

EE 427 Computer Aided Circuit Design

Credits: 3

Categorization of credits: engineering topic

Instructors or course coordinator: Vinod Malhotra

Textbook and Other Required Materials:

Text: B. Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw-Hill, 2001.

Reference: Allen and Holberg, *CMOS Analog Circuit Design*, Oxford University Press, 2002.

Designation: Elective

Catalog Description:

EE 427 Computer-Aided Circuit Design (3) Application of the computer to the analysis, design, simulation, and construction of analog circuits and digital circuits. Pre: 326 and 326L, or consent. DP

Prerequisites: EE 326 and EE 326 L

Class/Lab Schedule: 3 lecture hours per week

Topics Covered:

- Review (1 hrs)
- MOS device physics (3 hrs)
- Short channel effects/CMOS processing technology (4 hrs)
- Single stage amplifier (5 hrs)
- Differential amplifier (5 hrs)
- Passive and active current mirrors (4 hrs)
- Frequency response and feedback (4 hrs)
- Op amps (6 hrs)
- Introduction to switched capacitor circuits (2 hrs)
- Student oral project presentation (variable)

Course Objectives and Their Relationship to Program Objectives:

The students learn the fundamental principles, analysis, and design of MOS analog integrated circuits. Learn computer aided techniques in the design of analog integrated circuits. Throughout the course, the students use software tools (such as Cadence) to do homework and projects. To develop intuition with analog circuits, whenever possible, the students are encouraged to first analyze circuits by inspection followed by validation of their results with computer simulation. There is a substantial

Course Outcomes and Their Relationship to Program Outcomes:

The following are the course outcomes and the subset of Program Outcomes (numbered 1-7 in square braces "[]") they address:

- Understand MOS physics and technology [1]
- Understand concepts related to device scaling and accompanying changes in device performance [1]
- Learn Cadence and other software tools for circuit design and analyses [1].
- Design single stage and differential amplifiers that meet realistic specifications [1, 2, 6]
- Group design projects, and oral and written presentations [1, 3, 5, 6]

Computer Usage:

Computer usage for this class is necessary and essential. Software tools (such as SPICE/Cadence) are used to verify analyses/concepts and to design circuits in homework problems and projects.

Design Credits and Features:

EE 427 has 1.5 design credits.

Person Preparing Syllabus and Date: V. Malhotra, May 2009. Revised Nov. 2014. Modified by A. Ohta, Jan. 20, 2021.

EE 435, Electric Power Systems

Credits: 3

Instructor: Matthias Fripp, Holmes 446, Phone: 956–3795, E-mail: mfripp@hawaii.edu

Textbook: *Power System Analysis and Design*, 5th ed., Glover, Sarma and Overbye

Designation: Elective

Catalog Description: This course is an introduction to the analysis and operation of electric power systems. It covers the history of electric power systems and the electricity industry; basics of AC analysis (phasors, three-phase power, real and reactive power); electrical properties of the main circuit elements (power transformers, transmission lines, distribution networks); load flow analysis; frequency control; optimal power flow; and renewable energy integration.

Prerequisites/co-requisites: MATH 243 or MATH 253A

Grading: 20% Mid-term I; 20% Homework; 20% Mid-term II; 10% Class participation (including online); 30% Final Exam

Course designation: Elective (systems or electrophysics track)

Course objectives and their relationship to program objectives: After completing the course, students will be able to participate in operating and adapting Hawaii's power system, including addressing the challenges of adopting large amounts of renewable power [contributes to program objectives 1, 2, 4]. They will also be prepared for more advanced study of power system operation and design [program objective 3].

Course outcomes and their relationship to program outcomes: After completing the course, students will be able to complete the following tasks (numbers in square brackets identify related program outcomes):

- Distinguish between vertically integrated and restructured electric utilities and identify factors that led to these business models. [3, 6, 8, 10]
- Identify key advantages of 3-phase AC power over DC. [1, 3, 8]
- Convert between sinusoidal values and phasor equivalents and analyze three-phase circuits using phasors and per-phase techniques. [1]
- Calculate voltage and current flows in circuits containing ideal and practical transformers, via per-unit or impedance referral techniques. [1, 2, 5]
- Calculate resistance, inductance and capacitance of transmission lines per unit of length. [1, 2, 3, 5]
- Use short, medium and long-line models to calculate transmission line voltage and current relationships and load limits. [1, 2, 3, 5]
- Write nodal equations for network power flow and use iterative methods and power flow software to solve them. [1, 5, 11]
- Calculate generator response to frequency excursions and estimate the generation adjustments needed to restore frequency. [1, 2, 5, 11]
- Perform security-constrained economic dispatch for a multi-generator system. [1, 3, 5, 8,

11]

- Distinguish between transmission and distribution networks and calculate ratings and reliability indices for distribution networks. [1, 2, 3, 5, 11]
- Identify the key challenges and mitigation measures for renewable energy integration. [1,3, 5, 6, 8, 10]
- Write clear and accurate solutions to power system engineering problems. [1, 5, 7, 11]

Contribution of course to meeting the professional component:

Math & Basic Sciences: 25%

Engineering Topics: 60%

General Education: 15%

Design credit: EE 435 has 0.25 design credit. About 10% of the assignments focus on choosing appropriate equipment and settings to achieve desired technical or environmental objectives.

Lectures will focus on the context, motivation and intuition for the main concepts, but you will need to read the textbook and complete the homework assignments to develop your mathematical understanding and analytical expertise. You should plan to spend 6-9 hours per week on this class in *addition* to attending lectures. Lecture slides will be handed out in class. Lecture slides and recordings will also be available on the Piazza website (see below).

Course Outline

# of hours(approx.)	Topic
2	Chapter 1: History and trends in the electric power system
4	Chapter 2: Fundamentals – phasors, instantaneous and complex power, network equations, balanced three-phase circuits
5	Chapter 3: Power Transformers – representation of ideal and practical transformers, per-unit system
5	Chapter 4: Transmission Line Parameters – resistance, stray conductance, inductance and capacitance (4.7, 4.11, and 4.12 can be skimmed)
3	Chapter 5: Transmission Line Operation – approximations, differential equations, equivalent π circuit, lossless lines, constraints, reactive compensation
8	Chapter 6: Power Flows – the power flow problem, solution methods, control of power flow, fast decoupled power flow, “DC” power flow
5	Chapter 12: Power System Controls – maintaining balance between supply and demand, at the lowest cost
4	Chapter 14: Power Distribution – delivering power from the transmission network to the customer
2	Wind & solar power – integrating intermittent power sources

This course focuses on planning and operation of the power system to avoid failures. You are advised to study chapters 7–11 & 13 independently to learn about system behavior and protection during faults.

(Note: For brevity, this ABET syllabus omits the following sections which are included in the student syllabus: homework, exams, calculators and on-line class discussions.)