system related to aerospace, biomedical, space, multimedia or consumer electronics (smart-phone, HDTV, etc.) device.
2. Development of a μcLinux based Real-time/Embedded Multitasking Application of your choice by employing an enhanced SoPC based on the SoPC developed in Lab Project.
3. Developing a Real-time/Embedded Multitasking Embedded Application of your choice by using an ARM Cortex Microcontroller..
4. Embedded System Architecture for one of the following or any other industrial application of your interest:
   - Smart Home Controllers.
   - Multimedia Applications including MP3, MPEG and JPEG 2000.
   - RFID based Embedded Systems.
5. Codesign of a specific embedded system for a particular application including signal and image processing, image compression, multimedia, or any other interesting application.
6. Study and Implementation of a Real-time Scheduling Technique using an RTX (RTOS) for ARM Cortex M3 Microcontroller.
7. Multitasking Embedded Application of your choice by employing RTX (RTOS) system for ARM Cortex M3 Microcontroller.
8. Case study of a Fault-tolerant Embedded System of your choice. (such as aerospace, military, banking or biomedical applications)
9. Modeling Embedded System of your choice or one of the following using UML, SystemC or any other simulation environment:
   - JPEG 2000, MPEG-1, MPEG-2 or MP3 encoder and decoder
   - RFID based embedded systems.
10. Any other approved project on Hardware-software Codesign and Network-on-Chip (NOC) and System on Chip (SoC) areas including:
    - Embedded System Co-Specification and Using SystemC for Embedded System Modeling.
    - Embedded System Partitioning into Hardware and Software Blocks.

- Embedded System Co-synthesis, NoC system design.
- ARM Cortex M3 processor and/or RTX, real time operating system

Course Content

Week	Detailed Description	Hours
1-2	Introduction to Embedded Computer Systems	4
2-3	Digital Camera Design: A Case Study	5
4	Embedded System on Programmable Chips	3
5	SystemC and Hardware Software Codesign of Embedded System	3
6	Embedded CPUs and IP Cores	3
7-8	ARM Cortex M3 Microcontroller and Embedded Systems	6
9-10	Real-time Operating System and Scheduling	6
11	Accelerator based Embedded System Co-synthesis	3
12	Introduction to Network on Chip and SoC Design	3

Project/Labs - Room ENG408

Labs. Project	Detailed Description	Week
1	Lab 1: Configuring a basic Embedded System on Programmable Chip (SoPC) on DE2 board.	2-3
2	Lab 2: Study of ARM Cortex M3 Microcontroller and uVision Embedded Software Development Environment.	4-5
Project	Students are required to design and analyze an embedded system employing FPGA or RTX -ARM Cortex real-time operating system environment. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented.	5-12

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
3. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the

Grading Promotion and Academic Standing Policy) and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

4. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
5. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
6. Students are required to adhere to all relevant University policies:
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
7. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
8. Any changes in the course outline, submission dates, marking or evaluation will be discussed in class prior to being implemented.
9. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
10. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
11. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade.

Name of Instructor		Signature of Instructor		Date	
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8207: High Performance Computer System Design

Prerequisites Digital systems and computer organization

Course Web Pages http://www.ee.ryerson.ca/~courses/ele818/
http://www.ee.ryerson.ca/~courses/ee8207

Compulsory Texts:

1. David Patterson and John Hennessy ``Computer Architecture A Quantitative Approach'' 2003, Morgan Kaufmann Publishers, San Francisco, California ISBN 1-55860-596-7

References Lab notes, SimpleScalar and WINMIPS Simulator manuals.

Calendar Description This course will focus on the design of high performance computer systems. Topics covered include: Advanced pipelining and parallelism issues, including branch prediction, instruction and data level parallelism; Advanced processors including superscalar, VLIW, speculative, vector and multi-processors; Physical limitations and scalability issues; Real-world examples including MMX technology, PowerPC and Alpha architectures, and DLX architectures. The lab projects include using CAD tools to design a branch predictor and trace cache for Pentium 4 processor. Antirequisites: ELE818, COE818. 1 Credit

Learning Objectives At the end of this course, the students will have a solid understanding of the design options available for high performance computers which include the design of advanced processors using superscalar, VLIW or vector processing. The students also will understand the design of recent multi-core and its limitations and how to improve system scalability. The students will understand the interaction between software and the different architectures and how to improve the performance of each system.

Course Organization 3 hours of lecture per week for 13 weeks
3 hours lecturing and an optional 1 hour of lab per week for 13 weeks

Course Evaluation		
	Labs or a project	25%
	Midterm test	25%
	Final Exam	50%
	Total	100%

Projects Download Software for SimpleScalar to evaluate performance of a high Performance computer

Report must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- Appendices
- Index - list of key words and their page number in the project report.

Course Content

Date	*Topic*	*Homework & Project discussion*
Week 1	**Instruction Set Principles** **- Review and Introduction** **-Instruction Set Architectures** **-Memory Addressing**	**LAB1: Installation of SimpleScalar Simulator**
Week 2	**Instruction Set Principles** **-Operations** **-Operands** **-Encoding Instruction Set** **-Role of Compilers**	**LAB1: SimpleScalar**
Week 3	**Pipelining** **-Basic Pipelining** **-Data Hazards**	**LAB1: Using SimpleScalar**
Week4	**Pipelining** **-Data Hazards**	**LAB2: Performance Evaluation**
Week 5	**Pipelining** **-Control Hazards** **-Dealing with Exceptions**	**LAB2: Performance Evaluation**
Week 6	**Advanced Pipelining** **Multi Cycle Operations**	**LAB2: Performance Evaluation**
Week 7	**Advanced Pipelining** **-Instruction Level Parallelism** **-Midterm Test**	**LAB2: Performance Evaluation**
Week 8	**Instruction Level Parallelism** **-Dynamic Scheduling** **-Branch Prediction**	**LAB3: Data Hazards or project**
Week 9	**Advanced Pipelining** **-Superscalar** **-VLIW** **-Vector Processor and MMX**	**LAB3: Data Hazards or project**
Week 10	**Multiprocessors** **-Introduction** **-Shared Memory and coherency**	**LAB4: ILP or project**
Week 11	**Multiprocessors** **-Coherency**	**LAB4: ILP or project**

Week 12	**Multiprocessors** **-Coherency** **-Synchronization** **-Multithreading**	**LAB4:** **ILP or project**
Week 13	**Review**	

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.

8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

Name of Instructor		Signature of Instructor		Date	
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8208: Architectural Synthesis and Design of Digital Systems

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~lkirisch/ee8208/ee8208.htm

Compulsory Texts:

1. Giovanni De Micheli, "Synthesis and Optimization of Digital Circuits", McGraw-Hill Inc., ISBN 0-07-016333-2
2. Lecture notes from Dr. Lev G. Kirischian and published scientific papers.
3. Laboratory manual: *Laboratory Manuals and Tutorials*, Ryerson University.

Calendar Description

The goal of this course is to give theoretical background and practical skills in the area of synthesis and design of modern digital systems from high-level architectural synthesis to physical design stage.

This course explores the methodologies for *high-level synthesis* and *architecture-to-task optimization* techniques for application specific computing circuits. Topics include: i) fundamentals in high-level synthesis of application specific computing architectures, ii) methodology for formal selection of the optimum architecture variant in the multi-objective design space and iii) formal conversion of the optimized architectural variant of the application specific processing circuit to the logic design and HDL-implementation.

Case studies include the architectural synthesis of custom pipelined data-stream processor from specification to logic implementation.

Students are expected to read selected papers from current research literature, learn one of hardware description languages (VHDL or Verilog), get practical experience in design methodology of the custom computing circuits on the base of Xilinx ISE CAD system coupled with Xilinx Spartan-3E FPGA development platform**.**

Learning Objectives

At the end of this course, the successful student will have a solid understanding of the concept of high-level synthesis of digital computing circuits, and methodology for design of dedicated application specific processors (ASP) from specification to actual logic synthesis level. In the second part of the course students will learn the concept and methodology for multi-objective architecture optimization. This methodology will be illustrated in example of the design process of function-specific ASP optimized to satisfy performance and power consumption constraints with minimum area of the System-on-Chip. The lab tutorials and design project will extend understanding the above design methodology and let students get the hands-on experience in development of ASP.

Course Organization 3hours of lecture per week for 13 weeks
2hours of lab per week for 7 weeks

Course Evaluation

Project 1: Literature survey	- 25%
Project 2: ASP design	- 25%
Final exam	- 50%
Total	100%

To achieve a passing grade, student must pass both the theory and aboratory/project components.

Examinations Final examination is a 3-hour, closed-book examination that covers all the lecture materials.

Projects Project 1: Students are required to conduct literature research on one of areas associated with high-level synthesis of application-specific computing circuits. The project assumes investigation of the state-of-art in the selected area of interest, analysis on main directions of research in this area based on recent publications and formulation of main trends and / or classification of methods of RCS development and application.

Project 2: Students are required to perform the engineering design of an on-chip function-specific ASP from determination of functional and technical specification to complete design and verification. The on-chip hardware design assumes: creation of ASP symbol and block-diagram of architecture followed by VHDL design using Xilinx ISP CAD system, compilation, and physical implementation on the Xilinx Spartan FPGA based evaluation platform. The performance verification using on-chip logic analyzer (e.g. Xilinx Chip-Scope) should complete the design process.

Course Content

Week	Detailed Description	Hours
1	Introduction to synthesis and design process of modern digital computing systems: stages of digital systems design, tools and means for system design	3
2	Architectural synthesis in multi-objective environment: Specification analysis, determination of constraints and optimization objectives, hardware/ software partitioning.	3
3	Introduction to high-level architectural synthesis. Mathematical background: Notation; Elements of the Graph theory; Decision & Optimization problems	3
4	Formalization of architectural level synthesis: scheduling and binding; process synchronization; area and performance estimation	3
5	Architectural Optimization: Area/Latency; Cycle-time/Latency, Cycle-time /Area; Design evaluation space & Pareto points	3
6	From SG-to-ASP. Conversion methodology: From the Sequencing Graph to the block-diagram of the Application Specific Processor (ASP)	3

7	From ASP block diagram to hardware implementation: determination of multiplexing scheme and data-path synthesis.	3
8	Determination of initiation / termination and synchronization signals and synthesis of the control unit for the ASP data-path.	3
9	From formalization to automation of high-level synthesis: i) automated architectural variants construction, ii) design space exploration and iii) selection of optimal variant of architecture in multi-objective design space	3
10-11	Case study: Architectural synthesis of pipelined function-specific ASP of video-stream processor: Analytical models construction and Design Space Explorer; Determination of constrained design space by performance and power consumption requirements	6
12	Selection of the optimal variant of ASP architecture in multi-objective design space. Concept of semantic filtration and determination of Pareto-set of architectural variants. Design verification process.	3
13	Course review and final examination	3

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages**will not**be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required

observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.

7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom.of Student Relig., Abor. andSpir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

Name of Instructor	Lev Kirischian	Signature of Instructor		Date	
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Department of Electrical and Computer Engineering

ELE 888: Intelligent Systems (EE 8209)

Course Outline: Winter 2013 (EPH 216, 3-6 pm)

TEACHING STAFF:

Professor: Anastasios (Tas) Venetsanopoulos

Phone: (416) 979-5000 Ext. 4037

e-mail: tasvenet@ryerson.ca

web: http://en.wikipedia.org/wiki/Anastasios_Venetsanopoulos

Office hours: Mondays 1 pm-3pm (ENG 428)

Teaching Assistants:

Ghassem Tofighi, gtofighi@ryerson.ca, office: EPH 408

Nastaran Rahnama, nastaram.rahnama@ryerson.ca, office: EPH 439

CALENDAR DESCRIPTION

Machine learning and pattern classification are fundamental blocks in the design of an intelligent system. This course will introduce fundamentals of machine learning and pattern classification concepts, theories, and algorithms. Topics covered include: Bayesian decision theory, linear discriminant functions, multilayer neural networks, classifier evaluation, and an introduction to unsupervised clustering/grouping, self-organization and evolutionar computation. The course will also discuss recent applications of machine learning such as image/data mining, robotic vision, biometrics and some biomedical applications.

INSTRUCTIONAL HOURS

3 hours of lecture per week for 12 weeks

1 hour of lab per week for 11 weeks

2 Teaching Assistants

PRE AND CO-REQUISITES

Prerequisite MTH 514, Co-requisite ELE 632

COURSE WEBSITE

Blackboard will be used as soon as it is activated

COURSE EVALUATION

Midterm Exam	30%
Lab Projects	30%
Final Exam	40%
Total	100%

To be awarded a passing grade, a student must pass both the **theory** and **lab** components of the course. Graduate students may replace Lab projects and Assignments by a research project, only after agreement with the professor.

Examinations: Midterm exam in week 8, two hours long, closed book, "cheat sheet provided" (Covers weeks 1-7).Final Exam: During exam period, three hours long, closed book, "cheat sheet provided" (Covers weeks 1-13).

COMPULSORY TEXT

1. R.O. Duda, P.E.Hart and D.G.Stork, *Pattern Classification,* 2nd edition, John Wiley and Sons, Inc., 2002.

REFERENCE MATERIAL

2. D.G.Stork, Elad Yom-Tod, *Computer Manual in MATLAB to accompany Pattern Classification,* 2nd edition, John Wiley and Sons, Inc., 2004.
3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer Science, 2006.
4. S. Theodoridis and K. Koutroumbas, *Pattern Recognition,* Academic Press, 2009.

5. A. Webb, *Statistical Pattern Recognition,* John Wiley & Sons, Inc., 2002.

6. N.B. Karayianis and A.N. Venetsanopoulos, *Artificial Neural Networks:*

Learning Algorithms, Performance Evaluation and Application, Kluwer

Academic Publishers, 1993.

7. cgm.cs.mcgill.ca/~godfried/teaching/pr-web.html

8. Machine Learning (Stanford). Twenty lectures on "Machine Learning"given by Prof. Andrew Ng (CS229) and available on the web through Utube.

COURSE CONTENT

Date	Week. No.	Topic	Approx. hours/weeks	chapter	pages
Jan 07	1.	Introd. and Review to course, Examples	3/1	1	19,notes
Jan 14	2.	Review of Lin A. Probab. and Info. Theory	3/1	Appendix	604-35
Jan 21	3.	Bayesian Decision Theory	9/3-5	2.1-2.4, 2.9	20-31 (exclude 2.3.1, 2.3.2)
Jan. 28	4.	>>		2.5, 2.6, 2.9, 2.11,	31-51
Feb. 4	5.	>>		2.12, summary,	51-54, 62-64
Feb. 11	6.	Linear Discriminant Functions	6/6-7	3.3, 5.1-5.6, 5.8,5.11,	84-102 107-124, 215-242, 259-265
Feb.25	7	>>		(excl. 5.5.3, 5.6.2,5.8.2-5)	
March 04	8.	Midterm Exam	Lectures 1-7, Labs, Prob sets 1-3		
March 11	9.	Multilayer Neural Networks	5/8-9	6.1-6.5, 6.8	282-303
March 18	10.	>>		>>	
March 25	11.	Neural Networks, Fuzzy Set Th.	4/10	Notes,	306-318
April 01	12.	Algorithm Independent Machine Learning	4/11-12	9.1-9.5 (exclude 9.5.3-4)	453-480
April 08	13.	Unsupervised Learning and Clustering	2/13	10.1-10.4, 10.6-10.9 10.13, 10.14, (exclude 10.9.3-4)	517-530, 537-555,568-570, 573-581

April ? 14. Final Exam TBA

LABORATORY

It starts one week after the lectures. Laboratory exams are shown below. All other lectures are preparatory.

Week 4-5	Lab. 1	Bayesian Decision Theory	ENG 409
Week 6-7	Lab 2	Linear Discriminant Functions	ENG 409
Week 10-11	Lab 3	Multilayer Neural Networks	ENG 409
Week 13	Lab 4	Unsupervised Learning and Clustering	E NG 409

IMPORTANT NOTES

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.

2. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment, but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assignments, even if that makes the grade on the final exam to be more than 70% of the final grade in the course.

3. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of "INC" (as outlined in the *Grading Promotion and Academic Standing Policy*) and a make-up exam (normally within two weeks of the next semester) that carries the same weight and measures the same knowledge must be scheduled.

4. Medical and Compassionate documents for the missing of an exam must be submitted within three working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.

5. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor not later than two weeks prior to the conflict in question (in

case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.

5. The results of the first test of mid-term test will be returned to students before the deadline to drop an undergraduate course in good Academic standing.

6. Students are required to adhere to all relevant academic policies including the Student Code of Academic Conduct ((www.ryerson.ca/senate/policies/po160.pdf) and Non-Academic conduct (www.ryerson.ca/senate/policies/po161.pdf).

7. Students are required to obtain and maintain a Ryerson matrix e-mail account for timely communications between the instructor and the students.

8. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.

RYERSON UNIVERSITY
Department of Electrical and Computer Engineering
EE8212
Winter 2014
Digital Image Processing II
Course Information

Professor:

Name	Office	Ext.	Email
Dr. Dimitri Androutsos	ENG 472	6104	dimitri@ee.ryerson.ca

Course Organization- Lecture/Tutorial Hours

Lecture – **3 hrs/week** Wednesdays 9am-12pm
ENG LG13

Course Description:

This course deals with advanced concepts in digital image processing. In particular, emphasis will be on color image processing. The concepts that will be covered include: color vision, trichromacy theory, color spaces, colour image creation/representation/storage, component colour image processing, vector colour image processing, segmentation, and colour image compression. The course will include a practical aspect by discussing applications and implementations of image processing techniques currently in use in industry. The course will also have student projects and literature reviews in selected areas.

Pre-requisites: **Courses in signal and image processing.**.

Text & References:

Required Textbook	**Digital Image Processing (3rd Edition),** R.C. Gonzalez & R.E. Woods**,** **Prentice Hall, ISBN: 0-20-118075-8**
Reference 1	**Color Image Processing,** K.N. Plataniotis & A.N. Venetsanopoulos **Springer 2000, ISBN: 3-540-66953-1**
Reference 2	**Fundamentals of Digital Image Processing,** A.K. Jain**,** **Prentice Hall, 1989, ISBN: 0-13-336165-9**

Lecture Content Outline:

Topic Descriptions	Hours
Colour Fundamentals - light and colour - human eye - trichromacy theory - additive/subtractive colour - colour spaces	6
Digital Colour Images - creation/display hardware - gamma - representation - noise	4
Colour Image Processing -Scalar Component image processing -Vector image processing	12
Image Segmentation - Region growing - Split & merge - Thresholding	4
STUDY WEEK	
Morphology - Erosion - Dilation - Opening - Closing	8
Upsampling - Increasing resolution - Super-resolution	8
Image & Video Compression - DCT - Wavelets & Multiresolution - JPEG - MPEG	4
Current Applications	4

Course Evaluation:

2 ASSIGNMENTS (topics to be announced)	**2 X 20% = 40%**
MIDTERM TEST (February 26, 2009)	**20%**
PROJECT	**40%**

- **Assignment 1**: Implementation Assignment. Will be due **February 21, 2010**. (11:59 pm)
- **Assignment 2**: Literature Review Assignment& Presentation. Due **March 25, 2010**
- **Project**: Will be due **April 19, 2010** (11:59pm)

IMPORTANT NOTE:

- **It is the students' responsibility to regularly check the course web page for updates and announcements**

NOTE: Ryerson University Policy

- "All of the required course specific written reports will be assessed not only on their technical or academic merit, but also on the communication skills of the author as exhibited through these reports."
- "All students are required to activate and maintain a Ryerson University central Matrix e-mail account which shall be an official means by which they will receive University communications." It is also recommended that, where possible, students utilize these accounts for communicating with their instructors.

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8213: Computer Network Security

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8213/

Compulsory Texts: None

Reference Texts:

1. Charles P. Pfleeger, Shari Lawrence Pfleeger, *Security in Computing*, 4th Edition, Prentice Hall, 2007
2. William Stallings, *Network Security Essentials,* 5nd Edition, Prentice Hall, 2014.
3. Ed Skoudis and Tom Liston, *Counter Hack Reloaded*, 2nd edition, Prentice Hall, 2006.

Calendar Description This course provides a thorough understanding of technologies and methodologies in network security. It deals with the fundamental techniques used in implementing secure network communications, and forms of attacks on computer networks and approaches to their prevention and detection. Topics that are covered include introduction to Cryptography, Virtual Private Networks (VPN), Firewalls and intrusion detection techniques. In addition, the course covers worms, viruses, and DDOS attacks and their remedies. Kerberos authentication Protocol, SSL, and anonymous communication protocols.

Learning Objectives At the end of this course, students will have a solid understanding of computer network security. In addition, students will have in-depth knowledge of security protocols, privacy, IP security, viruses, attack and defense techniques. Students will be able to analysis the vulnerabilities of security protocols.

Course Organization	3 hours of lecture per week for 13 weeks	
Course Evaluation	Assignment	5%
	Midterm exam	15%
	Course Project	35%
	Final exam	45%
	Total	100%

Examinations

Midterm examination is a 1-hour, closed-book examination that covers all the lectures up to the week of mid-term examination.

Final examination is a 3-hour open-book examination that covers all the course materials.

Project

Students are required to write a research or survey paper on one of the following topics in wireless network security (ad-hoc networks, wireless mesh network, wireless sensor network, WLAN, etc):

- Authentication Protocol
- Secure handover
- Routing protocol
- Key management
- Secure payment
- Role-based Access Control
- Attack and Defence
- Anonymity and privacy

Research Paper

You can work on original research problems. The outcome should be a paper with original technical contribution. Your grade on this will be judged on originality, soundness of the approach, and quality of presentation. The research paper must be 8-12 pages (single-spaced) long and contain the following sections:

1. Title
2. Abstract
3. Introduction – motivate the problem and situate it in the context of security
4. Related work – provide comprehensive survey of existing work with references to literature
5. Your contribution – present your ideas/thoughts
6. Conclusion
7. References

Survey paper

You can write a paper that surveys a particular field on network security (25 - 30 papers). The outcome should be a paper that summarizes the trend in the field you have chosen. The survey paper must be 8-12 pages (single-spaced) long and contain

the following sections:
1. Title
2. Abstract
3. Introduction
4. Body of survey paper
5. References

You will be graded based on your writing, presentation, and how it enhances the understanding of the research topic. Criteria include:

Thoroughness and scope of survey
Classification and organization of trends
Critical evaluation of approaches (relative advantage/disadvantages)
Quality of explanation (Draw your own figures, diagram, charts)
Reference

Course Content

Week	Detailed Description	Hours
1-2	Introduction of network security and cryptography	6
3	Access control	3
4	Web security	3
5	Multicast security	3
6-7	Authentication protocols	6
8	VPN	3
9	Firewall	3
10	Intrusion detection systems	3
11	Malicious software	3
12-13	Attack and defense	6

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8214: Computer Systems Modelling

Prerequisites Probability theory in undergraduate level

Course Web Page http://www.ee.ryerson.ca/~odas/ee8214.html

Compulsory Texts:

1. G. Bolch, S. Greiner, H. de Meer and K. S. Trivedi, Queueing Networks and Markov Chains: Modeling and Performance Evaluation with Computer Science Applications, Second Edition, John Wiley, New York, NY, 2006. ISBN number: 0471565253.
2. Lecture notes from Dr. Olivia Das and published scientific papers.

Reference Texts:

1. Kishor S. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, 2nd Edition, John Wiley and Sons, 2001.
2. R. A. Sahner, K. S. Trivedi and A. Puliafito, Performance and Reliability Analysis of Computer Systems: An Example-Based Approach Using the SHARPE Software Package, Kluwer Academic Publishers, 1996.
3. A. O. Allen, Probability, Statistics, and Queuing Theory With Computer Science Applications, Academic Press, 2 edition, 1990.
4. D. P. Siewiorek, R. S. Swarz, Reliable Computer Systems: Design and Evaluation, AK Peters, Ltd., 3rd edition, 1998.
5. F. Bause and P. Kritzinger, Stochastic Petri Nets. An Introduction to the Theory, Vieweg, 2002.
6. E. D. Lazowska, J. Zahorjan, G. S. Graham, K. C. Sevcik, Quantitative System Performance, Computer System Analysis Using Queuing Network Models, Prentice Hall, 1984. This book is available online at http://www.cs.washington.edu/homes/lazowska/qsp/

Calendar Description The objectives of this course are to study the characteristics of various analytical models of computer systems and to learn how to apply those models to analyze system performance and dependability. The modeling techniques to be covered include Poisson, renewal, Markov processes, fault trees, Petri nets and queuing networks. Examples include models of computer systems, computer networks, and wireless systems.

Learning Objectives

At the end of the course, students will have the knowledge of various models of computer-based systems for analyzing their performance, availability and reliability. The students will have in-depth knowledge of models, for example, fault trees, reliability block diagrams, Markov Chains and their applications in reliability and performance, Product-form Queueing Networks and Stochastic Petri Nets. The students will be able to build and solve models for computer-based systems using state-of-the-art modelling tools.

Course Organization

3 hours of lecture per week for 12 weeks

Course Evaluation

Assignments	30%	(Students must submit their work by the deadline to receive credit.)
Midterm Exam	10%	
Final Exam	30%	
Project	30%	(10% Presentation, 20% Report)
Total	100%	

Examinations

Midterm examination is a 1-hour, closed-book examination that covers all the lecture materials and assignments up to the week of mid-term examination.

Final examination is a 2-hour closed-book examination that covers all the course materials.

Project

The project must be done in a group of maximum 3 students. Projects should make an extensive use of the knowledge acquired from the course. It may involve one of the followings: (i) The students should survey at least 10 papers in a research domain related to stochastic modeling of computer-based systems. (ii) The students should build/extend and analyze a model of a computer-based system reported in a paper. The model results should be reported.
The project report should be at least 5 pages and at most 6 pages. The report format should adhere to the IEEE double-column conference format.
The project report must contain the following:
1. Abstract
2. Introduction: Describe the problem and explain why the problem you are studying is important.
3. Other Sections relevant to your project
4. Conclusions and Suggestions for Future work
6. References -- Provide a list of relevant references.

Course Content

Week	Detailed Description	Hours
1	Basic definitions of reliability, availability and performance Methods of Evaluation	3

2	Fault trees and Reliability Block Diagrams	3
3-4	Quick review of probability, random variables and distributions Order statistics and its applications in reliability modeling	6
5	Stochastic Process: Renewal, Poisson processes	3
6-7	Discrete-time Markov chains, Continuous-time Markov chains and their applications in reliability	6
8-9	Introduction to queuing theory (single queues and Little's law)	6
10	Product-form queuing networks	3
11	Stochastic Petri Nets	3
12	Project presentations	3

Note: Schedule of lectures is tentative. There may be some changes in the schedule that will be announced in the class and posted in Blackboard.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.

7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE 8215: Human Computer Interaction

Prerequisites Registration within Ryerson's School of Graduate Studies or approval.

Course Web Page www.ee.ryerson.ca/~jasmith/courses/ee8215 & Blackboard

Compulsory Texts: None. Reference texts to be posted or linked to online.

Reference Texts: None. Reference texts to be posted or linked to online.

Calendar Description

This course looks at Human-Computer Interface from the perspective of human capabilities and limitations. Human sensory processes and central processing mechanisms will be studied along with optimal design of visual/auditory displays and human control input devices. Topics covered will include memory, attention, human error and decision making. Information theoretical approaches will be discussed in the modelling of human perception and information processing. Experimental techniques will be covered along with measurement and quantification methods. The perception of motion and human motion sensation will be introduced. Applications to be addressed include aviation and space, automation and robotics and various computer interfaces.

Learning Objectives

Describe differences between the various approaches that can be used to solve a human computer interaction problem using appropriate tools. Select one specific approach to solve the problem. When the selected approach fails to solve the problem satisfactorily, analyze the cause of failure using standard methods and debugging methodologies. Based on the analysis, come up with new suggestions to improve the existing approach. Integrate the new suggestions into the existing design plan. Judge the completeness and quality of the generated solutions using standard methods and debugging methodologies.

Produce lab and project reports using appropriate format, grammar, and citation styles for technical and non-technical audiences.

Course Organization 3 hours of lecture and discussion per week for 12 weeks

Course Evaluation

Discussion and Brainstorming (Participation)	10% of final grade
Midterm Project (in-class demo & presentation)	20% of final grade
Midterm Exam	20% of final grade
Final Project (in-class demo & presentation)	30% of final grade

Final Exam	20% of final grade
Total	100%

(a) Discussion & Brainstorming sessions: a number of discussions and design-oriented brainstorming sessions will be held throughout the semester. Your participation grade will be based on your work during these sessions.

(b) Midterm Exam: A single midterm exam will be held. The midterm exam will be take-home, essay-based and will be submitted electronically through TurnItIn. The topic will be based on your project selection and related to the presentation component of your project. A marking guide will be provided ahead of time.

(c) Final Exam: A single final exam will be held. The final exam will be take-home, essay-based and will be submitted electronically through TurnItIn. The topic will be based on your project selection and related to the presentation component of your project. A marking guide will be provided ahead of time.

(d) Midterm & Final Projects: You will choose a project on human-computer interaction early in the semester and be evaluated on it both mid-semester and end-of-semester. This will include a presentation component and a written component published online. The technical scope of the project will be determined on an individual basis, based on a consultation with the instructor. A marking guide will be provided ahead of time.

Project

Hands-on projects are an integral part of the course experience. Project material will be discussed during class time. Project selection and strategies will be tuned to the background and strengths of the individual students. For this reason student participation in the classroom and interaction with other students and the instructor is strongly encouraged.

The midterm and final reports are expected to adhere to IEEE format, including referencing, unless the student eventually intends to submit the work in some form to a non-IEEE publication, in which case the specific publication's formatting style is to be adhered to (and a web link specifying this format is provided by the student to the instructor). Refer to the marking and style guides for details on what is required in these reports.

The hardware and software platforms for the projects will be discussed, debated and decided by the students and instructor during class. Options include -- but are not limited to -- Arduino, PIC32, ARM or Intel hardware platforms, as well as C, AJAX, Python, Processing or Wiring for software.

Course Content

Topic	Readings	Hours	Topic, description
Introduction	TBA	3	- Introduction to Design Thinking
Displays	TBA	3	- Current display technologies
Controls	TBA	3	- Current control interface technology
Rapid Prototyping	TBA	3	- Methods of rapid prototyping - Applications of rapid prototyping to HCI
The Internet of Things (IoT)	TBA	3	- Current Trends in IoT - Embedded systems (hardware and software tools) - Wearable computing
HCI & Biomedical Engineering	TBA	3	- Biomedical devices - Ubiquitous computing - Affective computing - Safety issues
HCI & Age	TBA	3	- memory, attention, human error and decision making - modelling of human perception and information processing
HCI & Robotics	TBA	3	- Biomimetic robotic systems - The Uncanny Valley - Haptics / Multimodal interfaces
HCI, Culture & Gender	TBA	3	- HCI factors related to culture - HCI factors related to gender
Student Presentations	n/a	6	- TBD

Note: The schedule is tentative. There may be some changes in the schedule that will be announced in the class and/or posted on the course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. No makeups will be provided for midterm exam or assignments. If any of the aforementioned are missed for an officially approved reason the associated weight will be assigned to the final exam.
4. Students who miss a final exam for an officially approved reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first assignment and/or midterm exam will be returned to students before the deadline to drop a course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including but not limited to:
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This may automatically will lead to a failing grade.

Name of Instructor	James Andrew Smith, PhD, PEng	Signature of Instructor		Date	July 18, 2014
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

1. Kishor S. Trivedi, **Probability and Statistics with Reliability, Queuing, and Computer Science Applications**, 2nd Edition, John Wiley and Sons, 2001.

2. R. A. Sahner, K. S. Trivedi and A. Puliafito, *Performance and Reliability Analysis of Computer Systems: An Example-Based Approach Using the SHARPE Software Package*, Kluwer Academic Publishers, 1996.

3. A. O. Allen, *Probability, Statistics, and Queuing Theory With Computer Science Applications*, Academic Press, 2 edition, 1990.

4. D. P. Siewiorek, R. S. Swarz, Reliable Computer Systems: Design and Evaluation, AK Peters, Ltd., 3rd edition, 1998.

5. F. Bause and P. Kritzinger, *Stochastic Petri Nets. An Introduction to the Theory*, Vieweg, 2002.

6. E. D. Lazowska, J. Zahorjan, G. S. Graham, K. C. Sevcik, *Quantitative System Performance, Computer System Analysis Using Queuing Network Models*, Prentice Hall, 1984. This book is available online at http://www.cs.washington.edu/homes/lazowska/qsp/

EE 8216
Computer Networks
Winter 2014

M. Jaseemuddin
Handout #1
Date: 06/01/2014

Course Information Sheet

Objective: *This is a graduate course in computer networking. The course is designed to include materials relevant to the industry, which is moving to deploy IP network in the backbone and offer QoS sensitive services, e.g. VOIP. The course deals with the principles, architectures, algorithms, and protocols related to Internet: with emphasis on routing, transport protocol design, flow control and congestion control, IP Quality of Service and Traffic Engineering.*

Outline: *Introduction:* Internet Architecture, Overview of IP and ICMP [Ch. 5.1]
IP Routing: ICMP Route Redirects, IP Source Routing, Distance Vector (RIP), Link State (OSPF) and Inter-domain (BGP), Multicast and IGMP [Ch. 5.2]
Transport Protocol: TCP flow control and congestion control (RENO, TAHOE, Vegas), Network assisted congestion control – ECN [Ch. 6.1 – 6.6]
IP QoS: Traffic Conditioning, QoS Scheduler (WFQ), Active Queue Management (RED), IntServ and RSVP, DiffServ [Ch. 5.4]
Traffic Engineering: IP Traffic Engineering, MPLS [Ch. 5.5 – 5.6]

Instructor: Muhammad Jaseemuddin
Email: jaseem@ee.ryerson.ca, Phone: 979-5000x6073, office: ENG470
Office hour: Monday 1:00pm – 2:00pm

Lectures: Mon 9:00am – 12:00noon @ENGLG02

Prerequisites: COE 768 Computer Networks or equivalent

Text: A. Tanenbaum and D. Wetherall, *Computer Networks* 5th edition, Prentice Hall, 2010.

Reference: W. Richard Stevens, *TCP/IP Illustrated Volume 1*, Addison-Wesley.
J. Kurose and K. Ross, *Computer Networking – A Top-Down Approach Featuring the Internet*, Addison-Wesley.
L. Peterson and B. Davie, *Computer Networks – A Systems Approach*, Morgan Kaufmann, 2002.

Grading: Based on the following weight

Two Quizzes	10%
Assignments	10%
Project	25%
Midterm Exam	20%
Final Exam	35%

Policies:

1. Textbook does not cover all the topics. Reading list contains list of papers that can be consulted for specific topics.
2. Please use e-mails for communicating your needs. I discourage phone calls unless it is an absolute necessity. I won't be able to answer your questions through email, please use office hours for that purpose.
3. Check Blackboard for course related information.
4. Please make yourself aware of university policies, especially regarding student code of conduct and plagiarism (http://www.ryerson.ca/senate/policies/).
5. Midterm is scheduled on **Feb 24th**.
6. Final exam, during the final exam period on the day of COE865 final exam, three hours, and closed book
7. Project marks breakdown and deadlines are as follows:
   Project proposal (2.5%) due **February 3rd**
   Interim Report (2.5%) due **March 3rd**
   Project Report (20%) due **April 7th**
8. Report will be marked based on the following criterion:
   - Introduction
   - Problem Definition: Statement, Motivation
   - Project Details: Analytical, Originality, Clarity, Writing style, Enough details
   - Conclusion: Remarks, Future work
9. Project should contain some original idea showing creative thinking and analysis.
10. Make yourself familiar with the resources available at Ryerson Library, especially browse IEEE Explore for accessing papers on-line.
11. You should browse the Internet Engineering Task Force's web page at www.ietf.org and familiarize yourself with its working process. You can also find all RFCs and current Internet Drafts at that site.
12. You can use www.google.com and CiteSeer (http://citeseer.nj.nec.com/cs) for citation lookup.

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8217: Reconfigurable Computer Systems Engineering

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~lkirisch/ee8603/ee8603.htm

Compulsory Texts:

1. Maya B. Gokhale and Paul S. Graham, "Reconfigurable Computing. Accelerating computation with Field Programmable Gate Arrays", Springer, 2005, ISBN-10 0-387-26105-2
2. Lecture notes from Dr. Lev G. Kirischian and published scientific papers.
3. Laboratory manual: *Laboratory Manuals and Tutorials*, Ryerson University.

Calendar Description

This course is designed to offer an introduction in the theory and engineering design principles of the modern Reconfigurable Computing Systems (RCS) – one of the most rapidly growing sectors of the high-performance computer technology. The emphasis is in understanding of the concepts of architecture re-configurability, classes of RSC, sources for performance acceleration and cost-efficiency of RCS. Concept of resource virtualization in RCS is discussed in details as well as stages of high-level synthesis of RCS architecture. The process of RCS development is described from the task algorithm / data structure analysis to virtual component synthesis, system integration and verification techniques. Additionally, the hardware basis of the modern RCS – fine and coarse-grained programmable logic devices: Field Programmable Gate Arrays (FPGA) and Coarse-Grained Reconfigurable Arrays (CGRA) will be overviewed.
The project portion of the course consists of: i) literature research project and ii) design project based on Xilinx FPGA-based platform. This project assumes getting hands-on experience in RCS component high-level synthesis, HDL-implementation, verification and comparative analysis with embedded software implementation**.**

Learning Objectives

At the end of this course, the successful student will have a solid understanding of the concept of RCS and classification of RCS architectures, RCS organization, sources and methods for performance acceleration in RCS and cost-efficiency. The novel concept of virtualization of computing resources and entire architecture is another important aspect to be learned in this course. In the second part of the course students will learn the design methodology and get hands-on experience in development of RCS components, integration and verification techniques.

Course Organization	3hours of lecture per week for 13 weeks 2hours of lab per week for 7 weeks
Course Evaluation	Project 1: Literature survey - 25% Project 2: Component design - 25% Final exam - 50% Total 100%

To achieve a passing grade, student must pass both the theory and laboratory/project components.

Examinations Final examination is a 3-hour, closed-book examination that covers all the lecture materials.

Projects

Project 1: Students are required to conduct literature research on one of areas associated with reconfigurable systems engineering. The project assumes investigation of the state-of-art in the selected area of interest, analysis on main directions of research in this area based on recent publications and formulation of main trends and / or classification of methods of RCS development and application.

Project 2: Students are required to perform the engineering design of a on-chip functional component from determination of functional and technical specification to complete design and verification. The on-chip hardware design assumes: creation of component's symbol and block-diagram of architecture followed by VHDL design, compilation, and physical implementation on the Xilinx Spartan FPGA based evaluation platform. The performance verification using on-chip logic analyzer (e.g. Xilinx Chip-Scope) should complete the design process.
In addition to the above, the comparison of performance between the designed hardware component and implementation in soft-core processor deployed in the same FPGA is required for analysis of component's cost-performance efficiency.

o

Course Content

Week	Detailed Description	Hours
1	Classification of computing systems and definition of Reconfigurable Computing Systems (RCS)	3
2	Classification of RCS architectures: homogenous and heterogeneous architectures, fine-grain and coarse-grain systems, statically and dynamically reconfigurable RCS	3
3	FCR - Field of Configurable Resources; Communication infrastructure; Memory hierarchy in RCS and Interface elements.	3
4	Performance acceleration in RCS: Sources of parallelism in task algorithm and data structure. Sources for hardware performance acceleration	3
5	Cost-efficiency of RCS: Performance-Cost Ratio (PCR) and cost-efficiency, PCR calculation. Increasing cost-efficiency by partitioning the workload between hardware and software in RCS	3
6	Virtualization of resources in RCS: Segmentation of task algorithm and concept of Virtual Hardware Components (VHC). Concept of Application Specific Virtual Processors (ASVP)	3
7	RCS architecture integration: Integration of ASVP in time domain (temporal partitioning) and in spatial domain (spatial partitioning)	3
8	RCS Development: Application and specification analysis. High-level synthesis of RCS architecture	3
9	Determination of RCS components: Determination of component set and component nature (HW or SW). Determination of component interface and synchronization scheme	3
10-11	High-level synthesis of RCS components: Creation of component's symbol, data-path and control unit. Main stages of process: creation of sequencing graph (SG), scheduling, binding and getting data-path block diagram.	6
12	RCS implementation – Low-level synthesis: Conversion of scheduled SG to the component block diagram; Resource sharing and multiplexing scheme; HDL coding and configuration bit-stream generation.	3
13	Course review and final examination	3

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages**will not**be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format.

Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom.of Student Relig., Abor. andSpir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8218: Parallel Computing

Prerequisites Computer architecture, mathematics, algorithms and programming

Course Web Page http://www.ee.ryerson.ca/~courses/ee8218/

Compulsory Texts: 1. David E. Culler, Jaswinder Pal Singh, with Anoop Gupta`Parallel Computer Architecture: A Software/Hardware Approach'' Morgan Kaufmann Publishers, San Francisco, California ISBN 1-55860-343-3

References MPICH2 "Message Passing Interface" Reference
2-http://www-unix.mcs.anl.gov/mpi/
3-OPENMP References

Calendar Description This course will introduce students to parallel computing including parallel algorithms, parallel programming and different parallel architectures. It covers the basic programming models used in parallel computers, parallel algorithms, parallel programming, the shared memory multiprocessor and NUMA multiprocessor. The Laboratory projects include parallel programming using one of the parallel models.
1 Credit

Learning Objectives At the end of this course, the successful student will have a solid understanding of different parallel computer models, and the limitations of each mode. Students should be able to know the methodology used to write an efficient parallel programs and implement them in real parallel computer using MPI or OPENMP or combination of both. Students will be able to use different Parallel Algorithms in parallel applications to improve scalability of parallel computer.

Course Organization 3 hours of lecture per week for 12 weeks
2 hours lecturing and 1 hour of lab or open discussion per week for 12 weeks

Course Evaluation

Assignments	10%
Labs	20%
Course Project	60%
Participation	10%
Total	100%

Projects

1-Download Software for implementing parallel computer (MPI, OPENMP or combination of both).
2-Install software
3-Run a parallel programs
4-Evaluate the performance gain for using parallel computing1

Final Report must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- Appendices
- Index - list of key words and their page number in the project report.

Course Content

Date	*Topic*	*Homework & Project discussion*
Week 1	**Introduction to Parallel Architecture** -shared memory -message passing -other parallel architectures -programming model and communication	Introduction to SIMD (download SIMPil simulator)
Week 2	**Parallel Programs** -Examples of Parallel Applications	Using SIMPil
Week3	**Parallel Programs** -Examples of Parallel Applications -Parallelization Process	Running application on SIMPil
Week 4	**Parallel Programs** -Examples of Parallel Applications -Parallelization Process	Installing MPI, OpenMP
Week 5	**Parallel Programs** -Example Program	Installing MPI, OpenMP
Week 6	**-Programming for Performance** -partitioning	Installing MPI, OpenMP
Week 7	**-Programming for Performance** -partitioning -Communication-Programming for Performance	Compile and Running application
Week 8	**Shared Memory Multiprocessors** -Cache Coherence -Memory Consistency	Compile and Running application
Week 9	**Shared Memory Multiprocessors** -Design Snooping Protocol -Design Trade-offs	Compile and Running application
Week 10	**Shared Memory Multiprocessors** -Synchronization -Implication for Software	Optimization of Performance
Week 11	**Multiprocessor Design**	Evaluate system Scalability and define bottleneck
Week 12	**Projects Presentation**	Final Presentation

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf

Accom. of Student Relig., Abor. and Spir. Observance,
http://www.ryerson.ca/senate/policies/pol150.pdf
Est. of Stud. Email Accts for Official Univ. Commun.,
http://www.ryerson.ca/senate/policies/pol157.pdf

9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

Name of Instructor		Signature of Instructor		Date	
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8219: Field-Programmable Gate Array Architectures

Prerequisites

Knowledge in digital hardware design and C programming. One of the following courses: ELE734 (Low-Power Digital Integrated Circuits), or ELE863 (VLSI Systems), or EE8501 (VLSI System Design), or EE8504 (VLSI Design Automation and CAD Tools) or Permission of instructor.

Course Web Page

http://www.ee.ryerson.ca/~courses/ee8501/

Compulsory Texts:

1. Vaughn Betz, Jonathan Rose, and Alexander Marquardt, *Architecture and CAD for Deep-Submicron FPGAs,* Kluwer Academic Publishers, 1999, ISBN: 0-7923-8460-1.
2. Research papers will be suggested as the course proceeds.

Reference Texts:

None

Calendar Description

This course will explore various aspects in the design of Field-Programmable Gate Arrays (FPGAs). FPGAs are a new class of digital devices that enable the rapid prototyping and implementation of digital systems. Comparing to traditional methods of implementing digital applications, FPGAs combine the programmability of CPU systems with the ability of exploring the massive amount of parallelism inherent in many digital applications. As the logic capacity and application domain of FPGAs grow, their design has become increasingly complex and requires specialized engineering expertise. This course will explore the design of FPGA devices from an architectural perspective. We will exam a wide range of FPGA architectures and discuss the various methods employed in the modeling and evaluation of these architectures. The particular topics that will be covered in this course include:

1. The Modeling and Evaluation of FPGA Architectures
2. High-Level CAD Algorithms used in FPGA Architectural Evaluation – Technology Mapping and Packing Tools
3. Physical-Level CAD Algorithms used in FPGA Architectural Evaluation – Placement and Routing Tools
4. Power Modelling and Power-Aware CAD Tools for FPGAs
5. Low Power FPGA Architectures and Circuit-Level Design Techniques

Learning Objectives

The design of FPGA architectures is a classic example of large scale SOC design, where the architect must be aware of the impact of his/her architecture-level design choices on high-level CAD that are required to support these choices and low-level circuits that are required to implement these choices. Furthermore the

architect must be able to accurately model and quantify the effect of each design choice on the power, performance and area efficiency of the resulting SOC design. At the same time real life benchmarks must be used in all evaluations in order to ensure the accuracy and fidelity of the evaluation results. Consequently this course is designed to give a flavor of such design processes through the review of 18 highly significant papers in the area. At the end of this course, the successful student will have a solid understanding of the modeling and evaluation of FPGA architectures, high-Level CAD algorithms used in FPGA architectural evaluation – Technology Mapping and Packing Tools, physical-Level CAD algorithms used in FPGA architectural evaluation – Placement and Routing Tools, power modeling and power-aware CAD tools for FPGAs, and low power FPGA architectures and circuit-level design techniques.

Course Organization

3 hours of lecture per week for 12 weeks

Course Evaluation

Assignments	30%
Project	30%
Final exam	35%
Class Participation	5%
Total	100%

To achieve a passing grade, student must pass both the theory and assignment/project components.

Examinations

Final examination is a 3-hour closed-book examination with 2 pages of aid-sheet that covers all the course materials.

Project

Students are required to model an FPGA architecture and construct a placer/router for the architecture (both in C). The placer/router must be successfully used to place/route 5 benchmark circuits provided by instructor and graphically display the routing results through the X-Windows programming interface. Project reports must be prepared in a single-column double-space format, and must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report – Snap shots of the graphical display of placement/routing results must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical

reports.
- o Appendices
- o Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1	Course Management, Introduction to FPGAs, FPGA Programming Technologies	3
2	The Evolution of FPGA Logic Block Architectures	3
3	The Evolution of FPGA Routing Architectures	3
4	Cluster-Based FPGA Logic Blocks and Packing Algorithms (Technology mapping and look-up tables, clustering)	3
5	FPGA Placement Algorithms (Simulated Annealing)	3
6-7	Routing Tools (Lee, Directed Lee, Negotiated Congestion, Path Finder)	6
8-9	FPGA Circuitry and Process Modeling	6
10	Power Modeling Techniques for FPGAs	3
11-12	Power Efficient Circuitry and Architectures for FPGAs	3

Assignments/Projects

Assignment	Detailed Description	Week
1	Commercially Available FPGAs	2-3
2	The Modeling of FPGA Logic and Routing Architectures	4-6
3	FPGA CAD and Circuit-Level Design	7-9
Project	Students are required to model an FPGA architecture and construct a placer/router for the architecture (both in C). The placer/router must be successfully used to place/route 5 benchmark circuits provided by instructor and graphically display the routing results through the X-Windows programming interface.	8-12

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on

the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Department of Electrical and Computer Engineering

EE 8220 ADVANCED DIGITAL FILTERING AND APPLICATIONS (KHE 220) WINTER 2013

Office hours 3-5pm on Tuesdays

Lecture hours 5-8 pm on Tuesdays

CALENDAR DESCRIPTION

This course will enable graduate students and other researchers to pursue research in linear, nonlinear, adaptive, multidimensional and multichannel (vector) digital filters in one and more dimensions, which are applied to such diverse fields as radar, sonar, telecommunications, biomedicine, remote sensing, biometrics and image/video processing. The students will be encouraged to develop designs and introduce their filters to novel applications.

PROGRAM LEVEL

This is a second level graduate course. It shall make use of the Blackboard.

INSTRUCTIONAL HOURS

3 hours of lecture.

PRE AND CO-REQUISITES

Prerequisites: undergraduate courses on “Signals and Systems”, “Probability Theory”, EE8105 “Digital Signal Processing I” or equivalent.

Other relevant courses are EE8202 “Digital Image Processing I”, 8212 “Digital Image Processing II”, which complement but do not overlap with this course.

DETAILED COURSE DESCRIPTION

1. Introduction, Overview of the Course, Mathematical and Statistical Foundations

Overview of the course. Advantages and limitations of nonlinear filters. Description of models for signal/image formation and degradation. Fundamentals of 2-D Digital Signals, Filters and Transforms. Mathematical and Statistical foundations for Nonlinear Filtering. Nonlinear Transformation and Enhancement. Examples and Applications.

2. Nonlinear and Adaptive 2-D Filters

Description of the main nonlinear filter families. Generalized Mean and Homomorphic filters. Polynomial filters, quadratic filters and the Cepstrum. Digital filters based on Order Statistics, Alpha Trimmed Mean filters, Max/min filters. Adaptive Nonlinear filters. Nonlinear Order Statistic filters. Applications and Examples.

3. Morphological Filters

Introduction to Mathematical Morphology. Current status of Morphological Filters. The Pattern Spectrum (Pecstrum), the Morphological Skeleton Transform, the Morphological Correlation function. Morphological shape decomposition. Morphological image analysis and object recognition. Applications to biomedicine and robotics.

4. Vector Filters, 3-Dimensional (3-D) and M-D Filters.

Multichannel signal processing. Fuzzy set theory and Fuzzy filters. Digital filters for color signal processing. 3-D image processing and analysis. 3-D image representation. 3-D and M-D Discrete Fourier transforms. Design of 3-D and M-D filte. Visualization techniques. Stereoscopic filters and emerging applications.

DETAILED LECTURES

1. January 15, 13. Overview of the Graduate Course. Nonlinear Filters. Advantages and Limitations of Nonlinear Filters Definitions, pp.1-10, Problems, notes.

2. M-D Signal Processing, Degradation and Modeling , pp. 37-61, notes, problems, notes.
3. January 22, 13. Fundamentals of 2-D Digital Signals, Filters and Transforms. Mathematical and Statistical Foundations for Nonlinear Filtering. Examples and Applications. [1], problems, notes.
4. January 29, 13. Mathematical and Statistical Foundations of Nonlinear Filtering, Nonlinear Transformation, Enhancement, problems, notes.
5. February 5, 13. Digital Filters Based on Order Statistics, [1], pp. 11-36, problems, notes pp 63-116, 117-150.
6. February 12, 13. Morphological Image and Signal Processing. [1], pp 151-187.
7. February 26, 13. The Pattern Spectrum (Pecstrum), the Morphological Correlation Function and the Skeleton Transform Image Analysis Applications. [1], pp 187-216.
8. March 5, Midterm Exam.
9. March 12, 13. Homomorphic and Polynomial Filters. [1], pp 217-266.

10.March 19, 13. Adaptive Nonlinear Filters.[1], pp 313-344.

11.March 26, 13. Multispectral (Color) Image Processing. Color Image Enhancement. Multichannel Filters, [5], pp 1-173.

13. April 02, 13. Color Edge Detection, Nonlinear Image Filters and Applications.[5] , pp 174-235.

14. April 09, 13. Discussion, Applications and Future Trends

15 April ? . Final Exam TBA

PROJECT COMiPONENTS: Students use MATLAB to design and implement their projects. Students are also encouraged to use C and C++ and Java as programming language tools. Problems will by assigned from time to time to increase the skills of the students.

MARKING SCHEME

1. Mid-term Exam 30%
2. Design Project 30%
3. Final Exam 40%

INSTRUCTOR

Anastasios (Tas) Venetsanopoulos, ENG 428, tel. 416-979-5000, Ext. 4037, email: <tasvenet@ryerson.ca.

PRESCRIBED TEXT

1. Ioannis Pitas and Anastasios Venetsanopoulos, " Nonlinear Filters in Image Processing: Principles and Applications", Kluwer Academic Publishers, 1990.

OTHER RELATED TEXTS

2. Charles R. Giardina and Edward R. Dougherty, "Morphological Methods in Image and Signal Processing, Prentice Hall, Inc. 1988.

3. Spyros Tzafestas and Anastasios Venetsanopoulos, (Editors), "Fuzzy Reasoning in Information Decision and Control Systems", Kluwer Academic Publishers, 1994.

4. Nikos Nikolaidis and Ioannis Pitas, "3-D Image Processing Algorithms", John Wiley and Sons, Inc., 2001.

5. Konstantine N. Plataniotis and Anastasios N. Venetsanopoulos, "Color Image Processing and Applications", Springer –Verlang, 2000

OTHER REFERENCES

6. Dan Dudgeon and Russel M. Mersereau, “Multidimensional Digital Signal Processing”, Prentice-Hall Inc., 1984.

7. Sanjit K. Mitra and Giovanni L. Sicuranza, “ Nonlinear Image Processing”, Academic Press, 2001.

8. Gonzalo R. Arce, “Nonlinear Signal Processing: A Statistical Approach”, A John Willey and Sons Publication, 2005.

9. Jaakko Astola and Pauli Kuosmanen, “Fundamentals of Nonlinear Digital Filtering”, CRC Press, 1997.

10. Ioannis Pitas, “Digital Image Processing Algorithms”, Prentice-Hall, 1993.

11. Rastislav Lukac, Kostantinos N. plataniotis, “Color Image Processing Methods and Applications”, CRC Taylor and Francis, 2007.

COURSE DOCUMENTATION AND ANNOUNCEMENTS

All course related information, announcements and material, such as sample programs, design and application sheets, handouts, etc. will be available from the web and Ryerson’s Blackboard system.

LECTURE ROOM

KHE 220 between 5pm-8 pm.

REMARKS

The written reports will be assessed not only on their technical or academic merit, but also on the communications skills of the author as exhibited through the reports.

January 30, 2013

RYERSON UNIVERSITY

Faculty of Engineering, Architecture and Science

Department of Electrical and Computer Engineering

EE8301: Linear System Theory

Prerequisites Undergraduate level control course and working knowledge of MATLAB.

Course Web Page http://www.ee.ryerson.ca/~courses/ee8301

Compulsory Texts None

Reference Texts

1. *A Linear Systems Primer*, P.J. Antsaklis*, et al.*, Birkhäuser, 2007.
2. *Linear Algebra and its Applications,* G. Strang, 4th Edition, Thomson 2006.

Calendar Description The main thrust of the class is to introduce an algebraic unification of finite-dimensional linear systems with emphasis on continuous and discrete dynamic systems, using an operator theoretic approach. Topics covered include transition matrices, functions of matrices, adjoint systems, weighing patterns, realizability; canonical forms; stability, minimal realization; minimum norm, and approximation problems.

Learning Objectives At the end of this course, the successful student will be able to:

1. Understand fundamental concepts of linear algebra such as vector spaces, subspaces, linear independence, basis, dimension and rank.
2. Understand the four fundamental subspaces and the relationship between them.
3. Formulate solutions of engineering problems as solutions of systems of linear equations and solving them as least-squares or least-norm problems.
4. Understand eigenvalues, eigenvectors and singular-value decomposition and their applications to engineering problems.
5. Model physical systems using linear state-space system model.
6. Obtain solution of systems described using linear state-space model.
7. Determine if a given linear state-space model is controllable and observable.
8. Design state-feedback controller and observer.
9. Solve certain optimal control problems as LQR problem.

Course Organization 3 hours of lecture per week for 13 weeks.

Course Evaluation	Midterm exam	30%
	Project	20%
	Final exam	50%
	Total	100%

Examinations Midterm exam in approximately Week 7, two hours, open-book.
Final exam, during exam period, 24-hour take-home exam.

Course Content

Topic	Hours	Description
1	1	**Introduction and motivation**
2	4	**Review of Linear Algebra** Linear functions, vector spaces, subspaces, linear independence, basis, dimension, rank. The four fundamental subspaces. Orthogonality and orthonormality.
3	4	**Least Squares Problems** Least squares solution of over-determined equations. Geometric interpretation. Applications.
4	4	**Least Norm Problems** Least norm solution of under-determined set of equations. Geometric interpretation. Applications.
5	7	**Symmetric and positive definite matrices** Eigenvalues and eigenvectors, quadratic forms, singular values decomposition, matrix norm and minimal rank approximations.
6	7	**Autonomous Linear Systems** Definition and interpretation. Solution using matrix exponential and Laplace transform. Eigenvalues and stability.
7	8	**Linear Systems with Bounded Inputs** Transfer matrix, impulse response and step response. Discretization. State transformation and similarity transformation. Controllability and observability.
8	2	**The LQR Optimal Control Problem**

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or

another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals, http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance, http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun., http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering, Architecture and Science

Department of Electrical and Computer Engineering

ELE869/EE8306: Fundamentals of Robotics

Prerequisites ELE639 or MEC709 or an undergraduate-level first control course.

Course Web Page http://www.ee.ryerson.ca/~courses/ele869

Compulsory Texts None

Reference Texts *Robotics: Modelling, Planning and Control,* B. Siciliano, *et al*., Springer-Verlag, 2009.

Calendar Description This course provides a comprehensive treatment on the fundamentals of robotics, particularly in kinematics and dynamics. Topics include: Forward kinematics: homogeneous transformations, the Denavit-Hartenberg representation of linkages. Inverse kinematics: closed-form and numerical solutions. Differential motion, Jacobian matrix, singularities. Dynamics: Euler-Lagrange formulation. Trajectory generation. Motion and interaction control of robotic manipulators. Actuators and sensors.

Learning Objectives At the end of this course, the successful student will be able to:

1. Develop mathematical models for robotic manipulators and use them to design control systems for robotic manipulators.
2. Interconnect electrical engineering, computer engineering and mechanical engineering concepts to solve control problems for robotic manipulators.
3. Propose improved mathematical models to simplify the control problem for robotic manipulators.
4. Use improved mathematical models to address nonlinearity in the control problem.
5. Develop MAPLE programs to automatically generate dynamics equations for robotic manipulators.

Course Organization 3 hours of lecture per week for 13 weeks.
1 hour of laboratory/tutorial per week for 10 weeks.

Course Evaluation

Home Work	10%
Midterm exam	30%
Project	10%
Final exam	50%
Total	100%

Examinations Midterm exam in approximately Week 7, two hours, closed-book, formula sheet provided.
Final exam, during exam period, three hours, closed-book, formula sheet provided.

Course Content

Topic	Sections	Hours	Description
1	1.1-1.4	1	**Introduction** Automation and robots, robot classification, applications, robot specifications.
2	2.1-2.5, 2.7	6	**Rigid Motion and Homogeneous Transformation** Rotation, composite rotation, translation, composite translation, homogeneous transform.
3	2.8-2.10	5	**Forward Kinematics and the Denavit-Hartenberg Representation** Coordinate frames, kinematic chains, link and joint parameters, the Denavit-Hartenberg (DH) representation, the arm equation. Joint Space and Operational Space.
4	2.12	5	**Inverse Kinematics** Solving the arm equation, general properties of solutions, kinematic decoupling, inverse position and inverse orientation problems.
5	3.1-3.3, 3.6	4	**Differential Kinematics and Differential Motion** Linear and angular velocities, the manipulator Jacobian, singularities, differential motion transform.
6	4.1, 4.3	6	**Dynamics** Kinetic and potential energy, Euler-Lagrange formulation, direct and inverse dynamics.
7	6.1-6.4, 7.1-7.3	8	**Motion and Interaction Control of Robotic Manipulators** Trajectory generation. Independent joint control, PID control, computed-torque control. Compliance control, impedance control.
8	8.1-8.3	2	**Actuators and Sensors** Joint actuating system; proprioceptive sensors.

Laboratory/Tutorials

Topic	Description	Hours
1	Rotation matrix and its applications	1
2	Homogeneous transformation matrix and its applications	1
3	Forward kinematics problem	1
4	Inverse kinematics problem	1
5	Differential kinematics and differential motion	1
6	Singular configurations	1
7	Dynamics model for robotic manipulators	2
8	Trajectory generation	1

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals, http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance, http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun., http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.

13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

Name of Instructor		Signature of Instructor		Date	
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8403: Advanced Topics in Power Systems

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8403/

Compulsory Texts:
1. Lecture notes from Dr. Bala Venkatesh and IEEE papers.
2. Power System Analysis, by John Grainger and William Stevenson, McGraw-Hill Science Engineering.

Calendar Description Basic concepts. Review of optimization techniques. Linear and non-linear programming. Pontryagin's maximum principle. Fletcher-
Powell method, etc. Systems security monitoring. State estimation. Optimal power flow. Real and reactive power optimization. Online
optimization. Load dispatching. Generator scheduling, maintenance scheduling in hydro, thermal and hydrothermal systems.
Some case studies.

Learning Objectives At the end of this course, a successful student will have a solid understanding of Power systems analysis, linear and nonlinear optimization techniques, electricity market formulation and nash-equilibrium, real power optimization, reactive power optimization and Unit commitment.
A successful student will be able design and develop computer codes for analysis and optimization of power systems.

Course Organization 3 hours of lecture per week

Course Evaluation

Final Examination	40%
Mid-term Examination/Evaluation	20%
Test/Assignment/Project 1:	20%
Test/Assignment/Project 2:	20%

Examinations Midterm examination is a 1.5-hour, closed-book examination that covers all the lecture materials up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination that covers all the course material materials.

Projects Students are required to complete two projects.

Project 1: design and develop a program in matlab to solve power balance equations of an AC N-bus transmission network using Newton-Rahpson technique.

Project 2: design and develop a program in matlab to solve linear optimization challenge using simplex technique.

Project reports must be prepared in a single-column double-space format, and must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles.
- Data sets studied and results of analysis
- Appendices
- Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1-3	Real and Reactive Power, Transmission Network, Power Balance Equations, System Jacobian, Solutions using Newton-Raphson Technique and Fast Decoupled Load Flow. Computing Transmission Loss and Generation Cost.	9
4-5	Linear Programming, example problem set up, simplex method, Prices in LP, Dual LP, Matlab functions.	6
6	Mid term	3
7	Non-linear programming, marginal prices, Matlab functions	3
8-9	Real Power Optimal Power Flow: problem formulation, solution using NLP method, solution using Successive LP.	6
10-11	Reactive Power Optimal Power Flow: problem formulation, solution using NLP method, solution using Successive LP.	6
12	Unit Commitment: problem formulation and an MILP Solution	3
13	Review	3

Note: Schedule of lectures is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All project reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.

10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their projects will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

Name of Instructor	Bala Venkatesh	Signature of Instructor		Date	
Name of Graduate Program Director	Lian Zhao	Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8405: Power System Stability and Control

Prerequisites None

Course Web Page http://www.ryerson.ca/content/dam/graduate/graduate_calendar/current/EM134EP.pdf

Compulsory Texts:
1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1994.
2. Lecture notes from Dr. Richard Cheung and published scientific papers.

Reference:
1. J.D. Glover, M.S. Sarma, T.J. Overbye, "Power System Analysis and Design," 4th edition, Thomson, 2008.
2. IEEE Std. 421.5, "IEEE Recommended Practice for Excitation System Models for Power System Stability Studies", 2005.

Calendar Description

This is an advanced course in power system stability studies focused on the design of digital signal processing systems for improvement of steady state and transient power system stabilities. This course provides studies on analytical techniques and computer methods for power system stability enhancement, and digital signal processing control design and implementation of advanced power system stabilizers.

Learning Objectives

At the end of this course, the successful students will have a solid understanding of large-scale power system stability and control. Students will also learn knowledge for the design of excitation systems for 540MW and 800MW generators used in Ontario nuclear generating stations, and acquire technical skills for the basic operations of these utility generators and the controls of the stability of these generators.

Course Organization 3 hours of lecture per week for 13 weeks

Course Evaluation Students are required to carry out 2 major projects, mid-term exam and final exam:

Project 1	25%
Project 2	30%
Mid-term Exam	15%
Final Exam	30%
Total	100%

Examinations The mid-term exam is a 2-hour open-book exam, covering all the lecture materials up to the week of mid-term exam.

The final exam is a 3-hour open-book exam, covering all the course materials.

Projects Students are required to design and analyze an optimal generation-transmission system for supplying power from a generating station for example Bruce Power Nuclear Power Station to a large load center such as the City of Toronto. The system must be designed with real generator data and the system must be able to deliver rated active power to the load center, without causing any stability problem even when a three-phase fault occurs on one transmission line and very near to the step-up transformer terminal. The design and analysis are to be carried out in two projects. The first project is to provide the design and analysis of a basic generator excitation system, and the second project is to carry out a design optimization of the system's PSS (power system stability) control.

Course Content

Week	Detailed Description	Hours
1	Power System General Characteristics	3
2	Power System Stability Concepts	3
3-4	Generator Modeling	6
5-6	Power System Models for Stability Studies	6
7-8	Excitation Systems	6
9	Active and Reactive Power Controls	3
10-11	Small-Signal Stability	6
12	Transient Stability	3
13	Voltage Stability	3

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. If a student misses the mid-term exam and its make-up exam, the grade will be loaded to the final exam.
3. If a student misses the final exam and its make-up exam, a grade of INC (as outlined in the *Grading*

Promotion and Academic Standing Policy) will be given.

4. Medical or compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
5. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
6. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
7. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
8. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
9. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
10. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
11. Projects submitted past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
12. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade.

Name of Instructor	Richard Cheung	Signature of Instructor		Date	
Name of Graduate Program Director	Lian Zhao	Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering, Architecture and Science
Department of Electrical and Computer Engineering

EE8407: Power Converter Systems

Prerequisite

ELE654 Power Electronics or equivalent

Course Web Page

http://www.ee.ryerson.ca/~courses/ee8407

Reference Text

Bin Wu, "High-Power Converters and AC Drives," Wiley - IEEE Press, 2006

Calendar Description

A course on the analysis, simulation and design of power converter systems. Main topics include: high-power multi-pulse rectifiers, multilevel voltage and current source converters, pulse width modulation, harmonic reduction techniques, modeling and simulation techniques, and industrial applications. Important concepts are illustrated with design projects using Matlab/Simulink.

Learning Objectives

At the end of this course, the successful student will have a solid knowledge on the converter topologies, operating principles, modulation techniques and control of a variety of high-power converters with a voltage rating of a few kilovolts and power rating in the megawatt range. The students will be able to analyze and design these converters using commercial simulation tools such as Matlab/Simulink.

Method used to asses the Learning Objective: project reports and final exam.

Course Organization

2 hours of lecture per week for 13 weeks
1 hour of lab per week for 12 weeks

Course Evaluation

Design projects (5 projects)	65%
Final exam	35%
Total	100%

Examinations

Final exam during the exam period, two hours, closed book, in computer laboratories (covers all the course and project materials).

Project

Students are required to analyze, model, simulate and design various types of high-power converters, including multi-pulse rectifiers, multilevel voltage source converters and PWM current source converters. All the projects are design-oriented. The students are required to make an extensive use of the knowledge acquired from the course, and submit a report for each of the projects, which must be prepared in a single-column double-space format, and must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Table of contents - list of sections, and subsections of the project report.
- Abstract - Abstract of the project report.
- Main body of the project report - including introduction, theoretical analysis and

design, simulation results, and conclusions.

- References - list of books, papers and other publications used in the project report. References must be listed using IEEE reference styles.
- Appendices - Top-level Simulink block diagrams used in the project.

Course Content

Week	Detailed Description	Hours
1	Introduction (Chapter 1)	2
1,2	High-Power Semiconductor Devices (Chapter 2)	2
3	Multipulse Diode Rectifiers (Chapter 3)	2
3,4	Multipulse SCR Rectifiers (Chapter 4)	2
4,5	Two-level Voltage Source Inverter (Chapter 6)	3
6,7	Multilevel Cascaded H-Bridge Converters (Chapter 7)	4
8,9	Multilevel Diode-Clamped Inverter (Chapter 8)	4
10	Other Multilevel Voltage Source Converters (Chapter 9)	2
11,12	Current Source Inverters (Chapter 10)	3
13	Current Source Rectifiers (Chapter 11)	2

Laboratory/Projects - Room ENG408 and ENG412

Projects/ Laboratories	Detailed Description	Marks	Week
1	Series-type 12-pulse Diode Rectifier	12%	2-3
2	Space Vector Modulation Technique	17%	4-6
3	Multilevel Cascaded H-Bridge Inverters	12%	7-8
4	Multilevel diode Clamped Inverters	12%	9-10
5	PWM Techniques for Current Source Converters	12%	11-12
Total		65%	

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed

over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing, http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals, http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance, http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun., http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

EE8408 Switch Mode Power Supplies
Course Outline (F2013)

Course Description

A course on switch mode power supplies. Major topics includes: Flyback converters, forward converters, bridge converters, Cuk converters, pre-regulators, inrush control, start-up methods, overvoltage and undervoltage protections, foldback current limiting, output filters, transformer design, induction and choke design, current mode control, stability.

Course Organization

This course consists of three hours of lecture every week and four projects.

Course Material

Text:

"Power Switching Converters Second Edition", by Simon Ang and Alejandro Oliva, published by Taylor and Francis, 2005.

"Fundamentals of Power Electronics, Second Edition" by Robert W. Ericson and Dragan Maksimovic, published by Spinger Science+Business Media Inc, 2001.

Reference:

"Power Electronics -- Converters, Applications and Design, Third Edition" by N.Mohan, T.Undeland and W.Robbins, published by John Wiley & Sons, Inc., 2003.

Y.S. Lee, Computer-Aided Analysis and Design of Switch-Mode Power Supplies, by Marcel Dekker, 1993.

Course Evaluation

Theoretical Component	**40%**
Final Examination	40%
Project Component	**60%**
Analysis of Cuk Converter	15%
Flyback Converter and Voltage Mode Control Scheme	15%
ZCS Resonant Converter	15%
Small Signal Model and Feedback Control for Buck-boost Converter	15%

Lecture Topics

1	**Basic Switching Converters**	**6 hrs (week 1, 2)**
	1.1 Introduction	
	1.2 Buck converters	
	1.3 Boost converter	
	1.4 Buck-boost converter	
	1.5 Cuk converter	
	1.6 Converter with nonideal components	
2	**Isolated Switching Converters**	**6 hrs (week 3, 4)**
	2.1 Introduction	
	2.2 Forward converter	
	2.3 Flyback converter	
	2.4 Half-bridge converter	
3	**Control Scheme**	**3 hrs (week 5)**
	3.1 Introduction	
	3.2 Voltage-mode PWM	
	3.3 Current-mode PWM	
	3.4 Hysteresis Control	
	3.5 Commercial integrated circuit	
4	**Resonant Converters**	**6 hrs (week 6, 7)**
	4.1 Introduction	
	4.2 Parallel resonant and serial resonant circuit	
	4.3 Zero-current-switching buck converter	
	4.4 Zero-voltage-switching buck converter	
	4.5 Series-loaded resonant converter	
	4.6 Parallel-loaded resonant converter	
5	**Dynamic Analysis**	**9 hrs (week 8, 9, 10)**
	5.1 Introduction	
	5.2 Switch converter models	
	5.3 Negative feedback using classical control techniques	
	5.4 Feedback compensation	
	5.5 Stability	
	5.6 State-space averaged model	
	5.7 Transfer Functions	
6	**Converter Design**	**6 hrs (week 11, 12)**
	6.1 Introduction	
	6.2 Voltage Mode DCM Buck Converter Design	
	6.3 UC3842 based flyback design	
	6.4 Transformer and Inductor Design	

Project Schedule

Projects	Topics	Week #
Project 1	Analysis of Cuk Converter	2-3
Project 2	Flyback Converter and Voltage Mode Control Scheme	4-6
Project 3	ZCS Resonant Converter	7-8
Project 4	Small Signal Model and Feedback Control for Buck-boost Converter	9-12

All the projects start with problems, analysis and simulations. You are required to do the analysis on the converters and use simulation software to verify the theoretical results. Semi-formal project reports are required.

As a Ryerson graduate student, you are eligible to download and install the MATLAB with simulink toolbox for academic use. Please refer to the following guides from Ryerson Electrical & Computer Engineering Department.

http://www.ee.ryerson.ca/matlab/

You are required to submit the reports with the simulation models. Electronic submission (using email) of the reports is acceptable. Sample models will be provided for the first three projects.

Instructor
David Xu, Ph.D.
Room ENG333, 245 Church Street, Toronto
Department of Electrical and Computer Engineering
Ryerson University
(416) 979-5000 ext: 6075.
Email: dxu@ee.ryerson.ca

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8409: Electromagnetic Theory

Prerequisites A basic field theory under graduate course

Course Web Page http://www.ee.ryerson.ca/graduate/EM%20Theory_Outline.pdf

Important References

1. M. Sadiku, *Elements of Electromagnetics*, 5th edition, Oxford, 2010.
2. R.E. Collin, *Field Theory of Guided Waves*, 2nd edition, IEEE Press, 1991.
3. M.A. Uman, *The Lightning Discharge*, Dover Publications, Inc., New York, 2001.
4. E.C. Jordan and K.G. Balmain, *Electromagnetic Waves and Radiating Systems*, 2nd edition, Printice-Hall, 1968.
5. R.S. Elliot, *Introduction to Guided Waves and Microwave Circuits*, Printice-Hall, 1993.
6. R.E. Collin, *Foundation for Microwave Engineering*, 2nd edition, McGraw-Hill, 1992.
7. J.V. Bladel, *Electromagnetic Fields*, McGraw-Hill, 1964.
8. D.K. Cheng, *Field and Wave Electromagnetics*, 2nd edition, Addison-Wesley, 1993.
9. W.H. Hayt and J.A. Buck, *Engineering Electromagnetics*, 6th edition, McGraw-Hill, 2001.

Calendar Description Electromagnetostatic field, time-varying electromagnetic field and Maxwell's equations, Poynting and uniqueness theorems, losses due to polarization damping forces, Helmholtz wave equation, auxiliary potential functions, Lorentz reciprocity theorem, transverse electromagnetic waves, wave polarization, reflection and transmission at interfaces, wave matrices, oblique incidence, antenna theory and characteristics, lightning-generated electromagnetic pulse.

Learning Objectives	Based on Maxwell's equations in their most general forms, an in-depth understanding of generation and propagation of electromagnetic fast transients, taking into consideration all losses, including those resulting from electric and magnetic polarization damping forces.

Course Organization	3 hours of lecture per week for 13 weeks	
Course Evaluation	Term Tests	30%
	Assignments	20%
	Final Exam	50%
	To achieve a passing grade, student must pass both the theory and laboratory/project components.	
Tests and Final Examination	Closed-book 3 term tests (one-hour each) and final a two-hour final exam that covers all lecture materials.	
Assignments	Four take-home problem set assignments, based on course lectures, in order to prepare students for term tests and the final exam.	

Course Content

Week	Detailed Description	Hours
1-4	Basic Electromagnetic Theory	12
5-7	Transverse Electromagnetic (TEM) Waves	9
8-10	Generation of Fast Transients	9
11-13	Electromagnetic Transients	9

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.

3. Should a student miss a term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.

13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

Name of Instructor	Ali Hussein	Signature of Instructor		Date	Sept. 2014
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

EE8410 Power Electronics
Course Outline (F2013)

Course Description

A course on microprocessor-controlled solid state converters. Major topics includes: solid state switching devices, dc-dc switch mode converters, diode & thyristor rectifiers, current & voltage source inverters, industry applications and microprocessor programming techniques. Typical control schemes for these converters will also be discussed. Important concepts are illustrated with laboratory design projects. An MC68HC11 microprocessor based MPP board will be used in the projects.

Antirequisite

ELE754 or Power Electronics equivalent.

Course Organization

This course consists of three hours of lecture every week, and three design projects.

Course Material

Text:

"Power Electronics -- Converters, Applications and Design" by N.Mohan, T.Undeland and W.Robbins, published by John Wiley & Sons, Inc.

Reference:

"Fundamental of Power Electronics, Second Edition" by R.W. Erickson and D. Maksimovic, published by Springer Science+Business Media Inc.

Course Notes

EE8410 Power Electronics - Course Notes, 2013 Edition.

Course Evaluation

- Theoretical component **55%**
  - Mid-term Examination 20%
  - Final Examination 35%

- Design Pojects **45%**
  - DC/DC Switch Mode Power Supply 15%
  - Phase Controlled Rectifiers 15%
  - Three-phase AC Power Supply 15%

Each project starts from choosing converter topology, design of passive components, developing controllers and demonstrating the simulation results. Three semi-formal project reports are required.

Lecture Topics

1	**dc-dc Switch Mode Converters** (pp 161-199)	7 hrs
	1.1 Introduction	
	1.2 Buck converters	
	1.3 One-quadrant chopper	
	1.4 Two-quadrant chopper	
	1.5 Review of 68HC11 based MPP board	
	1.6 Microprocessor control of dc-dc converters	
2	**Microprocessor Controlled dc Motor Drives** (pp 377-398)	5 hrs
	2.1 Introduction	
	2.2 Equivalent circuit of dc motors	
	2.3 dc motor speed control	
	2.4 Converters used in the dc motor drives	
	2.5 Microprocessor control of dc motor drives	
3	**Diode and Thyristor Rectifiers** (pp 79-160)	8 hrs
	3.1 Introduction	
	3.2 Single and three phase diode rectifiers	
	3.3 Total harmonic distortions and power factor	
	3.4 Single and three phase thyristor (SCR) rectifiers	
	3.5 Microprocessor control of thyristor rectifiers	
4	**Inverters (dc -ac converters)** (pp 200-248)	8 hrs
	4.1 Introduction	
	4.2 Single-phase Inverters	
	4.3 Three-phase IGBT Inverters	
	4.4 PWM techniques	
	4.5 Current source Inverters	
	4.6 Induction Motor Speed Control (pp 399-434)	
5	**Applications** (pp 354-364, 460-504)	6 hrs
	5.1 Introduction	
	5.2 Uninterruptible power supplies (UPS)	
	5.3 Power supplies	
	5.4 Motor drives	
	5.5 Active power filters	
	5.6 Static var compensators	
	5.7 Electronic ballasts	
6	**Design Considerations** (pp 667-730)	3 hrs
	6.1 Introduction	
	6.2 Snubber circuit design	
	6.2 Gate drive circuits	
	6.3 Heatsink design	

Project Schedule

Projects	Topics	Week #
Project 1	DC/DC Switch Mode Power Supply	3-6
Project 2	Phase Controlled Rectifier	7-9
Project 3	Three-phase AC Power Supply	10-12

Instructor

David Xu, Ph.D.
Room ENG333, 245 Church Street, Toronto
Department of Electrical and Computer Engineering
Ryerson University
(416) 979-5000 ext: 6075.

Office hours

Every Thursday 3:00PM – 5:00PM, ENG333

EE8412 Advanced AC Drive Systems

Course Outline

Course Description

The topics include general configurations of voltage source inverter (VSI) and current source (CSI) fed drives, reference frame theory, space-vector and dq-axis models of ac machines, dynamic behavior of ac machines, principle of field orientation, indirect and direct field oriented controls (FOC) for VSI and CSI drives, direct torque control (DTC), sensorless control, and drive system simulation and design.

Course Organization

This course consists of two hours of lecture and one hour of laboratory per week.

Textbook

Bin Wu, "High-Power Converters and AC Drives", Wiley – IEEE Press, 2006.

Lecture Slides

Download from http://www.ee.ryerson.ca/~bwu/courses.html

Design Projects

		Marks
Project 1:	Induction Motor Transient Characteristics	20%
Project 2:	Two-level VSI Fed Induction Motor Drive with V/F Control	20%
Project 3:	Field Oriented Control (FOC) of Induction Motor Drive	30%
Project 4:	Direct Torque Control (DTC) of Induction Motor Drive	30%
	Total	**100%**

Lecture Topics

1. Introduction
2. Induction motor dynamic models
3. Power Converter Topologies
4. Voltage Source Inverter Fed Drives
5. Current Source Inverter Fed Drives
6. Field Oriented control (FOC)
7. Direct Torque Control (DTC)

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8414: Lightning: Modelling and Detection

Prerequisites A basic field theory under graduate course

Course Web Page http://www.ee.ryerson.ca/graduate/???

Important References

1. M. Sadiku, *Elements of Electromagnetics*, 5th edition, Oxford, 2010.
2. J.M. Crowley, *Fundamentals of Applied Electrostatics*, John Wiley and Sons, 1986
3. V.A. Rakov and M.A. Uman, *Lightning: Physics and Effects*, Cambridge, 2003
4. M.A. Uman, *Arts and Science of Lightning Protection*, Cambridge University Press, UK, 2008.
5. M.A. Uman, *Lightning Discharge*, Dover Publications, Inc., New York, 2001.
6. V. Cooray, The Lightning Flash, Institution of Electrical Engineers, London, UK, 2003
7. M.A. Uman, *All About Lightning*, Dover Publications, Inc., New York, 1986.
8. E.C. Jordan and K.G. Balmain, *Electromagnetic Waves and Radiating Systems*, 2n edition, Printice-Hall, 1968.
9. D.K. Cheng, *Field and Wave Electromagnetics*, 2nd edition, Addison-Wesley, 1993.

Calendar Description

Thunderstorm electrification mechanisms, electrical structure of thunderstorm clouds, electrostatic dipole and tri-pole models, mechanism of the downward-initiated lightning, tall-structure lightning, electromagnetic transients, mathematical modelling of lightning return stroke to a perfectly conducting flat ground, modelling of return stroke to a tall object, lightning-generated electromagnetic pulse, measurement of fast transients, lightning detection systems, deleterious effects of lightning and protective techniques.

Learning Objectives

Awareness and understanding of deleterious effects of lightning, one of modern-time most studied natural phenomena, starting with electrostatic modelling of a thunder cloud towards sophisticated time-domain modelling of lightning return stroke as antenna carrying fast transients for the purpose of computing the lightning-generated electromagnetic pulse (LEMP), which is necessary for the evaluation and development of detection algorithms, where the lightning current is estimated based on the easily measured LEMP. This study is fundamental to lightning protection of power systems, including wind turbines.

Course Organization

3 hours of lecture per week for 13 weeks

Course Evaluation

Four Assignments	45%
Project	25%
Final Exam	30%

Final Examination

Two-hour final exam that covers all lecture materials and assignments.

Assignments

Four take-home assignments, based on course lectures.

Course Content

Week	Detailed Description	Hours
1	Introduction and thunderstorm electrification mechanisms	3
2	Deleterious effects of lightning, including those affecting power systems	3
3	Electrostatic dipole and tri-pole models	3
4	Downward- and upward-initiated lightning flashes	3
5-6	Measurement of the lightning current and its generated electromagnetic pulse (LEMP)	6
7-8	Maxwell's equations for electromagnetic transients in the time domain to determine the magnetic and electric fields of LEMP	6
9	Return-stroke modelling of lightning to flat ground	3
10	Return-stroke modelling of lightning to a tall structure, such as the CN Tower	3
11	Lightning protection measures	3
12-13	Project presentations an final exam	6

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf

9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

Name of Instructor	Ali Hussein	Signature of Instructor		Date	Sept. 2014
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering, Architecture and Science
Department of Electrical and Computer Engineering

EE 8416 – Modeling and Control of Power-Electronic Converters

Course Outline (Fall 2014)

Calendar Description

This course will enable graduate students to pursue research in the area of design, modeling, and analysis of static, electronic, power converters. Even though the presented methodologies are rather general and thus applicable to various types of power-electronic converters, the emphasis will be on the three-phase Voltage-Sourced Converter (VSC) technology, which is widely employed in such systems as Distributed Energy Resource (DER) systems; active distribution systems and microgrids; wind, photovoltaic (PV), and fuel-cell energy systems; Flexible AC Transmissions Systems (FACTS); and High-Voltage DC (HVDC) transmission.

List of Topics

1. Introduction to high-power electronics, power switches, and power-electronic converter systems
2. Half-bridge Voltage-Sourced Converter (VSC) and Pulse-Width Modulation (PWM)
3. Switched and averaged models of the half-bridge VSC
4. Current-mode and voltage-mode control methods
5. Three-phase VSC, Sinusoidal PWM (SPWM), and SPWM with third harmonic injection
6. Space-phasors and vectorial representation of three-wire, three-phase systems
7. αβ-frame and *dq*-frame representations of three-wire, three-phase systems
8. Instantaneous real and reactive powers in three-wire, three-phase networks
9. Synchronization and the Phase-Locked Loop (PLL)
10. Real- and reactive-power control by the three-phase VSC
11. DC-link voltage regulation in the VSC, and Controlled DC-Voltage Power Port
12. State-space modeling and analysis of power-electronic converter systems
13. Sampled-data modeling and control of power-electronic converter systems
14. Review and analysis of important applications (wind power system, PV system, HVDC systems, etc.)

Prerequisites

1) An undergraduate course or background in classical control (transfer functions, root-locus, Bode plot, lead/lag compensation, feed-forward, etc.).
2) An undergraduate course in power electronics or industrial electronics.

Methods of Delivery and Communications

The course will be delivered through lectures. All course-related communications will be conducted through Blackboard.

Contact Hours

3 hours of lecture per week for 12 weeks

Software Requirements

MATLAB/SIMULINK or PSCAD/EMTDC.

Instructor

Dr. Amirnaser Yazdani
Office: ENG 326
Phone: (416) 979-5000 X. 6178
Email: yazdani@ryerson.ca
Website: www.ee.ryerson.ca/people/yazdani.html

Office Hours

Mondays 9:00-10:00 or by appointments.

Evaluation Components and Weights

Component	Weight	Content and Delivery Format	Due Date
Assignment #1	10%	Modeling and simulation of current-controlled half-bridge and full-bridge converters using their detailed switched models. A paper-based written report, of a maximum of 10 letter-size pages, shall be delivered.	Sep. 29
Assignment #2	10%	Modeling and simulation of the three-phase "Real- /Reactive-Power Controller", using the detailed switched model and αβ-frame control. A paper-based written report, of a maximum of 10 letter-size pages, shall be delivered.	Oct. 20
Assignment #3	10%	Modeling and simulation of the three-phase PLL. A paper-based written report, of a maximum of 10 letter-size pages, shall be delivered.	Nov. 3
Assignment #4	20%	Modeling and simulation of the "Controlled DC-Voltage Power Port", using the detailed switched model and dq-frame control. A paper-based written report, of a maximum of 10 letter-size pages, shall be delivered.	Nov. 17

Final Exam	50%	It is open-book and includes both conceptual and analytical questions on the topics covered in the course.	See below
Total	100%		

Final Exam Information

The final exam will be written during the exam period, on the date, at the time, and at the place determined by the University.

Return of Academic Work

Every marked academic work will be returned to the student approximately one week after the respective due date, in a manner that respects the privacy of the student. The marks will be posted through Blackboard. Final exams will not be returned.

Prescribed Text

1) A. Yazdani and R. Iravani, "*Voltage-Sourced Converters in Power Systems*", IEEE-John Wiley, ISBN 978-0-470-52156-4, 2010. Please check the book up-to-date errata maintained by the author at http://www.ee.ryerson.ca/~yazdani/YazdaniErrata.pdf

Reference Text

2) J. G. Kassakian, M. F. Schlecht, G. C. Verghese, "*Principles of Power Electronics*", Addison Wesley, ISBN 0-201-09689-7, 1992.

Other References

3) Selected transaction and journal papers will be introduced as the course progresses.

Important Notes

1. Students are required to adhere to all relevant University policies, such as the student code of conduct (policies 60 and 61), which are listed at http:/www.ryerson.ca/acadcouncil/policies.html, set out in the Ryerson calendar and the Graduate Student Information Guide.

2. The written reports will be assessed not only on their technical merits, but also on the communication skills of their authors as exhibited through the submitted work.

Approved by _____ Date _____

Associate Chair, Program Director
or Department Chair

Last Updated: August 17, 2014—AY

RYERSON UNIVERSITY

Faculty of Engineering, Architecture and Science
Department of Electrical and Computer Engineering

EE 8417 – Vector Control of Rotating Machines

Course Outline (Winter 2013)

Calendar Description

This course will enable graduate students to pursue research in the area of advanced control of rotating electric machines. The applications include regenerative industrial drives, rotating-machine-based distributed generation and energy storage systems, high-performance position-control machines, and transportation systems. The course will teach methodologies for design, parameter selection, and signal-processing and estimation techniques pertaining to advance control of rotating electric machines.

List of Topics

1. Elementary principles of three-phase AC machines
2. Dynamics of motion and torque-speed characteristics
3. Space-phasor, αβ-frame, and *dq*-frame representations of three-phase AC machines; the generalized model of three-phase AC machines
4. Pulse-width Modulation (PWM) and Hysteresis-Band methods of control
5. Voltage-Sourced Converter (VSC); the Current-Sourced Converter (CSC)
6. Torque and speed control of squirrel-cage induction machines based on the quasi steady-state model (constant V/f control)
7. Filed-oriented torque and speed control of squirrel-cage inductions machines
8. Field-oriented torque and speed control of doubly-fed induction machines
9. Field-oriented toque and speed control of synchronous machines
10. Review and analysis of important applications (wind energy systems, flywheel energy storage systems, regenerative mine conveyors, etc.)

Pre-requisites

1) An undergraduate course in electric machines
2) An undergraduate course or enough background in classical control
3) An undergraduate course in power electronics or industrial electronics

Methods of Delivery and Communications

The course will be delivered through lectures. All course-related communications will be conducted through Blackboard.

Contact Hours

3 hours of lecture per week for 13 weeks

Software Requirements

MATLAB/SIMULINK or PSCAD/EMTDC.

Instructor

Dr. Amirnaser Yazdani
Office: ENG 326
Phone: (416) 979-5000 X. 6178
Email: yazdani@ryerson.ca
Website: www.ee.ryerson.ca/people/yazdani.html

Office Hours

TBA

Evaluation Components and Weights

Component	Weight	Content and Delivery Format	Due Date
Assignment #1	10%	Modeling and simulation of an induction machine speed control system based on the scalar (v/f constant) control strategy. A paper-based, page-limited, written report shall be submitted.	TBA
Assignment #2	10%	Modeling and simulation of an induction machine speed-control system, based on the vectorial control strategy in rotor flux coordinates. A paper-based, page-limited, written report shall be submitted.	TBA
Assignment #3	20%	Modeling and simulation of a double-fed induction machine speed-control system based on the vectorial control strategy in stator flux coordinates. A paper-based, page-limited, written report shall be submitted.	TBA
Project	20%	Design, modeling, simulation, and validation of a wind energy conversion system based on the doubly-fed induction machine, using the model developed in Assignment #3 and the design techniques presented in the course. A comprehensive electronic written report is expected to demonstrate the design process, simulation results verifying the fulfillment of the design objectives, and to comment on the behavior of the designed system under normal and adverse operating conditions. In addition, the simulation model used	TBA

		shall be submitted. The written report and the simulation model will be delivered through a CD.	
Final Exam	40%	It is the open-book nature and includes both conceptual and analytical questions on the topics covered by the course.	See below
Total	100%	--------	

Final Exam Information

The final exam will be written on "***date, time, and venue***".

Return of Work

Every marked academic work will be returned to the student approximately one week after the respective due date, in a manner that respects the privacy of the student. The marks will be posted through Blackboard. Final exams will not be returned.

Prescribed Text

1) W. Leonhard, "*Control of Electrical Drives*", Springer, 3rd edition, ISBN: 978-3-540-41820-7, 2001

Reference Texts

2) A. Yazdani and R. Iravani, "*Voltage-Sourced Converters in Power Systems*", IEEE-John Wiley, ISBN 978-0-470-52156-4, 2010.
3) B. Wu, "*High-Power Converters and AC Drives*",
4) IEEE-John Wiley, ISBN: 978-0-471-73171-9, 2006.
5) B. Wu, Y. Lang, N. Zargari and S. Kouro, "*Power Conversion and Control of Wind Energy Systems*", IEEE-John Wiley, ISBN: 978-0-470-59365-3, 2011.

Other References

6) Selected transaction and journal papers will be introduced as the course progresses.

Important Notes

1. Students are required to adhere to all relevant University policies, such as the student code of conduct (policies 60 and 61), which are listed at http:/www.ryerson.ca/acadcouncil/policies.html, set out in the Ryerson calendar and the Graduate Student Information Guide.

2. The written reports will be assessed not only on their technical merits, but also on the communication skills of their authors as exhibited through the submitted work.

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8501: CMOS Mixed-Mode Circuits and Systems

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8501/

Compulsory Texts:

1. R. Schreier and G. Temes, *Understanding Delta-Sigma Data Converters*, John Wiley & Sons, 2005.
2. Lecture notes from Dr. Fei Yuan and published scientific papers.
3. Laboratory manual: *ELE 7xx Laboratory Manual*, Ryerson University.

Reference Texts:

1. T. Chan Carusone, D. John, and K. Martin, *Analog Integrated Circuits Design*, 2nd edition, John Wiley & Sons, 2011.
2. S. Henzler, *Time-to-Digital Converters*, Springer, 2010
3. F. Yuan, CMOS Current-Mode Circuits for Data Communications, Springer, 2006.

Calendar Description

This course deals with the design of CMOS mixed-mode circuits and systems. Key components include switching noise, analog & digital grounding, ESD Protection, cock and power distribution, fundamentals of ADCs, Nyquist ADCs, introduction to switched-capacitor networks, over-sampling ADCs, dynamic element matching, time-mode ADCs, and decimation filters. The laboratory component consists of the design of a set of ADCs using mixed-mode circuit techniques. The third essential component of the course is the project. Students are required to complete a design project on CMOS mixed-mode circuits with a professionally prepared project report.

Learning Objectives

At the end of this course, the successful student will have a solid understanding of switching noise, analog and digital grounding, electrostatic discharge (ESD) protection, on-chip clock and power distribution, fundamentals of ADCs and Nyquist ADCs (flash, pipelined, and charge redistribution successive approximation ADCs). In addition, the student will have in-depth knowledge of switched-capacitor networks, over-sampling ADCs, time-mode ADCs and decimation filters. The student will also be able to design a complex mixed-mode circuit using state-of-the-art commercial computer-aided design tools for integrated circuits and systems.

Course Organization

3 hours of lecture per week for 13 weeks
2 hours of lab per week for 12 weeks

Course Evaluation

Midterm exam	20%
Labs	30%
Course Project	20%
Final exam	30%
Total	100%

To achieve a passing grade, student must pass both the theory and laboratory/project components.

Examinations

Midterm examination is a 1.5-hour, closed-book examination that covers all the lecture and laboratory materials up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination that covers all the course material and laboratory materials.

Project

Students are required to design and analyze an analog or mixed analog-digital system using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies. The design of the system must contain the followings: (i) Background studies - An extensive background study of the system to be designed is required. A literature review must be included in the project report. (ii) Schematic-level design - The schematic-level design must be simulated. All schematics of the design must be included in the project report. The dimensions of all transistors and devices must be tabulated explicitly and included in the project report. All simulation results must be included in the project report. (iii) Project reports must be prepared in a single-column double-space format, and must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- Appendices

- Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1-2	Switching noise analog & digital grounding	6
3	ESD Protection	3
4	Clock and power distribution	3
5	Fundamentals of ADCs	3
6-7	Nyquist ADCs (Flash, Pipelined, and Charge redistribution Successive Approximation ADCs)	6
8	Introduction to switched-capacitor networks	3
9-10	Over-sampling ADCs	6
11-12	Time-mode ADCs (voltage-to-time converters, time-to-digital converters, VCO quantizers, time-mode Nyquist ADCs, Time-mode noise-shaping ADCs)	6
13	Decimation filters	3

Laboratory/Projects - Room ENG408

Labs.	Detailed Description	Week
1	Lab 1: ring oscillators and switching noise	2-3
2	Lab 2: charge redistribution successive approximation ADC	4-6
3	Lab 3: Switched-capacitor 2nd-order delta-sigma modulator.	7-9
4	Lab 4: Time-mode 2^{nd}-order delta-sigma modulator.	10-12
Project	Students are required to design and analyze a mixed analog-digital system using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies.	

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8502: Analog CMOS Integrated Circuits

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8501/

Compulsory Texts:

1. R. Schreier and G. Temes, *Understanding Delta-Sigma Data Converters*, John Wiley & Sons, 2005.
2. Lecture notes from Dr. Fei Yuan and published scientific papers.
3. Laboratory manual: *ELE 7xx Laboratory Manual*, Ryerson University.

Reference Texts:

1. T. Chan Carusone, D. John, and K. Martin, *Analog Integrated Circuits Design*, 2nd edition, John Wiley & Sons, 2011.
2. S. Henzler, *Time-to-Digital Converters*, Springer, 2010

Calendar Description

This course deals with the design of CMOS mixed-mode circuits and systems. Key components include switching noise, analog & digital grounding, ESD Protection, cock and power distribution, fundamentals of ADCs, Nyquist ADCs, introduction to switched-capacitor networks, over-sampling ADCs, dynamic element matching, time-mode ADCs, and decimation filters. The laboratory component consists of the design of a set of ADCs using mixed-mode circuit techniques. The third essential component of the course is the project. Students are required to complete a design project on CMOS mixed-mode circuits with a professionally prepared project report.

Learning Objectives

At the end of this course, the successful student will have a solid understanding of switching noise, analog and digital grounding, electrostatic discharge (ESD) protection, on-chip clock and power distribution, fundamentals of ADCs and Nyquist ADCs (flash, pipelined, and charge redistribution successive approximation ADCs). In addition, the student will have in-depth knowledge of switched-capacitor networks, over-sampling ADCs, time-mode ADCs and decimation filters. The student will also be able to design a complex mixed-mode circuit using state-of-the-art commercial computer-aided design tools for integrated circuits and systems.

Course Organization

3 hours of lecture per week for 13 weeks
2 hours of lab per week for 12 weeks

Course Evaluation

Midterm exam	20%
Labs	30%
Course Project	20%
Final exam	30%
Total	100%

To achieve a passing grade, student must pass both the theory and laboratory/project components.

Examinations

Midterm examination is a 1.5-hour, closed-book examination that covers all the lecture and laboratory materials up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination that covers all the course material and laboratory materials.

Project

Students are required to design and analyze an analog or mixed analog-digital system using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies. The design of the system must contain the followings: (i) Background studies - An extensive background study of the system to be designed is required. A literature review must be included in the project report. (ii) Schematic-level design - The schematic-level design must be simulated. All schematics of the design must be included in the project report. The dimensions of all transistors and devices must be tabulated explicitly and included in the project report. All simulation results must be included in the project report. (iii) Project reports must be prepared in a single-column double-space format, and must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- Appendices

- Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1-2	Switching noise analog & digital grounding	6
3	ESD Protection	3
4	Clock and power distribution	3
5	Fundamentals of ADCs	3
6-7	Nyquist ADCs (Flash, Pipelined, and Charge redistribution Successive Approximation ADCs)	6
8	Introduction to switched-capacitor networks	3
9-10	Over-sampling ADCs	6
11-12	Time-mode ADCs (voltage-to-time converters, time-to-digital converters, VCO quantizers, time-mode Nyquist ADCs, Time-mode noise-shaping ADCs)	6
13	Decimation filters	3

Laboratory/Projects - Room ENG408

Labs.	Detailed Description	Week
1	Lab 1: ring oscillators and switching noise	2-3
2	Lab 2: charge redistribution successive approximation ADC	4-6
3	Lab 3: Switched-capacitor 2nd-order delta-sigma modulator.	7-9
4	Lab 4: Time-mode 2^{nd}-order delta-sigma modulator.	10-12
Project	Students are required to design and analyze a mixed analog-digital system using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies.	

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be

worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8503: VLSI Circuits and Systems for Data Communications

Prerequisites EE8501 or equivalent

Course Web Page http://www.ee.ryerson.ca/~courses/ee8503/

Compulsory Texts:

1. No single text can serve as the text book of the course.
2. Lecture notes from Dr. Fei Yuan and published scientific papers.
3. Laboratory manual: *EE8503 Laboratory Manual*, Ryerson University.

Reference Texts:

1. W. Dally and J. Poulton, *Digital Systems Engineering*, Cambridge University Press, 1998.
2. F. Yuan, *CMOS Current-Mode Circuits for Data Communications*. Springer, 2006.
3. K. Oh and X. Yuan (ed.), *High-speed signaling: Jitter Modeling, Analysis, and Budgeting*, Prentice-Hall, 2012.
4. R. Poon, *Computer Circuits Electrical Design*, Prentice-Hall, 1995.
5. H. Johnson and M. Graham, *High-speed digital design - A handbook of black magic*, Prentice-Hall, 1993.
6. Published peer-reviewed scientific papers in scientific journals and conference proceedings.

Calendar Description This graduate course deals with the design of VLSI circuits and systems for communications. Major topics include fundamentals of data communication (modeling of MOS devices, noise figures, PWM, PAM. Inter-symbol interference, modeling of channels, transmission lines, and impedance matching, pre-emphasis and post-equalization0, wideband amplifier design techniques (low-noise design, gain-boosting, bandwidth enhancement, switching noise, mismatch compensation, voltage-mode and current-mode), high-speed electrical signaling schemes, Gbps serialization and de-serialization, voltage and current-controlled oscillators, phase noise of oscillators, phase-locked lops, clock and data recovery. Pre-requisites: EE8501 or EE8502 or equivalent.

Learning Objectives At the end of this course, successful students will gained a solid understanding of wire channels, fundamental of data communications over wire channels, electrical signaling for high-speed data links, channel equalization techniques, and clock and data recovery. Students will also be able to design serial links using commercial computer-aided design tools for integrated circuits.

Course 3 hours of lecture per week for 13 weeks

Organization 1 hours of lab per week for 12 weeks

Course Evaluation

Midterm exam	20%
Labs	30%
Course Project	20%
Final exam	30%
Total	100%

To achieve a passing grade, student must pass both the theory and laboratory/project components.

Examinations Midterm examination is a 1.5-hour, closed-book examination that covers all the lecture and laboratory materials up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination that covers all the course material and laboratory materials.

Project Students are required to design a serial link with pre-emphasis and post-equalization using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies. The design of the system must contain the followings: (i) Background studies - An extensive background study of the system to be designed is required. A literature review must be included in the project report. (ii) Schematic-level design - The schematic-level design must be simulated. All schematics of the design must be included in the project report. The dimensions of all transistors and devices must be tabulated explicitly and included in the project report. All simulation results must be included in the project report. (iii) Project reports must be prepared in a single-column double-space format, and must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- Appendices
- Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1-2	Interconnects	6
3	Bandwidth enhancement techniques	3
4-5	Electrical signaling	6
6-7	Fundamentals of serial links	6
8-10	Channel equalization	9
11-13	Clock and data recovery	9

Laboratory/Projects - Room ENG408

Labs.	Detailed Description	Week
1	Lab 1: Phase-locked loops	2-4
2	Lab 2: Pre-emphasis	5-6
3	Lab 3: Linear post-equalization	7-8
4	Lab 4: Decision feedback equalization	9-12
Project	Students are required to design and analyze a serial link with pre-emphasis and post-equalization using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies.	

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8504: VLSI Design Automation and CAD Tools

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8504/

Compulsory Texts:

- Sait, S., 1999, "VLSI Physical Design Automation", IEEE Press, ISBN 981- 3883- 5

Reference Texts:

- Naveed A. Sherwan, 2013, "Algorithms for VLSI Physical Design Automation", ISBN - 10: 1475722214, ISBN - 13: 9781475722215
- Gerez, S., 1999, "Algorithm for VLSI Design Automation", Wiley & Son, ISBN 0- 471- 98489- 2 (Course Text)
- Smith, M. J. S., 1997, "Application-Specific Integrated Circuits", Reading, MA: Addison-Wesley, ISBN 0- 201- 50022- 1.

Calendar Description

The objective of this course is to introduce the fundamental principles of VLSI (Very Large Scale Integrated) circuit design and layout. Algorithms for VLSI design automation will be presented in order to explain how VLSI CAD tools function. The goal is to show why some problems can only be approximately solved after short computation times while others are solved exactly in a longer time.

Each lecture consists of two sections: The first section will deal with an introduction to the mathematical topics of "algorithmic graph theory", and will be followed by introductions to,"computational complexity", and "general methods for combinatorial optimization" for layout partitioning, floorplaning, placement, routing and compaction based on exact mathematical programming (linear, integer and nonlinear programming) as well as an introduction to advanced heuristic techniques (i.e. Tabu search, genetic algorithms and simulated annealing, neural networks, etc).

Learning Objectives

At the end of this course, the successful student will have a solid understanding of "computational complexity", and "general methods for combinatorial optimization" for layout partitioning, floorplaning, placement, routing and compaction based on exact mathematical programming (linear, integer and nonlinear programming) as well as an introduction to advanced heuristic techniques. Additionally, each lecture will introduce design flow for full-custom, semi-custom, and programmable design using CAD tools.

Course Organization	3hours of lecture per week for 13 weeks 1hours of lab per week for 12 weeks
Course Evaluation	Design project 25% Examination 75% Total 100%

To achieve a passing grade, student must pass both the theory and laboratory/project components.

Examinations Final examination is a 3-hour closed-bookexamination that covers all the course material and laboratory materials.

Project Students are required to design and analyze an digital system using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies. The design of the system must contain the followings: The first step in the design flow of an integrated circuit typically involves defining a specification. For circuit generation either a behavioral or structural VHDL code can be used or a circuit schematic can be drawn. The next step in the design process involves running a simulation of the circuit to verify that the circuit is operating correctly. Synopsys software will be used to synthesize and simulate the circuit. In the layout synthesis a manual or automatic physical layout of the circuit will be generated using floorplaning, placement and routing of the circuit's components. Verification of the generated layout involves running Design Rule Checker to determine whether any process rules such as minimum wide or spacing rules have been violated. Following the circuit extraction, parasitic extraction and electrical rules check procedures the final step of the design process deals with the conversion of the layout to a format suitable for fabrication, such as CIF or GLSII.

Project reports must be prepared in a single-column double-space format, and must contain the followings:

- Deadline for report: last day of fall term
- Report should include:
- Description of circuit designed (full schematic and layout)
- Block diagram showing different module in chip
- Print of the entire chip
- Evidence that it works (from simulation plots)

Course Content

• Week 1	Course Outline, Course Management	
• Week 2	Introduction to Graph Theory, Complexity, Combinatorial Optimization Problem, Definitions	
• Week 3	Algorithms – Design Flow	Set-up of Synopsys and Cadence
• Week 4	Specification – Circuit Generation	Synopsys
• Week 5	Circuit Generation – Simulation Algorithms	Synopsys & Cadence
• Week 6	Layout Synthesis - Layout Generation with Cadence	Cadence-Synopsys Data Transfer
• Week 7	Partitioning / Algorithm	Cadence
• Week 8	Floorplanning / Algorithm	Cadence
• Week 9 Generation)	Placement / Algorithm	Cadence (Manual, Auto Layout
• Week 10	Routing: Global, Area, Channel / Algorithm	Cadence
• Week 11 Generation)	Routing: Detailed / Algorithm	Cadence (Manual, Auto Layout
• Week 12	Design Rule Check (DRC), Extraction, Layout vs. Schematic (LVS), Post Layout Simulation	Cadence

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages**will not**be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom.of Student Relig., Abor. andSpir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8505: Digital Systems Testing

Prerequisites None

Course Web Page http://www.ee.ryerson.ca/~courses/ee8505/

Compulsory Texts:

1. M. Bushnell and V. Agrawal. *Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits,* Kluwer Academic Publishers, 2000 [course text].
2. B. Sklar. Digital Communications: Fundamentals and Applications, Prentice Hall, 2001.
3. M. Abramovici, M. Breuer, and A. Friedman. *Digital Systems Testing & Testable Design,* Wiley-IEEE Computer Society Press, 1994.
4. S. Mourad and Y. Zorian. *Principles of Testing Electronic Systems,* John Wiley & Sons, 2000.
5. V. Geurkov. *Lecture notes*.

Reference Texts:

1. S. Lin and D. Costello. *Error Control Coding: Fundamentals and Applications,* Prentice Hall, 2004.

Calendar Description

The course covers theory and techniques for digital systems testing and testable design. The concepts of fault modeling, fault simulation, test generation, functional testing, and logic-level diagnosis are examined. Memory testing, programmable logic array (PLA) and field-programmable gate array (FPGA) testing, microprocessor testing, and design for testability issues are discussed. Compression techniques, built-in self-test and self-checking circuits are also covered.

Learning Objectives

At the end of this course, the successful student will have a solid understanding of principles of digital testing and test philosophy, fault models, fault simulation, testability measures, combinational and sequential circuit test generation methods, memory testing, delay test methodology, various methods of design for testability (including scan design, built-in self-test, and boundary scan). In addition, the student will have fundamental understanding of the principles of error-control coding and their application to self-checking design and design for test of digital devices (including programmable logic devices).

Course Organization 3 hours of lecture per week for 13 weeks

Course Evaluation

Course Project	50%
Final exam	50%
Total	100%

Examinations Final examination is a 3-hour examination that covers all the course material.

Project A project involves reading papers from research literature pertinent to a testing topic and writing a report on this topic. The topics of interest include but are not limited to: FPGA, Microprocessor and System-on-Chip (SoC) Test; Design for Test in Nano-Technologies; Analog, Mixed-Signal and RF Test; Built-in Self-Test and Self-Repair; Design for Testability and Diagnosis; Defect/Fault Tolerance and Reliability; On-line Testing; Compaction Techniques; Embedded System Testing; Dependable HW/SW Systems. The project can contain a review of existing approaches, or can involve a novel technique. Project topics are proposed by students and approved by the instructor.

Course Content

Week	Detailed Description	Hours
1	Introduction, VLSI Testing Process and Test Equipment, Test Economics and Product Quality	3
2	Fault Modeling	3
3	Logic and Fault Simulation	3
4	Testability Measures	3
5	Combinational Circuit Test Generation	3
6	Sequential Circuit Rest generation	3
7	Memory Test and Delay Test	3
8	Digital DFT and Scan Design	3
9	Introduction to Error-Control Codes and Built-In Self-Test	3
10	Boundary Scan and Systems Test and Core-Base Design	3
11	Self-Checking Design	3
12	PLA Testing, Testing FPGAs and Microprocessors	3
13	Review and Catch Up	3
Final Examination		

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.

2. All reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.

12. Projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade.

Name of Instructor	Vadim Geurkov	Signature of Instructor		Date	
Name of Graduate Program Director	Lian Zhao	Signature of Graduate Program Director		Date	

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8506: Digital CMOS VLSI Integrated Circuits

Prerequisites None

Course Web Page Course website on Blackboard (http://my.ryerson.ca)

Compulsory Texts:

1. Neil H. E. Weste and David Harris, *CMOS VLSI Design: A Circuit and Systems Perspective,* Addison-Wesley, 2011. (ISBN-13: 978-0-321-54774-3)
2. Laboratory manual: *ELE734 Low Power Digital Integrated Circuits Laboratory Manual,* Ryerson University.

Reference Texts: None

Calendar Description This course deals with the design of Digital CMOS integrated circuits. The course consists of three essential components: Theory, Laboratory, and project. Variety of design techniques, such as Static CMOS, Dynamic CMOS, and Transmission Gate are discussed in theory. These designs are studied on basic logic gates as well as combinational and sequential circuits. The lessons learned are applied to arithmetic building blocks such as adders, multipliers, and memory elements. A MOS transistor is studied using I-V equations, and the different areas of operations are modeled. The static (DC) are dynamic (transient) behaviors for an important building block, a CMOS inverter, are studied in depth.

Learning Objectives At the end of this course, the successful student will have a solid understanding of the operations of MOS transistors pertaining to digital circuit operations including the I-V characteristics of MOS transistors, static and dynamic behaviours of the CMOS inverter, Static CMOS design techniques, Dynamic CMOS design techniques, Transmission Gate design techniques, and the performance and power evaluation of digital CMOS circuits. The student will develop a good understanding of the basic logic gate design techniques as well as advanced combinational and sequential circuit design techniques including the design and implementation of arithmetic building blocks such as adders, multipliers, and memory elements. The student will also be able to perform schematic-level and layout-level design of advanced digital CMOS circuits using computer-aided design tools (CAD) from Cadence Design Systems (CAD tools for IC design are used extensively in both laboratories and course projects).

Course 3 hours of lecture per week for 13 weeks

Organization 2 hours of lab per week for 12 weeks

Course Evaluation

Midterm exam	20%
Labs	30%
Course Project	20%
Final exam	30%
Total	100%

To achieve a passing grade, student must pass both the theory and laboratory/project components.

Examinations Midterm examination is a 1.5-hour, closed-book examination with one page of aid-sheet that covers all the lecture and laboratory materials up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination with two pages of aid-sheet that covers all the course material and laboratory materials.

Project Students are required to perform the design and layout of either a 4x4 array multiplier or an 8 entry SRAM block using a given CMOS technology and CAD tools from Cadence Design Systems. The design of the system must contain the followings: (i) Schematic-level design - The schematic-level design must be fully simulated to verify its correctness. All schematics of the design must be included in the project report. The dimensions of all transistors and devices must be tabulated explicitly and included in the project report. All simulation results must be included in the project report. The critical path(s) of the circuit must be correctly identified. The performance of the critical path(s) must be measured through simulation. Reasonable effort must be made to minimize the delay of the critical path(s). (ii) Layout-level design – the layout-level design must faithfully reproduce the schematic-level design decisions that are made in (i). Efforts must be made to produce a modular and regular layout in order to minimize layout effort. (iii) Layout Vs Schematic (LVS) comparison and the measured performance of the post layout critical path(s) through simulation. (iv) Project reports must be prepared in a single-column double-space format, and must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical

reports.
- o Appendices
- o Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1	Introduction to Digital CMOS Design	3
2	MOS Transistor Theory	3
3	Circuit Simulation	3
4-5	Delay Estimation	4.5
5-6	Power Estimation	4.5
7-8	Interconnect Design (Midterm in week 8)	4
9-10	Combinational Circuit Design	4.5
10-11	Datapath Subsystems	4.5
12-13	Sequential Circuit Design	4.5
13	Review and Catch-up	1.5

Laboratory/Projects - Room ENG408

Labs.	Detailed Description	Week
1	Lab 1: Characteristics of MOSFET Devices	2-4
2	Lab 2: CMOS Inverter Design	5-7
3	Lab 3: CMOS Logic Families	8-10
4	Lab 4: 1-bit CMOS Full Adder	11-13
Project	Students are required to perform the design and layout of either an 4x4 array multiplier or an 8 entry SRAM block using a given CMOS technology and CAD tools from Cadence Design Systems.	

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or

exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8604: Radio-Frequency Circuits and Systems

Prerequisites EE8501 or equivalent

Course Web Page http://www.ee.ryerson.ca/~courses/ee8604/

Compulsory Texts:

1. Thomas H. Lee, *The Design of CMOS Radio-Frequency Integrated Circuits, Second Edition*, Cambridge Press, 2003.
2. B. Razavi, *RF Microelectronics*, 2nd edition, Prentice-Hall, 2012
3. Published scientific papers.
4. Laboratory manual: *EE8604 Laboratory Manual*, Ryerson University.

Reference Texts:

1. For fundamentals of ADCs: D. John and K. Martin, *Analog Integrated Circuits Design*, 2nd edition, John Wiley & Sons, 2011.
2. For advanced coverage of ADCs: R. Schreier and G. Temes, *Understanding Delta-Sigma Data Converters*, IEEE Press / John Wiley & Sons, 2005.

Calendar Description

This course deals with design of CMOS circuits for wireless communications. Topics include: characterization of RF circuits, architecture of RF transceivers, low-noise amplifiers, mixers, frequency synthesizers, and power amplifiers. Students are required to complete a design project with a professionally prepared project report.

Learning Objectives

At the end of this course, successful students will have a solid understanding of RF transceivers, characterization of RF circuits, low-noise amplifiers, mixers, frequency synthesizers, and power amplifiers. Students will also be able to design a RF circuit using commercial computer-aided design tools for integrated circuits.

Course Organization

3 hours of lecture per week for 13 weeks
2 hours of lab per week for 12 weeks

Course Evaluation

Midterm exam	20%
Labs	30%
Course Project	20%
Final exam	30%
Total	100%

To achieve a passing grade, student must pass both the theory and laboratory/project components.

Examinations Midterm examination is a 1.5-hour, closed-book examination that covers all the lecture and laboratory materials up to the week of mid-term examination.

Final examination is a 3-hour closed-book examination that covers all the course material and laboratory materials.

Project Students are required to design and analyze a RF circuit using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies. The design of the system must contain the followings: (i) Background studies - An extensive background study of the system to be designed is required. A literature review must be included in the project report. (ii) Schematic-level design - The schematic-level design must be simulated. All schematics of the design must be included in the project report. The dimensions of all transistors and devices must be tabulated explicitly and included in the project report. All simulation results must be included in the project report. (iii) Project reports must be prepared in a single-column double-space format, and must contain the followings:

- Title page - Title of the project, authors' name, and course name.
- Abstract - Abstract of the project report.
- Table of contents - list of chapters, sections, and subsections of the project report.
- List of figures - list of all figures in the project report.
- List of tables - list of all tables in the project report.
- Main body of the project report - All schematics and figures must be embedded in the main body of the report and numbered.
- References - list of the books, journal papers, conference papers, and other publications used in the project report. References must be listed using IEEE reference styles. You need to take a look at *IEEE Transactions on Circuits and Systems I - Regular Papers* and *IEEE Journal of Solid-State Circuits* for IEEE reference styles on books, journal papers, conference papers, and technical reports.
- Appendices
- Index - list of key words and their page number in the project report.

Course Content

Week	Detailed Description	Hours
1-2	Architecture of RF transceivers	6
3-4	Impedance transformation	6
5	Low-Noise Amplifiers	3
6-8	Mixers	9

9-10	Power amplifiers	6
11-13	Frequency synthesizers	9

Laboratory/Projects - Room ENG408

Labs.	Detailed Description	Week
1	Lab 1: Low-noise amplifier	2-4
2	Lab 2: Mixer	5-7
3	Lab 3: Frequency synthesizer	8-12
Project	Students are required to design and analyze a RF circuit using a given CMOS technology and CAD tools from Cadence Design Systems. Projects must make an extensive use of the knowledge acquired from the course. Projects must be design-oriented and all designs must be in CMOS technologies.	

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive

accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.

7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8605: Semantic Web Technologies

Prerequisites

None

Compulsory Texts:

1. Liyang Yu, A Developer's Guide to the Semantic Web, Springer, 2011. ISBN Number 978-3-642-15970-1

Reference Texts:

1. Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, 2nd edition, MIT Press, 2008.
2. John Hebeler, Matthew Fisher, Ryan Blace, Semantic Web Programming, Wiley, 2009. ISBN - 10: 047041801X
3. Toby Segaran, Colin Evans, Jamie Taylor, Programming the Semantic Web, O'Reilly Media, 2009. ISBN: 978-0-596-15381-6

Calendar Description

The objectives of this course are to provide an in depth understanding of Semantic Web Techniques. The emphasis will be on how data and information can be formally represented such that machines not only efficiently store and retrieve them but also exploit them for automated inference, integration, reasoning and reuse. This course will cover topics such as Semi-Structured Data, Semantic Relations, Resource Description Framework, Querying Semantic Information, Ontologies, Reasoning and the Linked Open Data.

Learning Objectives

In this course, students will learn how to semantically model and describe complex domain and information models in order to enable efficient reasoning and automation. Students will get practical experience in information and knowledge modeling, formal reasoning, working with Semantic Web and Linked Open Data.

Course Organization

3 hours of lecture per week for 13 weeks

Course Evaluation

Assignments	30%
Course Project	40%
Final exam	30%
Total	100%

To achieve a passing grade, student must pass both the theory and assignment/project components.

Examinations Final examination is a 3-hour closed-book examination that covers all the course material and project materials.

Course Content

Week	Detailed Description	Hours
1-2	Fundamentals of data modeling techniques especially relational models	6
3-4	Semi-Structured Data, XML, XML Schema, XPath, XQuery	3
5-6	Resource Description Framework, RDF, RDFS	3
7-8	Formal Ontologies, RDFS, OWL	3
9-10	Querying the Semantic Web through SPARQL	6
11-12	Embedded Semantics, RDFa, Microformat	3
13	Linked Open Data Cloud and Semantic Data Integration	6

Note: Schedule of lectures and labs is tentative. There may be some changes in the schedule that will be announced in the class and posted on course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.
4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this

deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.

7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including:
   Undergraduate Grading, Promotion and Academic Standing,
   http://www.ryerson.ca/senate/policies/pol46.pdf
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.
12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO. In some genuine cases late submission will be allowed with a penalty of 5% per day.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This automatically will lead to a failing grade

RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Department of Electrical and Computer Engineering

EE8606: Biomedical Simulations (Selected Topics in Biomedical Engineering)

Prerequisites Registration within Ryerson's School of Graduate Studies or approval.

Course Web Page http://www.ee.ryerson.ca/~jasmith/courses/ee8606

Compulsory Texts:

1. Fundamentals of Surgical Simulation: Principles and Practice, Anthony G. Gallagher, & Gerald C. O'Sullivan, Springer 2012. (eBook at Ryerson)
2. Medical Moulage : How to Make Your Simulations Come Alive by Bobbie Merica (eBook at Ryerson).
3. Biomimicry for optimization, control, and automation by Kevin M. Passino. ; London ; New York : Springer, 2004. (eBook at Ryerson)
4. Principles of object-oriented modeling and simulation with Modelica 2.1; Peter Fritzson; Piscataway, N.J. : IEEE Press : Wiley-Interscience, c2004. (eBook at Ryerson)
5. Programming Interactivity, 2nd Edition; Joshua Noble (eBook at Ryerson)
6. "The Efficacy of Prototyping Under Time Constraints", Steven P. Dow and Scott R. Klemmer, in Understanding Innovation Design Thinking edited by Christoph Meinel, Larry Leifer and Hasso Plattner; Springer-Verlag Berlin Heidelberg 2011 (article at Ryerson)
7. "Design Thinking" by Jean S. MacFadyen, Holist Nurse Pract, 28(1): 3-5, 2014 (article at Ryerson)
8. "Design Thinking" by Tim Brown, Harvard Business Review, June 2008 (article online)

Reference Texts: To be determined.

Calendar Description

This course provides a comprehensive treatment on design processes and fundamental concepts of device design related to medical simulations of people and interactive biomedical devices. Topics include: biomimetics, physical simulation tools (electrical and mechanical), and computer simulations. Biology- and human-centric design methodologies will be applied to contemporary problems such as soft devices, medical suturing simulators, and robotics. By the end of the course, the student will have gained knowledge in some of the essentials of biomedical simulation engineering and its application to environments where interactions with and mimicry of people are key. The student will be capable of specifying design requirements, components and system integration strategies in such scenarios.

Learning Objectives

Describe differences between the various approaches that can be used to solve a biomedical simulation problem using appropriate tools. Select one specific approach to solve the problem. When the selected approach fails to solve the problem satisfactorily, analyze the cause of failure using standard methods and debugging methodologies. Based on the analysis, come up with new suggestions to improve the existing approach. Integrate the new suggestions into the existing design plan. Judge the completeness and quality of the generated solutions using standard methods and debugging methodologies.

Produce lab and project reports using appropriate format, grammar, and citation styles for technical and non-technical audiences.

Course Organization

3 hours of lecture and discussion per week for 12 weeks

Course Evaluation

Discussion (Participation)	10% of final grade
Assignments	20% of final grade
Midterm Exam	20% of final grade
Final Project	30% of final grade
Final Exam	20% of final grade
Total	100%

(a) Discussion sessions: a number of discussions and design-oriented brainstorming sessions will be held throughout the semester. Your participation grade will be based on your work during these sessions.

(b) Assignments Exam: Five half-page "milestone" reports related to the final project, distributed throughout the semester.

(c) Midterm Exam: A single midterm exam will be held.

(d) Final Exam: A single final exam will be held.

(e) Final Project: You will choose a project early in the semester and be evaluated on it by the end-of-semester. The technical scope of the project will be determined on an individual basis, based on a consultation with the instructor. A marking guide will be provided ahead of time.

Project

The final project report is expected to adhere to IEEE format, including referencing, unless the student eventually intends to submit the work in some form to a non-IEEE

publication, in which case the specific publication's formatting style is to be adhered to (and a web link specifying this format is provided by the student to the instructor). Refer to the marking and style guides for details on what is required in these reports.

Course Content

Topic	Readings	Hours	Topic, description
Introduction	Ch. 1 Fritzson; Ch. 1 Passino Ch. 1 Gallagher & O'Sullivan	3	- Introduction to Biomedical Simulations - Biomimetics and Biomimicry; Evolutionary vs. Engineering Constraints
Design Thinking	Dow and Klemmer; MacFadyen; Brown	3	- General human-centric design methodologies - Design requirements, components and system integration strategies
Medical & Mechanical aspects of Biomedical Physical Modeling	Ch. 2, 3, 5, Gallagher & O'Sullivan; Ch 1, 2, 3, 17, 45 Merica	9	- Simulations for Procedural Training - Human Factors in Acquiring Medical Skill - Metrics for Measurement of Skill - Medical moulage materials, techniques and processes. - Modeling Abscesses, Bites and Stings - Modeling Blood - Modeling Scars - Case Studies
Electrical Aspects of Biomedical Physical Modeling	Ch. 7, 8, 11, Noble	6	- Physical Input - Graphical Output - Sensor & actuator interfacing
Computer Models & Simulations of Biomedical Systems	Ch. 2, 13, 14 & 15 Fritzson	9	- Multiphysics approaches to computer simulations - MapleSim and Modelica - System Modeling Methodology & Continuous Model Representation - Discrete Event, Hybrid and Concurrent Modeling - Basic Laws of Nature
Student Presentations	n/a	6	- TBD

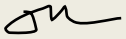
Note: The schedule is tentative. There may be some changes in the schedule that will be announced in the class and/or posted on the course website.

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.
2. All assignment and lab/tutorial reports must have the standard cover page which can be completed and printed from the Department website at www.ee.ryerson.ca. The cover page must be signed by the student(s) prior to submission of the work. Submissions without the cover pages **will not** be accepted.
3. No makeups will be provided for midterm exam or assignments. If any of the aforementioned are missed for an officially approved reason the associated weight will be assigned to the final exam.
4. Students who miss a final exam for an officially approved reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.
5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
6. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.
7. The results of the first assignment and/or midterm exam will be returned to students before the deadline to drop a course in good Academic Standing.
8. Students are required to adhere to all relevant University policies including but not limited to:
   Student Code of Academic Conduct, http://www.ryerson.ca/senate/policies/pol60.pdf
   Student Code of Non-Academic Conduct, http://www.ryerson.ca/senate/policies/pol61.pdf
   Undergraduate Academic Consideration and Appeals,
   http://www.ryerson.ca/senate/policies/pol134.pdf
   Examination Policy, http://www.ryerson.ca/senate/policies/pol135.pdf
   Accom. of Student Relig., Abor. and Spir. Observance,
   http://www.ryerson.ca/senate/policies/pol150.pdf
   Est. of Stud. Email Accts for Official Univ. Commun.,
   http://www.ryerson.ca/senate/policies/pol157.pdf
9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.
10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.
11. In-class use of cellular telephones is not permitted. Please turn off your cell phone prior to class. Quiet use of laptops, text-messengers and similar non-audible devices are permitted only in the rear

rows of the class. This restriction allows use of such devices by their users while limiting audible and visual distractions to other students. This policy may change without notice.

12. Labs, projects handed in past the due date and time will not be accepted for marking and will receive a mark of ZERO.
13. Students found to have plagiarized *any* portion of their labs and final project will receive a grade of zero on the *complete* project. This may automatically will lead to a failing grade.

Name of Instructor	James Andrew Smith, PhD, PEng	Signature of Instructor		Date	July 18, 2014
Name of Graduate Program Director		Signature of Graduate Program Director		Date	

Ryerson University

Electrical and computer Engineering Department

EE8608 Antenna Theory and Design

Winter Term 2014

The course introduces the fundamental principles of Analysis and design of antennas. In addition, the course develops appreciation for research issues of antennas for mobile wireless and advanced communications systems.

Particular topics covered are: fundamental parameters of antennas such as radiation patterns, directivity, gain, near field and far field zones, Detailed Analysis of traditional antennas such as linear wire antennas, loops, arrays and aperture antennas .Theory will also be covered for the analysis and design of linear planar arrays.

Lecturer: Dr. Farah Mohammadi,

Office: ENG 461

Email: fmohamma@ee.ryerson.ca

Extension: 6094

Prerequisites:
Decent Math background in vector Analysis, differential equations and complex numbers
Undergraduate Electromagnetic Courses (e.g. ELE531-Electromagnetics)
Knowledge of Maxwell Equations and Basic Waves.

Review material: Review Maxwell's Equations and a Wave Chapter in any available undergraduate textbook

Recommended text Book: *Antenna Theory and Design*, Balanis, Wiley 2005.

Other Textbooks: *Antenna Theory and Design*, Stutzman and Thiele, Wiley

Antennas and RadioWave Propagation, Collin, McGraw Hill

Antennas for All Applications, Kraus and Marhefka, McGraw Hill

Office hours: Mondays 4pm to 6pm

Course Evaluation:	Project	30%
	test 1:	15%
	test 2:	15%
	Final:	40%
	Bonus:	Antenna picture and report assignment 15%
	Assignments	Optional

The instructions for the Project and Antenna picture assignment will be provided in detail.

Course Outline:

I. Introduction to Antennas for Wireless Communications

II. Electromagnetic Theory Review

III. Antennas

a. Types of antennas
b. Radiation mechanism
c. Current distribution
d. Historical advancement

IV .Fundamental Parameters of Antennas

a. Antenna
b. Radiation mechanism
c. Radiation pattern
d. Radiation intensity
e. Directivity
f. Gain
g. Efficiency, beam width, and bandwidth
h. Polarization
i. Impedance
j. Antenna as an aperture
Test 1

V. Radiation Integrals

a. Vector potential A
b. Vector potential F
c. Far-field radiation
d. Duality, reciprocity, and reaction theorem

VI. Wire Antennas

a. Short wire
b. Finite length dipole
c. Ground effects

VII. Loop Antenna

a. Small circular loop
b. Large circular loop
c. Ground effects
d. Polygonal loops
Test 2

VIII. Arrays

a. Linear array
1. Broadside
2. Endfire
3. Scanning
4. Binomial
5. Dolph-Tchebyscheff
b. Planar array
c. Circular array
d. Designs
1. Dolph-Tschebyscheff
2. Yagi-Uda
3. Log-Periodic
e. Smart/Intelligent/Adaptive Antennas