North Shore Community College  
Telecommunications Technology A.A.S. Degree

Course Number: IEL210  
Section: MAL  
Course Name: Linear Electronics 2  
Semester: Spring 2004  
Credit: 4  
Hours: 3 Hours Lecture, 2 Hours Laboratory per week  
Tuesdays, 12:45-3:30pm Lecture, 3:45-5pm Lab  
Room: LW207 Lecture, LE210 Laboratory  

Instructor: George H. Walsh Jr.  
Office: Lynn Campus LW228  
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email: gwalsh@northshore.edu  
Office Hours: * on-line

Text:  

Supplemental:  
Lap-top Computer with analysis and simulation software  
Scientific Calculator  

Software: (Multisim) or Circuit Maker

Additional Materials:

Prerequisite: Technical Math I, Computer Applications

Co-requisite: (Applied Physics) NextStep Program

Course Description: This course is designed to train students in the analysis and application of advanced electronic circuits. Topics include differential amplifiers, stage gain in decibels, input and output impedances, linear IC operational amplifiers, frequency response and Bode plots, active filters, D/A and A/D circuits, oscillators and high frequency amplifiers, troubleshooting of test circuits, and analysis by computer simulation.
Procedures: There are five hours of lecture and laboratory per week. The student is introduced to topic material in the lecture followed by a demonstration pertaining to the topic as solved by the use of a computer, a calculator and by connecting components on a breadboard for the purpose of testing and troubleshooting actual circuits

Course Rationale: This course will build upon knowledge and skills gained from the Electronic circuits course to show the tools, techniques and understanding of amplifiers and filters as used in the Telecommunications Industry. This course is recommended by the Bell Atlantic Next Step Program for the Telecommunications Technology Degree.

Course Objectives: Instructors shall make every effort to incorporate the following umbrella competencies into the course: Problem solving, teamwork, project leadership, quality, contextual learning, technology and service delivery and customer focus. The following list of course goals will be addressed in the course. Students will use skills and knowledge gained from lectures, readings, demonstrations and exercises to perform tasks in preparation for employment in local businesses and industry. Those tasks directly relate to these goals. Students shall demonstrate the following competencies:

1. Use the computer as an analytical tool. Know how to use computer simulation software to solve digital electronics problems, and save or print solutions and graphs.
2. Describe the operation of BJT differential amplifiers with single and balanced outputs.
3. Calculate and describe the frequency response of passive and active networks; generate Bode magnitude and phase plots.
4. Know how to find and interpret IC Op Amp specification sheets.
5. Design inverting and non-inverting IC Op Amp circuits for a specified gain.
6. Know how to analyze specialty Op Amp circuits including buffer amplifiers, summing amps, V/I converters, comparators, sample/hold circuits, and compensated differential amplifiers.
7. Know how to analyze and design active integrators, differentiators, and active filter circuits.
8. Describe the difference between audio, video, and RF amplifiers.
9. Analyze and troubleshoot oscillator circuits.
10. Describe the characteristics of D/A and A/D circuits.
11. Analyze the operation of a phase locked loop.
12. Know how to follow and describe prescribed lab test procedures, set up equipment, take measurements, interpret results, and run computer simulations. Interpret schematic diagrams and construct breadboard circuits. Troubleshoot electronic circuits/
13. Given a supplemental assignment or an activity assignment, know how to develop a technical report (using a computer) in one of the areas described in items 1-10 above.
   (a) use the library facilities, Internet and other sources to collect supplemental information to write a technical report which includes an introduction, main body, an summary.
(b) know how to develop a formal laboratory report including objectives, theory, procedures, equipment list, schematics, calculated and measured data, and conclusion.

14. Given the specifications for a hardware project, students shall make every effort to:
   (a) work productively as a team, practicing project leadership, interpersonal skills, and conflict resolution.
   (b) practice problem solving via the planning and organizing of the project.
   (c) obtain materials needed for the project and construct the unit.
   (d) test the unit to project specifications, and create necessary documentation.
   (e) assess the overall quality of the teamwork, and of the project.
   (f) develop and deliver to his/her colleagues a 10 minute oral presentation.

15. Listen and think critically. Apply mathematical procedures and quantitative methods, logically troubleshoot electronic circuits and propose corrective measures.

PROGRAM OBJECTIVES:

1. Continue development of umbrella competencies
2. Effectively use course objective in performance of daily work assignments
3. Develop enabling competencies for further work in digital electronics and telecommunications course

Attendance: All students are expected to attend every session of each course for which they are registered. Students are responsible for all that transpires in class whether or not they are in attendance. The College defines excessive absence or lateness as more than the equivalent of one week (four hours) of class meetings during the semester. Excessive absence or lateness may lead to failure in a course or removal from the class roster. Students must notify the instructor of any anticipated absences.

Homework: Reading assignments are the responsibility of the student. Most topics are covered by the book or supplemental material and should be read before class. Other readings are suggested during the course. Since topics are fragmented throughout the text and supplemental materials, the student should utilize indices to locate readings pertinent to each topic.

Examinations:  
1. Three tests on material to date (60 min)  30%
2. Comprehensive final exam (120 min)  15%
3. Lab work  30%
4. Homework  10%
5. Project  15%
**Laboratory:** This course requires extensive laboratory work. All assignments must be turned in one week from the date of issue, unless otherwise indicated. All assignments are graded for timeliness, accuracy, completeness and neatness. A final project is required for all students, however, students are encouraged to work in teams in order to accomplish project objectives within the time frame.

**Accommodation Statement:** If a student feels that due to a disability you have the need for special assistance and/or adaptations to accomplish the goals of this course, please see the instructor within the first week of classes.
IEL210
Linear Electronics 2
Topical Outline

1. Frequency Response of Passive Networks
   Bode plots, gain and phase

2. Operational Amplifiers.
   Introduction to Differential Amplifier using discrete components.
   Gain, impedances, single ended and balanced output
   a. Typical characteristics, spec sheet, offset slew rate GBW product, CMMR
   b. Op Amp without feedback

3. Op Amp with Feedback
   Inverting and non-inverting configurations, gain, loop gain,
   impedances: Zin, Zo.
   Buffer amp, comparators.
   Troubleshooting points.

4. Test No. 1 (suggested)
   Op-Amp Applications I:
   a. sample/hold
   b. Summing amp, VA converters, AV converters, constant current sources.
   c. Troubleshooting points

5. Op-Amp frequency response, Stability and compensation:
   a. Open- and Closed-loop frequency response.
   b. Stability criteria and compensation.

6. Op-Amp Applications II:
   a. Integrators and differentiators. Applications (ramp, square wave, triangular wave
      generators, etc.)
   b. Instrumentation amplifier: Av, Zin, Zo.

7. Active Filters I:
   a. High pass, low pass, bandpass: characteristics, parameters
   b. Filter characteristics: Butterworth, Chevyshev, Bessel, etc.
   c. Active low-pass filter: Single-pole, Sallen-key (two poles), etc.
   d. Cascading low-pass filters.

8. Test No. 2 (suggested)
   Active Filters II:
   a. Active high-pass filter: Single-pole, Sallen-key (two poles), etc.
   b. Cascading high-pass filters.
   c. Active band-pass filters: multiple-feedback BPF, state-variable BPF.
d. Active band-stop filter: multiple-feedback BSF, state-variable BSF.

9. Oscillators:
   a. Oscillator principles, positive feedback, loop gain
   b. Wien bridge, phase shift
   c. Crystal Oscillators.
   d. (This is a good time to introduce the topic(s) of the final project for the course. It is suggested that the instructor give specific details vis-à-vis this topic.)

10. The 555 timer:
    a. Internal diagram.
    b. Monostable operation.
    c. Astable operation.
    d. The 555 timer as an oscillator.
    e. Voltage-controlled oscillator (VCO).
    f. The 556 timer.

11. Phase Locked Loop
    a. Basic PLL operation.
    b. Phase detector.
    c. Frequency synthesis
    d. Applications: frequency demodulation, frequency-shift keyed (FSK).

12. Test No. 3 (suggested)
    High Frequency Op Amps:
    a. Frequency effects.
    c. RF Op Amps.

13. Miscellaneous applications:
    a. ADC and DAC applications
    b. Dual Slope, SAR
    c. Signal Generator chips (i.e., 8038)
    d. Waveshaping
    e. Switching Power supply.

14. Final Project presentation. Each team present their project.

15. Topic Review for Final Test
## IEL210
### Linear Electronics 2
#### Activity Outline

<table>
<thead>
<tr>
<th>Week</th>
<th>Activity</th>
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<tbody>
<tr>
<td>1.</td>
<td>Bode plots of high-pass, low-pass and band pass filters</td>
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| 2    | OP Amp DC specifications and characteristics  
|      | BJT differential amp using CA3086 |
| 3    | OP Amp inverting and non-inverting amplifier  
|      | Gain, impedances, frequency response |
| 4.   | Summing amplifier, buffer amplifier |
| 5.   | Differential amplifier |
| 6.   | Integration and differentiation with OP Amps |
| 7.   | Active Op Amp filter |
| 8.   | Video amplifier, RF amplifier |
| 9.   | Oscillator |
| 10.  | DAC with OP Amp |
| 11.  | A/D IC chip |
| 12.  | Function Generator chip |
| 13.  | Phase Locked Loop |
| 14.  | Project presentations. Each team should present their semester project |

This Course Outline was adapted from the Knowledge Depot of the Bell Atlantic Next Step Program and was developed by, **Abraham M. Michelin** in concert with other Faculty of the Next Step Program.