

LINEAR CIRCUITS

Advanced Technologies Sector

Course Number: ELN8257	Contribution to Program: Core	Educator(s): C. Sauriol
Applicable Program(s): Electronics Engineering Technology 008XRI	AAL Fifth semester	Approval Date: August 2002
Prerequisites: Electronics 2 (ELN8232) Mathematics IV (MAT8304)		Approved By: <u>Mike McNeil</u> Title: <u>Academic Manager</u>
Course Hours: Normative: 112 hrs Delivery: 112 hrs	Corequisites: Nil	Approved for Academic Year: 2002 - 2003

COURSE DESCRIPTION

This course introduces students to the study of linear electronic systems in general with the use of Laplace transforms to predict static and dynamic system response to various input stimuli. Computer simulation will also be used to predict system response. This broad-based approach will be applied to filters, phase-locked loops, switching regulators, power amplifiers and many other applications involving feedback loops. Stability of the systems will be analyzed and correction techniques will be presented to stabilize the feedback loops.

RELATIONSHIP TO PROGRAM LEARNING OUTCOMES

This a vocational course that supports the following vocational program standards:	This course contributes to your program by helping you to achieve the following provincial generic standards:
To be provided	To be provided

I.

COURSE CURRICULUM

Course Learning Requirements	Embedded Knowledge and Skills
<p>When you have earned credit for this course you will have demonstrated an ability to:</p>	
<p>1. Predict the response of simple systems to an input stimulus.</p> <p>2. Represent and model mathematically varying types of simple systems and predict their response to typical stimuli.</p> <p>3. Represent and model mathematically more advanced systems. Know classical families of filters and their associated characteristics and determine field of application of each family.</p> <p>4. Understand and explain ideal system characteristics. Understand and explain unideal system characteristics and their effect on system response.</p> <p>5. Implement filters to meet a given set of technical specifications and predict their performance under different temperature and component tolerance conditions.</p>	<p>-Solve differential equations using traditional methods and using Laplace transforms. -Use computer simulation to verify solutions.</p> <p>-Recognize types of first and second-order transfer functions and calculate the poles and zeros. -Understand and explain the effect of the poles and the zeros of a TF on frequency response and transient response. -Use computer simulation to plot frequency response and transient response.</p> <p>-Understand and explain the different features of Butterworth, Bessel and Chebychev families with regard to frequency response and transient response. -Calculate poles and zeros of Butterworth, Bessel and Chebychev filters and write their transfer functions. - Calculate attenuation, group delay and group delay distortion, response time, minimum order required for application, etc.</p> <p>-Understand and explain the characteristics of an ideal filter frequency response. -Determine the effect of amplitude distortion and delay distortion on transient response of various filter families</p> <p>-Analyse and design low-pass, high-pass, band-pass and band-reject active filters with Butterworth, Bessel or Chebychev characteristics. -Analyze and design a switched-capacitor filter with external anti-aliasing and ripple filters. -Use computer software to simulate filter gain, phase and delay responses as well as their transient response. -Use filter design software to verify a manual design. -Use computer software to evaluate the effect of component tolerance and temperature variation on filter performance.</p>
<p>6. Understand and explain phase-locked loop principles.</p> <p>7. Implement PLL-based subsystems mainly in telecommunication applications.</p>	<p>-Understand and explain the basic principles of phase-locked loops (PLL's): locking, phase error, lock range, capture range, etc. -derive a PLL transfer function and use it to calculate loop parameters and predict frequency response and transient response for various inputs.</p> <p>-Analyze, design, build and test PLL's in applications such as AM carrier recovery, tone detection, FM and FSK demodulation, and frequency synthesis.</p>

	-Use computer software to design and simulate PLL subsystems.
8. Understand and solve stability problems involved in linear feedback loops.	-Understand and explain self-oscillation mechanism in a feedback loop, absolute stability and relative stability. -Calculate phase and gain margins. -Explain and apply frequency compensation methods: unity gain lag compensation, gain specific lag compensation, lag-lead compensation, etc.
9. Apply common stabilization techniques to typical subsystems involving control loops.	Apply frequency compensation techniques to simple and more complex op amp circuits, to PLL's, to voltage regulators, to power amplifiers, etc. -Explain the effect of frequency compensation on bandwidth and transient response. Calculate resulting BW, response time, phase and gain margins.
10. Specify and select a switching power supply, or design it, for a given application.	-Understand and explain the operating principles, including magnetics, of the various <u>switching</u> regulator topologies: step-down, step-up, inverter, flyback, push-pull, half-bridge and full-bridge. -determine switching power supply parameters and specifications. -Analyze and design simple switching regulators in all topologies.
11. Implement basic RF systems	-design, analyse and test varying RF circuits.

II. Learning Resources

1. All course material will be provided on line from my web site <http://www.algonquincollege.com/staff/saurioc/> or will be handed out during regular classes.
2. *Microcap VII demo* software is an essential tool for this course and can be downloaded from the internet site <http://www.spectrum-soft.com/>. The instruction manual can also be downloaded from the same site.
3. SystemView software will also be used and can be downloaded free to students, courtesy of Elanix Corp. The software available at <http://www.elanix.com/html/evaluation.asp> allows you to run the professional version of SystemView for one semester if you are a duly registered student.
4. A calculator that handles functions of complex numbers and complex polynomial roots is also essential for this course. Suggested models: TI-85 TI-86 and most HP scientific models. TI-83plus calculators will do as bare minimum but have to be programmed for polynomial roots – see me for program.

REFERENCES

1. *DESIGN WITH OPERATIONAL AMPLIFIERS AND ANALOG INTEGRATED CIRCUITS*, 3rd edition, Sergio Franco, McGraw Hill. You can buy it at Amazon.com and get it real fast.
2. Other references are available at the library in Electronics/Linear or Analog Circuits section
3. **Op Amp Circuit Design Guide** from Texas Instruments – go to <http://www.algonquincollege.com/staff/saurioc/> for soft copy of manual.

III. Teaching/Learning Methods

- Formal lectures will be held four hours a week.
- Some lectures and lab sessions will be used as tutorials and problem solving.
- Lab experiments will be held weekly in three-hour blocks.
- Consultation is offered as shown on instructor's timetable posted on office door B202C.

IV. Learning Activities and Assessment

- 1) Attendance of lectures and lab sessions are essential to learn course material.
- 2) Each student is expected to review class theory at home on a daily basis.
- 3) Exercises and old tests are provided in the theory manual and should be done on a regular basis to re-enforce and verify understanding of the theory.
- 4) Tutorials and problem solving sessions will be used to provide feedback and answers to difficulties encountered in course material.
- 5) Pre-labs are used to verify understanding of theory and provide ongoing feedback to students.
- 6) Lab experiments provide practical hands-on experience where circuits are built and tested or simulated using computer software.
- 7) Computer simulations are used for analysis and also to learn and re-enforce some theoretical concepts.

V. Evaluation/Earning Credit

Theory	Weekly Quizzes	16%
	2 Term Tests	36%
	Final Exam	18%
Labs	Pre-labs	8%
	Lab work	12%
	Lab reports	10%
Total		<u>100%</u>

* The final exam is actually **term** test #3 (compulsory) that covers the third section of the course. Laboratory material is also covered in theory tests.

A supplemental exam may be offered in marginal cases. A supplemental exam will be a privilege not an automatic right.

The student must pass both the theory and lab portions of the course **separately** in order to pass the entire course: failing one or the other will result in a failure of the entire course. Unjustified absence to **more than six hours of lab sessions** will result in **automatic failure of the entire course**.

All lab experiments, must be done satisfactorily in order to pass the course: that is pre-labs and lab reports must be submitted in time and performance in the normally scheduled lab time must be satisfactory - you must demonstrate circuit functionality to the instructor whenever required.

GRADE	A ⁺	90-100%	A	85-89%	A ⁻	80-84%
	B ⁺	77-79%	B	74-76%	B ⁻	70-73%
	C ⁺	67-69%	C	64-66%	C ⁻	60-63%
	D ⁺	57-59%	D	54-56%	D ⁻	50-53%
	F	BELOW 50%				

VI. Prior Learning Assessment

PLA candidates may challenge this course, provided they complete the following assessment with a minimum mark of 60% in (a) (b) and (c).

a) A supervised written exam, of no longer than 2 1/2 hours, containing questions selected to assess the understanding of the course requirements.

b) An oral exam of no longer than one hour containing questions selected to assess the understanding of the course requirements.

c) A performance test consisting of at least 2 laboratory exercises requiring practical "hands-on" demonstrations of needed practical skills.

RELATED INFORMATION

Students, it is your responsibility to retain course outlines for possible future use to support applications for transfer of credit to other educational institutions.