RYERSON UNIVERSITY

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

Course Outline (W2016)
EES604: Electronics and Sensors

Instructor	Dr. Sattar Hussain. Office: ENG324 Phone: TBA Email: sattar.hussain@ryerson.ca Office hours: Tuesdays 1:00 pm – 3:00 pm **Note:** The office hours may not be available during examination period, or after April 15th. Please take advantage of them as much as possible during the term.
Teaching Assistants	Nicholas Burgwin , Email: nburgwin@ryerson.ca Abdulfatah Kesibi, Email: akesibi@ryerson.ca
Lecture Hours	Tuesdays 3:00pm-6:00pm, LIB 072 Theatre
Lab Hours	Two hours per week • Section 1: Mondays, 2 pm – 4 pm in ENG303 • Section 2: Wednesdays, 12 pm – 2 pm in ENG303 • Section 3: Mondays, 10 am – 12 pm in ENG 303 • Section 4: Tuesdays, 8 am – 10 am in ENG 303 • Section 5: Thursdays, 8 am – 10 am in ENG 303 • Section 6: Wednesdays, 2 pm – 4 pm in ENG303
Prerequisites	ELE202, EES512, and MTH312
Compulsory Texts	Custom-made book, available at the bookstore under, "*EES 604—Electronics and Sensors, Winter 2013*" **ISBN 1-256-61377-0**. The original textbook is *Electrical Engineering: Principles and Applications*, Allan R. Hambley, 5th Edition, 2011 Prentice Hall: **ISBN 978-0-13-213006-6.**
Reference Texts	*Microelectronic Circuits*, A. Sedra and K.C. Smith, 7th Edition, 2014 Oxford University Press: **ISBN 978-0199339136**

Calendar Description

Input-output relationships, transfer functions and frequency response of linear systems; operational amplifiers, operational amplifier circuits using negative and positive feedback; diodes, operational amplifier circuits using diodes; analog signal detection, conditioning and conversion systems; transducers and sensors, difference and instrumentation amplifiers, active filters, transistors including BJT and MOSFET.

Learning Objectives

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

1. Use relevant computer simulation and visualization software. (2c)
2. Determine the data that are appropriate to collect. (3a)
3. Apply mathematical and scientific principles to predict behavior of systems or processes. (3b)
4. Understand differences between electronic components and circuit configurations, select a suitable configuration in a design situation and with respect to the specified requirements, and evaluate, simulate, refine, and implement the design. (4d)
5. Develop further knowledge of use of modern instrumentation, data collection techniques, and equipment to conduct experiments and obtain valid data. (5a)
6. Verify and validate experimental results. (5b)

Note: Numbers in parentheses (e.g. 10a) refer to the graduate attributes required by the Canadian Engineering Accreditation Board. For more information, see: http://www.feas.ryerson.ca/quality_assurance/accreditation.pdf

Course Organization

3 hours of lecture per week for 13 weeks, in 1 section
2 hours of lab every week for 13 weeks

Course Evaluation

Labs	**30%**
Midterm exam	**30%**
Final exam	**40%**
Total	**100%**

Examinations

Midterm exam in Week 7 (scheduled for Tuesday March 1, 3:00pm-5:00pm, 2 hours, closed book (covers Weeks 1-6 of lecture and laboratory materials)
Final exam, during exam period, 3 hours, closed book (covers all the course material).

Course Content (the orders might not necessarily be as indicated below)

Topic	Text Sections	Hours	Details
Introduction		1	-Course management details -Overview of applications
Signals and Amplifiers	MT: 11.1-11.6, 11.10- 11.11 RT: 1.1, 1.2, 1.4, 1.5	4	-Signals, transduction, and amplification -The voltage amplifier, transfer characteristic, and circuit model -Difference (differential) amplifier -Other amplifier types and their circuit models
Fundamentals of Operational Amplifier (Op-Amp) Circuits	MT: 14.1-14.4, 14.6, 14.8 RT: 2.1-2.4, 2.8	4	-Ideal op-amp -Inverting amplifier -Non-inverting amplifier -Weighted summer -Difference amplifier -Instrumentation amplifier
Linear Op-Amp Circuits	MT: 14.9-14.10, 11.7 RT: 2.5.1-2.5.3, 1.6.1-1.6.5	3	-Integrators and differentiators -Frequency response and active filters
Diodes	MT: 10.1-10.7 RT: 4.1-4.7	6	-Diode: circuit symbol, characteristic, and circuit models -Zener diode and Light-Emitting Diode (LED) -Analysis techniques: load-line method, numerical method, and assumed states method -Rectifiers and peak detectors -Clippers, wave shapers, and clampers
Nonlinear Op-Amp Circuits	RT: 4.5.5, 17.9.1-17.9.8	3	-Non-linear op-amp circuits -"Superdiode" and precision rectifier -Logarithmic and anti-logarithmic amplifiers -Multipliers and dividers
Bipolar Junction Transistor (BJT)	MT: 13.1, 13.4-13.9 RT: 6.2-6.7	9	-Types and circuit symbols -Characteristics and modes of operation -Switching applications -Active mode and DC biasing -Small-signal model and basic amplifiers
Op-Amp Circuits with Positive Feedback	RT: 17.4.1-17.4.2, 17.4.5-17.4.7, 17.5.1-17.5.2	3	-Comparators -Positive feedback, hysteresis, and Schmitt Trigger -Square- and triangular-wave signal generators
Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET)	MT: 12.1, 12.3-12.6	3	-Types and circuit symbols -Characteristics and modes of operation -Switching applications -Active mode and DC biasing -Small-signal model and basic amplifiers

Schedule of Lectures (approximate and subject to refinements without prior notice)

Week	Date	Title
1	Jan. 12	-Introduction (1 hr) -Signals, transduction, voltage amplifier abstraction, and transfer characteristic (2 hrs)
2	Jan. 19	-Other amplifier types and their models (2 hrs) -Ideal op-amp (1 hr)
3	Jan. 26	-Inverting, non-inverting, and weighted summing amplifiers (2 hrs) -Difference and instrumentation amplifiers (1hr)
4	Feb. 2	-Op-amp differentiators and integrators (1 hr) -Dynamic op-amp circuits, frequency response, and op-amp active filters (2 hrs)
5	Feb. 9	-Diode and its symbol, characteristic, and models (1 hr) -Zener diode, Light-Emitting Diode (LED) (1 hr) -Analysis of circuits with diodes (1 hr)
SW	Feb. 16	**Study Week (No Lecture)**
6	Feb. 23	-Rectifiers, peak detectors, clippers, waveshapers, and clampers
7	March 1	**Midterm Test (No Lecture)**
8	March 8	-Circuits with op-amps and diodes: superdiode, peak detectors, precision rectifiers, logarithmic and anti-logarithmic amplifiers, multipliers and dividers (3 hr)
9	March 15	-BJT and its characteristic (1hrs) -BJT as a switch (1 hr) -BJT in active mode, and DC biasing (1hr)
10	March 22	-BJT as an amplifier building block, and its small-signal model (3 hr)
11	March 29	-Basic BJT amplifiers (CE, CC, and CB) (3 hr)
12	April 5	-Op-amp circuits with positive feedback: comparators and Schmitt Trigger (2 hrs) -Square-wave and triangular-wave signal generators (1 hr)
13	April 12	-MOSFET and its characteristics (2 hrs) -Comparisons with the BJT (1 hr)

Schedule of Labs

Week	Week of	Title	Room	Report Due
1	Jan. 11	No labs		
2	Jan. 18	No labs		
3	Jan. 25	Lab 1: Introduction	ENG303	Week of Feb. 8
4	Feb. 1	Lab 1: Cont'd		
5	Feb. 8	Lab 2: Op-Amp Circuits	ENG303	
SW	Feb. 15	**No Labs (Study Week)**		
6	Feb. 22	Lab 2: Cont'd		Week of March 7
7	Feb. 29	**No Labs (Midterm Exam)**		

8	March 7	Lab 3: Op-Amp Linear Circuit Applications	ENG303	Week of March 14
9	March 14	Lab 4: Diode Circuits	ENG303	Week of March 21
10	March 21	Lab 5: Precision Rectifier Circuits	ENG303	Week of March 28
11	March 28	Lab 6: Single-Stage BJT Amplifiers	ENG303	Week of April 11
12	April 4	**No Labs**	ENG303	
13	April 11	**No Labs: TAs will hold office hours**	ENG303	

Lab Rules and Related Matters

Lab Rules	A comprehensive set of lab rules are posted on D2L, under "Lab Rules" document. Note that the **Lab Rules will be strictly enforced**.
Lab Instructions	All "Lab Instructions" documents have been posted on Blackboard. It is students' responsibility to access the document prior to each lab, populate it with the required information (pre-lab assignment, experimental data, and conclusions), and submit it to the TA in charge as an individual lab report.
Lab Kit	**YOU NEED A LAB KIT FOR THIS COURSE.** **EACH LAB PARTNER NEEDS THEIR OWN.** **Students without a lab kit will get *zero* for the missed lab**. See the Lab Rules document for the detailed list of electronic components included in the Lab Kit.
Circuit Simulation Software	As part of some pre-lab assignments, the students are required to use Multisim circuit simulation software. The software is available for students' use on computers at the rooms ENG306, ENG307, ENG308, ENG406, ENG408, ENG409, ENG411, and ENG412.

Important Notes

1. To achieve a passing grade, ***the student must pass both the theory and laboratory components*** of the course.
2. 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.
3. All lab reports must include the standard cover page which shall be signed by the student prior to submission of the work. Submissions without the cover pages **will not** be accepted.
4. 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.
5. 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
- Undergraduate Course Management Policy, http://www.ryerson.ca/senate/policies/pol145.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

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

Course Developer ___Sattar Hussain_____ Date _____Dec 23, 2015_____

Approved by _____ Date _____

Associate Chair, Program Director

or Department Chair