MAE 140
Linear Circuits

Designation: Required course

Catalog Data:
MAE 140 Linear Circuits (4)

Steady-state and dynamic behavior of linear, lumped-parameter electrical circuits. Kirchoff's laws. RLC circuits. Node and mesh analysis. Operational amplifiers. Signal acquisition and conditioning. Electric motors. Design applications in engineering.

Prerequisites: Admission to the engineering major and grades of C- or better in Phys 2B, Math 20D and Math 20F.

Textbook, Required Materials: Thomas and Rose, The Analysis and Design of Linear Circuits, 2nd edition, John Wiley & Sons, 1998.

Prerequisites by topic: Integral and differential calculus, differential equations, basic physics of electricity, matrix algebra.

Class/Laboratory Schedule: 4 lecture hours per week

Course topics:
1. Circuit variables, units, symbols
2. Ideal elements - resistor, switch, voltage source, current source, capacitor, inductor
3. Kirchoff's laws
4. Elements in series and parallel, wye and delta
5. Nodal analysis; mesh analysis
6. Properties of linear circuits - proportionality, superposition
7. Thevenin and Norton equivalent circuits
8. The operational amplifier (OP-AMP), analysis and design of circuits using OP-AMPS
9. Signal conditioning: offset removal, scaling, anti-aliasing
10. Signal acquisition by analog-to-digital converter
11. Deriving and solving linear, constant-coefficient, ordinary differential equations of electrical circuits subject to known inputs and initial conditions
12. Electric motors

Course objectives:
(Numbers in parenthesis refer to the specific MAE Program Outcomes)

Objective 1: To teach students the basic principles underlying the dynamics of linear electrical circuits (1a, 11k).

Objective 2: To train students to formulate and solve the equations describing electrical circuits (1a, 5e, 11k).

Objective 3: To introduce students to active circuits and to provide them with an understanding of their application to signal conditioning and acquisition (1a, 3c, 5e, 11k).

Objective 4: To acquaint students with the rudiments of electrical-to-mechanical energy conversion via motors (1a, 11k)

Methods of evaluation:
1. Homework will be regularly collected and graded.
2. Exams

Performance criteria:
(Numbers in parentheses refer to the methods of evaluation used to assess student performance.)

Objective 1
1.1 Given a resistance circuit with dc inputs, students should be able to define a set of circuit variables, and to formulate the algebraic equations which describe the circuit. (1,2)
1.2 Given a dynamic circuit with time-varying inputs, students should be able to define a set of circuit variables, and to formulate the differential equations which describe the circuit. (1,2)

Objective 2
2.1 Given a resistance circuit with dc inputs, select an appropriate analysis technique and find the circuit response. (1,2)
2.2 Given a dynamic circuit with time-varying inputs, select an appropriate analysis technique and find the circuit response. (1,2)

Objective 3
3.1 Students will demonstrate an understanding of the design of active circuits using operational amplifiers and an appreciation of the signal conditioning properties required for digital acquisition. (1,2)

Objective 4
4.1 Students will demonstrate an understanding of the types and properties of electric motors and some appreciation of their applications. (1,2)

Contribution of Course to Professional Component:
Engineering Science

Syllabus prepared by: Alan Schneider, March 2000. Modified by Robert Bitmead, April 2000.

Last Revised: Miroslav Krstic and Robert Bitmead, April 2008 via Teaching Work Group Meeting