ECE 3200: Electronics II
Required Course

2006-2007 Catalog Data:

Design, analysis, simulation, and laboratory evaluation of electronic amplifiers, filters, and nonlinear signal shaping circuits composed of transistors, diodes, and integrated circuits. Transient response and steady state frequency response behavior for both small signal and large signal excitation conditions. Amplifier macro-model description and behavior is introduced.
Credit: 4 hours
Prerequisites: ECE 2210, ECE 3100

Textbook(s) and/or Required Materials:

1. Sedra, A. S. and Smith, K.C., 2004. *Microelectronic Circuits*, (5th Edition). Oxford University Press.
2. M. Rashid, *Introduction to PSpice® Using OrCAD® for Circuits and Electronics*, 3rd ed., Prentice Hall, 2004.
3. Smith, K. C., 1998. *Laboratory Explorations for Microelectronic Circuits.* Oxford University Press.
4. Gejji, R. R., Gesink, J., and Miller, D. A., 2007. *Electronics II (ECE 3200) Laboratory Manual.* WMU IEEE student branch.
5. SPICE circuit simulation software, e.g. OrCAD® PSpice® circuit simulation package (available in Computer Aided Engineering Center or free download)

Recommended Materials:

1. MATLAB® and Simulink® (or similar) mathematics software suite (MATLAB® and Simulink® available in Computer Aided Engineering Center)

Reference Materials:

1. Wolf, S. and R. F. M. Smith, 2004. *Student Reference Manual for Electronic Instrumentation Laboratories*, (1st or 2nd Edition). Pearson/Prentice Hall.

Course Coordinator: Dr. Damon A. Miller, Associate Professor, ECE

Instructor (Fall 2006): Dr. Johnson Asumadu, Associate Professor, ECE

Prerequisites by Topic:

1. Transient and steady state analysis of linear circuits
2. Terminal characteristics of transistors and semiconductor diodes
3. Large and small signal equivalent circuits of transistor and semiconductor diodes
4. Diode signal shaping circuits
5. Biasing techniques for transistor amplifiers
6. Large and small signal equivalent circuit analysis of elementary transistor amplifiers
7. Quiescent power dissipation considerations in semiconductor circuits
8. Basics of transistors as switches
9. Computer aided analysis of semiconductor circuits using the software simulation program SPICE

Course Objectives: (ABET Learning Outcomes)

ABET learning outcome assigned to this course by ECE assessment plan: b and d.

1. an ability to analyze, design, simulate, and experimentally validate electronic that utilize operational amplifiers while taking into account practical limitations of operational (a, b, c, e, k);
2. an ability to analyze, design, simulate, and experimentally validate electronic circuits utilizing metal-oxide semiconductor field-effect transistors, including MOS based operational amplifiers (a, b, c, e, k);
3. an ability to design, analyze, simulate, and experimentally validate electronic oscillator circuits (a, b, c, e, k);
4. an ability to design, analyze, simulate, and experimentally validate nonlinear waveshaping circuits (a, b, c, e, k);
5. an ability to utilize circuit simulation and/or mathematical software tools for electronic design and analysis (k);
6. an ability to use appropriate statistical measures to characterize experimental error (a, b, k);

7. an understanding of negative and positive feedback systems and their application to electronic circuit analysis and design (a, c);
8. an understanding of frequency compensation and its application to electronic circuit design (a, c);
9. a basic understanding of electronic noise analysis (a, c);
10. an ability to use electronic test instrumentation to validate and debug electronic circuits (k);
11. an ability to prepare effective written technical communications for engineering analysis and design work (g);
12. an ability to thoroughly and accurately document laboratory work using a laboratory notebook (b, g); and
13. an ability to function as an effective engineering team member (d).

Topics:

1. Continuous and discrete signals, Fourier analysis, single time constant circuits, transient and steady state analysis, basic amplifier concepts
2. The operational amplifier (ideal model, feedback, large and small signal operation and associated models, DC imperfections, frequency effects, applications)
3. Metal-Oxide Field-Effect Transistors (biasing, small and large signal models), current mirrors, MOS integrated circuit amplifiers, active loads, VLSI Fabrication, MOS differential amplifiers
4. Amplifier stability (effects of feedback, gain and phase margins, frequency compensation)
5. CMOS operational amplifier design
6. Hysteresis, sinusoidal oscillators and multivibrators, timers, nonlinear waveshaping
7. Noise in electronic circuits

Course/Laboratory Schedule: Three 50 minute lectures, one 3 hour lab

Evaluation:

1. Examinations (60%) 2. Laboratory (30%) 3. Homework (10%)

Laboratory Projects:

1. Laboratory Safety and Equipment Familiarization (1 week)
2. Passive Bandpass Filter Design (1 week)
3. Active Bandpass Filter Design (1 week)
4. Transfer Functions, Parameters, and Equivalent Circuits of Linear Amplifiers (3 weeks)
5. Operational Amplifiers Imperfections and Applications (Experiment #2 in [Smith, 1998])(1 week)
6. MOSFET Measurements and Applications (Experiment #5 in [Smith, 1998]) (1 week)
7. CMOS Op Amps (Experiment #10 in [Smith, 1998])(2 weeks)
8. Oscillator Circuits (1 week)
9. Frequency Compensation of an Operational Amplifier (computer experiment)

Computer Usage:

Students extensively use electronics circuit simulation software in laboratory preparation assignments. Mathematics software packages are used in homework and laboratory assignments.

Contribution to Professional Component:

ABET professional component content as estimated by faculty member who prepared this course description:

Engineering Design: 1 credit or 33.3% Engineering Science: 2 credits or 66.7%

Relation of Course to Program Outcomes:

This course provides significant support for:

EE program objectives: Depth

ECE expected learning outcomes: b and d.

Person who prepared this description and date of preparation:

Prepared by: Damon A. Miller Date: 14 February 2007