Instructor: Homer Nazeran PhD, CPEng (Biomed.)
Office: A338, Office Hours Tuesdays and Thursdays: 10:30 AM – 11:30 AM
Other times by prior email appointment ONLY. Email: EE3340@gmail.com

Theoretical Support
Sedra/Smith, Microelectronic Circuits, Sixth Edition, Oxford University Press, 2010
Nazeran H., Lecture Notes, Dept. of ECE, Univ. of Texas at El Paso

Course Outline
- An overview of amplifiers as versatile analog signal processing and conditioning building blocks (loading, impedance matching, gain and frequency response, complex plane or s-plane analysis and Bode plots)
- Feedback theory, feedback circuits, stability of amplifiers, oscillator circuits
- Analysis and design of amplifiers and application circuits using OP-Amps
- Active filter design
- An overview of what is inside the OP-Amp (Analysis and design of current sources and differential amplifiers using transistors)

Prerequisites: EE 3338 (Electronics I) with a grade of “C” or better.

Course Grading
Exams: A total of 4 Exams (3 In-class and 1 modular Final, 15% each). Lower of the In-class Exams I or III grades will be dropped. No make-up exams will be granted. No EXCEPTIONS! Please refer to the EE 3340 Timetable (below) for Exam dates. 45%

Homework – (Exercises from Sedra & Smith. Note: Full marks will be granted to manual solutions that are verified by computer simulations for Homework problems shown in Bold). Homeworks will be fully recorded in Student Journals! 20%

In-Class Activities and Professional Behavior
Doing the in-class Exercises, participation in class problem-solving, questions and answers, demonstration of a positive, collaborative, and professional attitude, inter- and intra-team interactions, regular and punctual attendance, attention to details, etc. 10%

Design Project - This will be formulated and assigned to students by mid-September: Simulation, Testing, Validation and Formal Report. 20%
Each team (typically comprised of 3 students) will thoroughly and comprehensively research the latest literature regarding The Design Project and do its best to find a creative and feasible solution. They will also research all related subtopics on the methods and techniques as well as the technological advancements relevant to the Design Project. They will present their findings and will incorporate these in their own designs and implementations.

Student Tutorial Presentations (End-of-Chapter Problems from Sedra & Smith and Stanley)- Each team will be given a number of problems from the textbook to research, solve, simulate and present in class. Professional quality presentation material, documentation, high quality research,
teamwork and professional presentation are required. Problems will be assigned on a random basis. Please refer to EE3340 Timetable for student presentation dates. 5%

Grading Scale:  90-100% → A, 80-89% → B, 70-79% → C, 60-69% → D, 0-59% → F

Course Outcomes
1. Apply the concepts of loading, impedance matching, gain and frequency response in electronic circuit design and analysis
2. Perform s-plane and frequency response analysis of electronic circuits using Bode plots (amplitude and phase)
3. Understand the feedback theory and apply it to analyze and design feedback circuits and electronic oscillators
4. Analyze and design application circuits using Op Amps
5. Analyze and design active filters using Op Amps
6. Analyze and design current sources and differential amplifiers using transistors (What is inside the Op-Amp)
7. Develop an appreciation for team work, ethical and professional behavior as well as effective communication skills

Project-Based Learning Approach
The main objective of this course is to assist ECE students in learning the fundamentals of Electronics II by integrating knowledge acquired from Electronics I and Electric Circuits courses using the Project-Based Learning approach.

Students will use the Design, Simulation, Testing and Validation of the assigned Design Project for learning and applying the content of this course.

To achieve our objective and address different aspects of The Design Project, the course is organized in a fashion to guide student learning activities centred around computer-aided design supplemented and enhanced with:
1. Theoretical support (lecture material and tutorials) from the required textbook and related references;
2. Student reading and research (available from textbooks, magazines and journals in Electronics, library and internet resources);
3. Student presentations of topics related to the generalized requirements of a signal generator (oscillator); analog signal processing and conditioning circuitry using feedback to amplify and shape the generated signals; active filters to select desirable frequency bands of the generated signals.
4. Preparation of professional-grade presentations and technical report and on all aspects of the Design Project.

Student Review and Research Topics
To complete the Design Project students will carefully study assignments from the required textbook, other relevant textbooks, magazines, journals, as well as Internet and library resources and perform research on the following topics:

• Generation of signals using electronic circuits.
• Analog signal conditioning and processing circuitry.
• Mixing signals using electronic circuits.
• Filtering signals using active filter circuits, etc.
**Student Learning Activities**

Student learning activities are focused on team design, electronic circuit modeling and simulation work. Students will have an opportunity to observe demonstrations on different possible implementations of the same Design Project.

**Specific Course Learning Goals:** At the completion of this course students will:

**Foundational Knowledge**
- Gain good working knowledge of: Impedance matching; Transfer function, gain and frequency response of electronic circuits; Bode plots as useful visualization tools for characterization of electronic circuits in the frequency domain; Feedback theory, negative and positive feedback concepts; Electronic circuits using feedback networks; Simple electronic oscillator circuits; Operational amplifier circuits; Active filters using Op-Amps; Bridge amplifiers; Instrumentation amplifiers, and biopotential amplifiers.

**Application**
- Be able to find information on linear circuits; Analyze, design, simulate, build and carryout performance testing of electronic circuits for a variety of applications in industrial, entertainment, communications, military and biomedical fields.
- Be able to apply feedback theory to analyze and design a variety of application circuits using Op-Amps.
- Be able to use PSpice, LabView, Matlab and/or other application software of their choice for computer aided design of Op-Amp-based application circuits.

**Integration**
- Be able to integrate knowledge acquired in different parts of this course to design and analyze linear electronic systems for different applications.
- Be able to explain the interaction between different subsystems in an electronic system and how the electrical characteristics of one subsystem influence the performance of other subsystems.
- Identify the role of linear circuits in modern instrumentation; Understand the interactions between linear circuits and digital circuits; Understand the role of linear circuits in interfacing and intelligent instrumentation, and so on.

**Human Dimension**
- Develop an appreciation for ethical and professional behavior as well as effective communication methods.
- Be able to interact positively and effectively with team members in class and outside class in generating feasible solutions to linear circuit problems.
- Be able to intelligently and knowledgeably engage in discussion of linear electronics with other colleagues and communicate effectively with other professionals in the field.

**Caring**
- Become interested in linear electronic circuits used in different courses (EE4210, EE4220, EE4230, EE4341, EE4350, EE4352, EE4356, EE4364, EE4385, etc.) and specialized fields such as entertainment devices, household devices, communication systems, control systems, military systems, medical instruments, etc.

**Learning How to Learn**
- Be able to interpret the significance of linear circuits in the front end of modern instruments.
• Be able to understand and use related information from textbooks in linear electronics, popular electronic magazines, Internet resources, manufacturers’ data sheets, and so on.
• Develop some specific ideas for designing novel and cost-effective linear circuits for future courses and job assignments.

Theoretical Support
The following topics will be presented to provide theoretical support for finding a feasible solution to the Design Project:

Reviews: Electric circuit analysis; Transistor circuit analysis. (HN Lecture Notes)

Amplifiers and frequency response Amplifier models, loading, impedance matching, cascading; Current, voltage, and power gain calculations in Amplifiers; Frequency response of Amplifiers; Bode Plots (magnitude plot and phase plot) (Sedra/Smith Chapter 1, Appendix F, and/or HN Lecture Notes)

Feedback theory, circuits and oscillators Effects of feedback on gain, reduction of nonlinear distortion, input and output impedances, feedback circuits, practical feedback circuits, transient and frequency response, effects of feedback on pole locations, stability of amplifiers, oscillator principles, the Wien-bridge Oscillator (Sedra/Smith Chapter 10 and/or HN Lecture Notes and/or Hambley: Chapter 9), phase-shift oscillator, Op-Amp implementation (Sedra/Smith Chapter 17 Section 17.1 and 17.2; HN lecture Notes; Stanley: Chapter 7, pp: 339-342)

Operational amplifiers and application circuits as versatile linear IC building blocks (overview) Ideal Op Amps, inverting, noninverting, differential, instrumentation amplifiers; comparators, rectifiers, log amplifiers, integrators, differentiators, active filters, frequency response, input & output resistance, non-ideal consideration in Op Amp circuits, practical considerations; Differential amplifiers, instrumentation amplifiers, sensing and measuring with the instrumentation amplifier, bridge circuit amplifiers (Sedra/Smith Chapter 2 and/or HN Lecture Notes)

Active filter design Active low-pass, high-pass, band-pass and band-reject filters, (HN Lecture Notes and/or Stanley: Chapter 8, pp: 361-412, Sedra/Smith Chapter 16).

What is inside the Op-Amp Current sources, current mirrors, Widlar current source; Wilson current source; Current sources as active loads; Differential amplifiers (DC transfer characteristics); Common-mode and differential-mode gains; Differential amplifier with constant-current source; Differential amplifier with single-ended input and output; Differential amplifier circuit analysis; Op-amps as integrated circuits (HN Lecture Notes and/or Hambley Chapter 7; Sedra/Smith Chapters 7, 8 – Sections 7.4.1, 7.5.2, 7.5.3, 8.3).

CLASSES:
TR 9:00 AM – 10:20 AM Theoretical Support/Student Tutorials/Exams Education 301. For details see EE 3340 Timetable.

Academic Dishonesty:
As an entity of The University of Texas at El Paso, the Department of Electrical and Computer Engineering is committed to the development of its students and to the promotion of personal integrity and self-responsibility. The assumption that a student’s work is a fair representation of the student’s ability to perform forms the basis for departmental and institutional quality. All students within the Department are expected to observe appropriate standards of conduct. Acts of scholastic dishonesty such as cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in the whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student, or the attempt to commit such acts will not be tolerated. Any case involving academic dishonesty will be referred to the Office of the Dean of Students. The Dean will assign a Student Judicial Affairs Coordinator who will investigate the charge and alert the student as to its disposition. Consequences of academic dishonesty may be as severe as dismissal from the University. See the Office of the Dean of Student's homepage at www.utep.edu/dos/acadintg.htm for more information.

American Disabilities Act:
If you feel you may have a disability that requires accommodations, contact The Center for Accommodation and Support Services at 747-5148 or http://sa.utep.edu/cass/ or go to Room 106E Union.

Attendance: Absence in more than 6 classes for any reasons will result in an automatic drop from the course!

Course Drop Deadline: Please Carefully Check UTEP Fall 2015 Calendar for last day to drop this course.
<table>
<thead>
<tr>
<th>Day, Date</th>
<th>Theoretical Support/Tutorials</th>
<th>Assignment before attendance</th>
<th>In-class Activity</th>
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<tbody>
<tr>
<td><strong>Module I: Review of Foundations and Some Analytical Tools</strong></td>
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<tr>
<td>T, Aug 25, 2015</td>
<td>Electric Circuit Analysis - Review</td>
<td>EE 1305 Intro. to EE</td>
<td>Do Examples (HN Notes) Record in Student Journal</td>
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<tr>
<td>R, Aug 27, 2015</td>
<td>Transistor Circuit Analysis - Review</td>
<td>EE 3338 Electronics I</td>
<td>Do Example (HN Notes) Simulate Record in Student Journal</td>
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<tr>
<td>T, Sep 1, 2015</td>
<td>Amplifier Models</td>
<td>S/S, pp. 14-30</td>
<td>Do Exercises S/S (1.10, 1.11), Record in Student Journal</td>
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<tr>
<td>T, Sep 8, 2015</td>
<td>Bode Plots</td>
<td>HN Notes; S/S Appendix F on DVD</td>
<td>Do Problems S/S (F.10, F.11), Simulate, Record in Student Journal</td>
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<tr>
<td>R, Sep 10, 2015</td>
<td>Student Tutorial Presentations</td>
<td>S/S Problems (P1.40, P1.41, P1.45, P1.67, P1.69, P1.76)</td>
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<tr>
<td><strong>Module II: Feedback Theory, Amps with Feedback, Practical Feedback Amps, Stability, Oscillators</strong></td>
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<td>T, Sep 29, 2015</td>
<td>Ideal and Practical Feedback Topologies</td>
<td>HN Notes: Tutorial on Feedback Circuits and/or S/S, pp. 823-863</td>
<td>Do Examples S/S (10.3, 10.7), Record in Student Journal</td>
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<tr>
<td>T, Oct 6, 2015</td>
<td>Oscillators I, Worked Examples</td>
<td>S/S, pp. 1334-1345, HN (Notes)</td>
<td>Do Exercise (17.3) Simulate, Record in Student Journal</td>
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<td><strong>Review Student Journal and Practice, Practice, Practice Exercise and End-of-Chapter Problems</strong></td>
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<tr>
<td>R, Oct 15, 2015</td>
<td><strong>Feedback &amp; Oscillators</strong> Prepare well Submit Journal Take Exam II</td>
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<tr>
<td>T, Oct 20, 2015</td>
<td>Operational Amplifiers 1 &amp; 2 S/S, pp. 52-75; 80-88; 89-107 Submit a 1-page summary of the Design Project (5PM); Do Exercises S/S (2.9, D2.11, 2.12, 2.13, D2.19, 2.24), Simulate, Record in Student Journal</td>
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<tr>
<td>T, Oct 27, 2015</td>
<td>Active Filter Design 1 Stanley Chapter 8 Do Stanley’s End-of-Chapter Problems (8.17, 8.21), Simulate, Record in Student Journal</td>
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<tr>
<td>R, Oct 29, 2015</td>
<td>Active Filter Design 2</td>
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<tr>
<td>T, Nov 3, 2015</td>
<td>Active Filter Design 3 &amp; 4 Stanley Chapter 8 Do Stanley’s End-of-Chapter Problems (8.35, 8.37, 8.39), Simulate, Record in Student Journal</td>
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<td>R, Nov 5, 2015</td>
<td><strong>Student Tutorial Presentations</strong> Stanley Problems (8.17, 8.21, 8.33, 8.35, 8.37, 8.39) Review Student Journal and Practice, Practice, Practice Exercise and End-of-Chapter Problems</td>
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<tr>
<td>T, Nov 10, 2015</td>
<td><strong>Op Amp-based APP Circuits &amp; Active Filters</strong> Prepare well Submit Journal Take Exam III</td>
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<tr>
<td>R, Nov 12, 2015</td>
<td>Current Sources 1 S/S, pp. 532-537 Submit a Block Diagram for the Design Project (5PM); Do Exercises S/S (7.17, D7.18), Record in Student Journal</td>
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<tr>
<td>T, Nov 17, 2015</td>
<td>Current Sources 2 S/S, 539-542; 543-546 Do Exercises S/S (7.21, 7.22), Record in Student Journal</td>
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<tr>
<td>T, Nov 24, 2015</td>
<td>Term Project – No Class Project Completion, Testing and Simulation</td>
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<td>R, Nov 26, 2015</td>
<td>Thanksgiving Holiday!</td>
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<td>T, Dec 1, 2015</td>
<td>Differential Amplifiers 2 S/S, pp. 621-628 Submit Individual Project Report (5 PM); Do Example 8.4, Record in Student Journal</td>
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<tr>
<td>R, Dec 3, 2015</td>
<td>Term Project Present Design Project, Submit Journal</td>
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<tr>
<td><strong>Review Student Journal and Practice, Practice, Practice Exercise and Example Problems</strong></td>
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The Design Project

This is a very important part of this Project-Based Learning course. Finding the most feasible and practical solution(s) to the Design Problem requires research, teamwork, coordination and creativity. This component serves as an integral activity to all aspects of the course. A realistic Design Project will be formulated early on this semester. Successful Completion of the Design Project will provide the students with the opportunity to integrate all the essential concepts in Electronics II and will produce an enhancing and meaningful learning experience for them. This will enable students to bring life to their creativity and problem solving skills. Team members will work in a very coordinated and organized manner to research possible approaches, they will then discuss these and form consensus on the best design(s). Teams will prepare and submit a 1-page summary of their original design idea based upon their research and team discussions. After this submission, teams will prepare a Block Diagram for their Design Projects. Students will have several weeks to simulate, test and validate their solution(s) using their preferred computer-aided circuit modeling and simulation program(s). Towards the end of the semester, teams will present their complete solution(s) to the Design Project in class, and each team member will submit a professional-grade individual report on the Design Project as LastnameFirstInitial.DP.Report.pdf. (For example my submission would be NazeranH.DP.Report.pdf). These submissions will be emailed to EE3340@gamil.com before 5 PM on Tuesday 1 December 2015. Late submissions will incur 50% grade reduction!

Teams will have an opportunity (for a 15% bonus if they choose to do so) to construct appropriate electronic circuitry. (This additional 15% will replace the second lower grade in the Exams I or III!)

Exams

Four Exams with equal weights (15% of total course grade each) constitute 45% of your final grade. The lower grade in Exams I or III will be dropped. No make up Exams will be granted for any reason. No exceptions!

Each exam is based on a module of concepts, exercises, examples, and problems. It goes without saying that regular and timely studies are extremely important for success in these exams and in this course. Students must allocate a minimum of 6 hours/week to study and practice for this course. Exams are closed book and closed notes. Necessary charts or in some cases formulas and circuit diagrams will be provided. Students are allowed to use a non-programmable calculator with cleared memory during these Exams.

Homework and In-Class Activities

Homework: All listed Exercises and Examples from the Textbook as well as some End-of-Chapter problems from Stanley (on Active Filter Design) are considered as Homework. These Exercises, Examples and End-of-Chapter problems (as well as their selected simulations) will be graded at the end of the semester for 20% of your total grade. At the end of each Module, Student Journals will be collected from students before taking the Exam in that respective Module, and checked for timely progress and completion. Please see EE 3340 Timetable for due dates!
In-Class Activity and Professional Behavior: This component of assessment, which constitutes 10% of your final grade, includes doing the in-class Exercises and Examples, participation in class problem-solving, questions and answers, demonstration of a positive, collaborative, and professional attitude, inter- and intra-team interactions, regular and punctual attendance, attention to details, etc. All members of each team will work collaboratively to find the best solution to each assigned problem during the allocated time in class (please see EE3340 Timetable for assigned problems for each session). Each student will record the solution to these problems in the scratch portion of his/her Student Journal and ask any questions before leaving the class. Students will then prepare a neat version of these solutions along with computer simulations for the problems shown in bold and submit for assessment at the completion of each Module before taking the Exam in that Module. For due dates please refer to your EE3340 Timetable.

Please Note: Homework problems are selected to support and enhance student teamwork, learning, and group discussion with the objective to help prepare students for the Exams. (It is strongly recommended that students solve example, exercise, and end-of-chapter problems in the textbook, references, and lecture notes and record their solutions in their Journals for their ease of review and maximum benefit.)

Attendance: Absence in more than 6 classes for any reasons will result in an automatic drop from the course!

Student Tutorial Presentations (STPs)
Students will be grouped into teams comprised of 3 (or 4) members. Each team will be assigned one or more End-of-Chapter problem(s) from Sedra and Smith and Stanley on a random basis to solve and simulate (and implement in hardware and demonstrate if they wish for extra credit - 5% of total grade) and present in class on the assigned dates. Please refer to EE3340 for presentation dates.

On presentation day:
- During student tutorial presentation periods, the presenting team will clearly define the assigned problem and then meticulously discuss its solution (manual and computer-aided for 8 min) and will be fully prepared to answer any questions. All students will then check their solutions against what is presented and ask questions and discuss (6 min). It is important that you understand the presenters’ approach and solution. Challenging your classmates will help their learning and is important for their professional development. It will also help you understand the problem better and improve your performance in the exam.

Before presentation day:
- Each team member of the presenting team will carefully study the assigned problem(s) and come up with a solution independently of other members.
- Team members will share their thoughts, ideas, solutions, simulations, etc. and will agree on the best method.
- Each team could consult with the Instructor to discuss the team’s solution if the team needs advice or help. (In that case, please make an email (EE3340@gmail.com) appointment to see HN during office hours at least 48 hours before your presentation day. No team will be assisted on their presentation day!)
• Each team will prepare a professional-grade and high quality PowerPoint for presenting their solutions and simulations to the class. (You could make use of any appropriate software to prepare your solution, simulation and presentation material.)

• After presenting in class, the presenting team will submit an electronic copy of the presented material with the names of all team members and their contributions (who did what) to EE3340@gmail.com before 5 pm on the presentation day for assessment. Submissions after 5 pm will incur a reduction of 50% of the allocated grade.

Assessments

Gradig Policy: 60% of full grade is allocated for correct approach and steps. 40% of full grade is allocated for correct answer(s) and solution(s).

Questions or concerns about student grades and performance will not be discussed in class. Such questions and concerns are to be discussed in a meeting during office hours! Please make an email (EE3340@gmail.com) appointment at least 1 day in advance.

Any questions or concerns about the course and class progress will be discussed with class representatives in a meeting during office hours.

Dropping the Course

As you are aware according to the rules, each undergraduate student is allowed to drop a maximum of 6 courses. To avoid any complications, if you have to drop this course, make sure you do it before the drop day. (NOTE: Check your Fall 2015 Course Schedule for the last day to drop courses.) If by this day, you have an average of less than 50% in your Exams and have not completed your Homeworks, it is advisable that you drop the course.

BEST WISHES & HAPPY LEARNING!