Spring 2021

# EE 201 CIRCUIT THEORY I

**Instructors**
Section 1: T. EnginTuncer (Office: E-109) office hour: Friday 9:30-10:30
Section 2: İsmet Erkmen (Office: D-124) office hour: Friday 9:30-10:30

**Reference Texts**
1.Fundamentals of Electric Circuits, C. K. Alexander and M. N. O. Sadiku, McGraw-Hill Book Company.
2.Electric Circuits, J. W. Nilsson and S. A. Riedel, Pearson Prentice Hall.
3 Linear and Nonlinear Circuits. L O Chua, C. A. Desoer, E. S Kuh, McGraw-Hill Book Company.

**Grading:** Midterm 1 25%, Midterm 2 30%, Final 40%, Attendance 5%

**Requirement for Final Exam:** Each student should take "all" the midterm examinations and the midterm average should be 20 or more. Attendance to course should be above %30. Those who do not satisfy these criteria will be graded as NA.

**Course Outline**
**I. Basic Concepts (8 Hrs.)**

**1.Introduction**
Electric components/devices and electric circuits; circuit variables, units. Analysis and design. Modeling, model elements and model circuits.
**2.Lumped Elements and Lumped Circuits**
Current, Kirchhoffs Current Law (KCL), current equations Voltage, Kirchhoffs Voltage Law (KVL), voltage equations. Terminal equations, schematic representations, branch representation. Composite elements. Branch voltage and branch current. Power and energy. One-port and multi-port circuits
**3.Interconnection Equations, Circuit Graphs, Circuit Matrices.**
Independent current and independent voltage equations. Tellegen's Theorem. Duality.
**4.Basic Lumped Elements and Waveforms.**
Independent voltage and independent current sources. Linear/nonlinear and time-invariant/time-varying relations. Resistors, capacitors, inductors. Source transformations. Voltage or current dependent voltage and current sources. Ideal transformers, coupled inductors. Classification of elements: resistive/dynamic, linear/nonlinear, time-invariant/time-varying, passive/active elements. Dual elements and dual circuits.
**5.Circuit Analysis**
Classification of circuits: resistive/dynamic, linear/nonlinear, time-invariant/time-varying, passive/active circuits. Circuit equations with input and outputs, circuit variables. Solution of circuit equations. Substitution Theorem .

**II. Linear Time-Invariant Resistive Circuits (12 Hrs.)**

**1.Linear Time-Invariant (LTI) Resistive Elements**
LTI resistors; series and parallel connections; delta-wye transformation. LTI dependent sources Ideal transformers.
**2. Analysis Methods**
Node, modified node and mesh analysis methods. Linearity and time-invariance; superposition.
**3. One-Port Circuits**
Input resistances of LTI one-ports. Thevenin/Norton equivalent circuits. Maximum power transfer
**4. Two-Port Circuits**
Resistance, conductance, hybrid and chain parameters. Reciprocity.

**III. Time-Varying and Nonlinear Resistive Circuits (4 Hrs.)**

**1. Linear Time- Varying Resistive Elements and Circuits**

**2.Nonlinear Resistive Elements and Circuits**

Analysis of resistive circuits with a single nonlinear resistor; load line. SmaII-signal analysis.

**3. Piecewise-Linear Resistive Circuits**

Analysis and design of one-ports composed of ideal diodes, sources and LTI passive resistors.

**IV. Operational Amplifier Circuits (6 Hrs.)**

**1. Operational Amplifiers**

Finite-gain/infinite-gain ideal operational amplifier (op-amp) models.

**2.Basic Op-Amp Circuits**

Buffer circuit; inverting and noninverting amplifiers. Feedback, stability. Summing and difference amplifiers.

**3.More Realistic Op-Amp Models**

Input and output resistances; common-mode-rejection-ratio.

**4.Miscellaneous Resistive Op-Amp Circuits**

Circuits with one or more op-amps, with or without nonlinear resistors.

**V. Dynamic Elements (6 Hrs.)**

**1.Ramp, Step and Impulse Functions**

**2.Capacitors**

LTI capacitors; initial condition models; series and parallel connections; delta-wye transformation. Simple circuits composed of LTI passive capacitors, independent sources and/or switches. Time-varying and nonlinear capacitors.

**3. Inductors**

**VI. First Order Circuits (12 Hrs.)**

**1.First Order Linear Differential Equations with Constant Coefficients**

Homogeneous solution; exponential function, bounded/unbounded solutions. Particular solution. Complete solution. Zero-input and zero-state solutions. Linearity and time-invariance of solutions. Convolution integral.

**2 Simple LTI RC Circuit**

Natural response; natural frequency, bounded/unbounded responses. Forced response; responses to constant and sinusoidal excitations. Transient and steady-state responses. Step, pulse, ramp, and impulse responses.

**3.Simple LTI RL Circuit**

**4.Analysis of Miscellaneous LTI First Order Circuits**

Circuits with one or more dynamic elements with or without switches.

**5.Piecewise-Linear First Order Circuits**

**6 Time-Varying and Nonlinear First Order Circuits**

**VII. Simple Second Order Circuits (6 Hrs.)**

**1.Second Order Linear Differential Equations with Constant Coefficients Homogeneous solution**; Bounded/unbounded solutions; Overdamped , critically damped, underdamped and lossless cases. Particular solution. Complete solution. Zero-input and zero-state solutions. Linearity and time-invariance of solutions. Convolution integral.

**2. Parallel LTI RLC Circuit**

Second order differential equation formulation. Natural response; natural frequencies, bounded/unbounded responses.Forced response; responses to constant and sinusoidal excitations, Transient and steady-state responses.Step and impulse responses.

**3.Series LTI RLC Circuit**

**4.Miscellaneous Simple Second Order Circuits**