

Course Outline, Telecommunication Circuits, ELEC 4505, Fall 2015

Instructor: Prof. Calvin Plett, **Office:** ~~5148 ME or 5170 ME,~~

5146

email: cp{at}doe.carleton.ca, **web:** www.doe.carleton.ca/~cp/telecom/telecom.html

Lectures: Tue, Thu 13:00-14:30, 4332 ME, (Term is Sept 2 – Dec 8, 2015, break Oct 26-30)

Labs: Fri 8:30-11:30, 14:30-17:30, Odd Weeks room 4135 ME, (or computer lab for Lab 1)

Marks: Lab 35%, Assignments 15%, Final 50% (must get at least 35/100 in final exam)

Academic accommodation for any reason must be sought as soon as possible, preferably early in the term. Verification will be required.

Course Description: Design of circuits making up the blocks in a communication system. Examples of such blocks are tuned amplifiers, mixers, oscillators, phase shifters and detectors. Communications systems considered are wireless transceivers, AM, FM and TV. Use of the PLL will be discussed.

Course Outline:

	<u>Page</u>
1. Introduction to Telecommunications	1
Components of a radio systems; noise, distortion, impedance matching.	
2. Amplifier Design	17
Tuned amplifiers, class C amplifiers, extension to frequency multipliers.	
3. Mixers and Modulators	39
4. Phase-Locked Loop and Applications	47
Introduction and applications such as: tracking filters, synthesizers, and FM demodulation.	
5. Oscillators (For 2012, done after Amplifiers, before Mixers)	72
6. Amplitude-Modulated Radio	83
7. Frequency Modulators and Demodulators	89
8. Television Systems	102
Transmission and reception of video and audio; May also discuss high-definition TV, stereo sound.	

Labs:

Group size is 2 for all labs, one write-up per group, due at 16:15 one week after the scheduled lab day. Lab 3 has two parts, done in weeks 7 and 9, the write-up combines both parts and is due in week 10. (Note that unlike labs, assignments are done individually.)

- 1. Tuned Amplifiers (Simulation Lab) (and Assignment 1)** (introduction: Week 1 Sept. 11, Lab 1 (and Assignment 1): Week 3, Sept 25) **115**
Design and simulation (in ADS) of a 0.8 MHz tuned amplifier, built with a bipolar transistor and passive components. You will learn about the use of transistor parameters, tuned circuits, noise figure and impedance matching.
- 2. Mixers and Modulators (Hardware Lab)** (Week 5, Oct. 9) **127**
Use of an analog multiplier on an IC to build frequency changers. DSBSC, filtering for single sideband.
- 3. Phase-Locked Loops (Hardware Lab)** (Week 7, Oct. 23 and Week 9, Nov. 13) **144**
Use of a commercially available package to build a tracking filter, a synthesizer and an FM demodulator. The IC contains a voltage-controlled oscillator and phase detectors. In this lab, the VCO and phase detectors will be characterized, then a complete phased-locked loop will be built. The main external components will consist of a simple active loop filter and a divider to realize the synthesizer.

Assignments: Assignment 1 is part of Lab 1, Assignment 2 is on PLLs and is related to Lab 3 and done in parallel with it, Assignment 3 in Week 11 is an oscillator simulation. Note that unlike labs, assignments are done individually.

Course Notes, Lab Notes, Assignments, extra info (past exams, lab hints, marking schemes):

Will all be available on a password protected course web page

Course Goals

The objective of this course is to learn about the design of communications circuits with topics as described in the above outline of the Lectures, Labs, and Assignments.

Student Learning Objectives

Upon successful completion of this course, students will be able to:

1. Understand the need in a communications system for amplification, filtering, mixing, signal generation, modulation, detection, and data conversion.
2. Understand how performance of telecommunications circuits is limited by parasitic capacitance, unwanted resistance, nonlinearity, and noise, and how to apply design principles to deal with such nonidealities.
3. Design tuned amplifiers and apply them in a communications system.
4. Design mixers and apply them in a communications system.
5. Design oscillators and apply them in a communications system.
6. Design PLL-based circuits such as a tracking filters, FM demodulators and frequency synthesizers

References:

Smith, *Modern Communication Circuits 2nd Ed.*, McGraw-Hill 1998, TK6553.S5595

Krauss, Bostonian, Raab, *Solid State Radio Engineering*, Wiley 1980, TK6553.K73

Plett, Rogers, *Radio Frequency Integrated Circuit Design*, 2nd Ed. Artech House, 2010, TK7874

Sedra, Smith, *Microelectronic Circuits*, (for introduction to tuned amplifiers, oscillators)

Stremmler, *Introduction to Communication Systems*, (or other introductory communications texts)

Various Data books, Data Sheets