CONCORDIA UNIVERSITY

**DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING**

ELEC 441/6081 WW – **(Modern** **Analog / Integrated Circuit Filters Analysis and Design)**

**(*Tetative*) Course Outline- Winter 2012-2013**

**Instructor**: Dr. R. Raut

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Office Hours: Mondays (4:00pm-5:00pm)

Tuesdays (2:00pm-3:00pm)

Wednesdays (1:00pm-2:00pm)

**Lecture Times**: **Section WW**: Mondays 5:45 p.m. – 8:15 p.m., **S- H 537**

**Text book**:      R. Raut and M.N.S. Swamy, *Modern Anaolg Filter Aanlysis and Design- A Practical Approach*, WILEY-VCH, © 2010, **ISBN** 978-3-527-40766-8

**References**:

1. R. Schaumann and M.E.Van Valkenburg, *Design of Analog Filters*, ISBN 0-19-511877-4
2. R. Schaumann, M.S. Ghausi, K.R. Laker, *Design of Analog Filters*, ISBN 0-13-200288-4.

**Laboratory:**      Mr. Shailesh Prasad(Laboratory Coordinator)

                                 Office:                         EV 16.189

                                 Telephone:                  848-2424/4106

                                 E-mail:                         shailesh@ece.concordia.ca

                                 Office Hours:              Tuesdays 1:00 p.m.- 2:00 p.m.

                                 Laboratory classes (bi-weekly) will commence on the week of **January 21, 2013**.  For the day and time of your lab section, refer to the schedule attached at the end of this document.  The laboratory is located in room S-H 855. *Graduate students should consult Mr. Prasad (lab coordinator) for relevant allocation.* Lab manuals are available at Concordia book store.

Laboratory Practices will focus on the following topics:

1. Passive LC filters.
2. Second order active RC filters with single amplifier (OP-AMP)
3. Second order active RC filters with multiple OP-AMP
4. OTA and capacitance (OTA-C) based second order filters.
5. Current-Conveyor (CC) based second order filter

**Course Outline**:       Objective

On completion of this course students will be familiar with the basic concepts underlying the analysis, design and implementation of electronic filters .They will have hands-on experience regarding analysis, design and measurements on electronic filters using (i) computer aided simulation tools, and (ii) using IC chips through laboratory practice.

Brief Description of Topics

***Lecture component***

1. Basic Concepts:  Network analysis review; concept of dual networks; frequency and magnitude scaling.
2. Approximation Problem:  Butterworth, Chebychev and Bessel approximations; synthesis of normalized low-pass filters; frequency transformations.
3. Analysis and Design of Second Order Active RC Filters:  SAB structures; multi OA structures; sensitivity; non-idealness of the OA; OTA and Current Conveyor (CC) based filters.
4. Monolithic Sampled Data Filters:  Switched capacitor techniques; switched C to R equivalence; SC integrators; analysis and simulation techniques; Second order SC filters.
5. Realization of High Order Filter Transfer Functions:  Passive LCR realization of all-pole transfer functions; active RC realizations; GIC and FDNR; cascade realization; active RC realization of general ladder filter. Multiple feedback structures.
6. Current mode Filters: Circuit theoretic principles. Implementation techniques using OTA,OA and CC.
7. Integrated Circuit Filters: Basic principles. Integrated circuit components; Example structures.

**Note**:

1. OA (Operational Amplifiers), OTA (Operational Trans-conductance Amplifiers, or Transcoductors), CC (Current Conveyors).
2. Solutions/hints to several exercise problems will be posted on Dr. Raut’s personal website (it is not MOODLE!).  The student is urged to work out as many as possible of the exercise problems appended at the end of each chapter of the text book.  Use of simulation tools (i.e., MATLAB, SPICE) is strongly encouraged.

***Soft skill component*** (*Skill types* *B, E: Investigation, Engineering Tool Usage)*

 The project work in this course will train the students in developing the skills for:

1. Theoretical investigation by studying appropriate materials from the lecture notes and the reference books, and
2. Use of several CAD tools to complete the project work.

**Grading scheme**

1. Project report (Submission deadline **April 15, 2013, 4p.m.**) : 55% (including 5% for oral presentation). Penalty for late submission will be **ten** (10) points per *each day of delay*.
2. Laboratory Practice (including test)  : 20%

**Note:** All submissions must be accompanied by a*signed certification*about the **\*expectation of originality** of the work**.** *Plagiarism*is a punishable offense under the code of academic conduct.

1. Class Test#1 **(February 11, 2013):** 10%
2. Class Test#2 (**March 25, 2013**): 15%

(*If a student misses a test, he/she will have to appear at an* ***oral examination*** *to prove his/her comprehension of the subject matter pertaining to the specific test(s) missed. No make- up question paper will be arranged to replace any of the missed test(s)).*

**Table (tentative) for Conversion of Numerical Marks to Letter Grades**

*Undergraduates:*                    Total Course Marks                             Final Grade

                                                           90-100 A +

85-89 A

80-84 A –

74-79 B +

68-73 B

65-67 B –

62-64 C +

59-61 C

56-58 C –

53-55 D +

51-52 D

50-51 D –

Below 50 F

*Graduates:*                  Below 50                                               F

50-60                                            C

61-66                                            B-

67-73                                            B

74-79                                            B+

80-84                                            A-

85-89                                            A

90 +                                              A+

**Policy of marking Exams/Tests**

|  |  |  |
| --- | --- | --- |
| Category | Description | You get % |
| 1 | Principle correct, explained all steps, calculated results all correct to the end | 100 |
| 2 | Principle correct, explained most of the steps, calculated results all correct | 90-95 |
| 3 | Principle correct, some explanations missing, calculated results all correct except at the end | 80-90 |
| 4 | Principle correct, no clear explanation of steps, calculated results all correct to the end | 70-80 |
| 5 | Principle partially correct, partial explanation, calculated results incorrect | 60-70 |
| 6 | Principle correctly stated, no explanation of steps, partial results | 50-60 |
| 7 | Principle partially stated, incorrect or incomplete results/calculations | 40-50 |
| 8 | Principle not stated, only numerical calculations, but results correct | 30-40 |
| 9 | Principle incorrect, calculations OK according to the incorrect principle used | 20-30 |
| 10 | Nothing stated, copied materials from the question paper, unfinished work | 0-20 |

**Use of MAPLE:**

It is felt that the students will find it convenient to use a software program, such as MAPLE to carry out lengthy analytical/numerical calculations. So the students are suggested to purchase a discounted copy of the software for their personal use. The course ELEC 312 has been registered so that students enrolled in this course can obtain the discounted version of MAPLE. The following is the link for further actions.

webpage: <https://webstore.maplesoft.com/index.aspx>

Use the **PROMOTION CODE:** *To be announced*

With this code the students can purchase a discounted version of Maple 14 Student Edition from the Maplesoft Webstore.

In case you need additional information you can call 1-800-267-6583 x 320 for details.

*Please note that the discount code is only valid from 2 weeks before the course start date until the course ends.*

**Academic Code of Conduct (related to the expectation of originality):**

Cheating is a serious offence. You must abide by the Academic Code of Conduct as described in the University Calendar. Any suspected violation of the Code will be reported to the Associate Dean for investigation. Penalties can be as severe as dismissal from the University.

The Code forbids *plagiarism*. For example, you may not copy any part of an assignment or report from a student who took the course in a previous year or the present year. The code also forbids you from providing the material to another student. If you allow another student to copy your work you have behaved unethically and have committed an offence.

**Schedule for ELEC 441**

**Location: H-855**

**Make-up:-** For the make-up will be held on Tuesday (April 2) and Friday (April 5) with the prior arrangement of the Lab demonstrator.

**Lab test: -** A 60 minutes experimental lab test would be held as shown below. This would be a hands-on test. Some oral questions may be asked.

**Lab cancellation** – March 29

|  |  |  |
| --- | --- | --- |
|  | Tuesday 14.45 – 17.30 | Friday 11:45-14:30 |
| Week of January 21, Expt. 1 | WI | WJ |
|  |  |  |
| Week of February 4, Expt. 2 | WI | WJ |
|  |  |  |
| Week of February 18 | SPRING BREAK | SPRING BREAK |
|  |  |  |
| Week of Feb. 25, Expt. 3 | WI | WJ |
|  |  |  |
| Week of March 11, Expt. 4 | WI | WJ |
|  |  |  |
| Week of March 25, Expt. 5 | WI | Holiday |
|  |  |  |
| Week of April 1 | Make-up for WI | Make-up for WJ |
| Week of April 8 | Test for WI | Test for WJ |

**Lab Demonstrator**

Christopher Williams- WI and WJ Email- ch\_willi@encs.concordia.ca

**Lab Coordinator** - Shailesh Prasad (Ext. 4106) – Shailesh.prasad@concordia.ca