Spring 2021/22

Middle East Technical University
Electrical and Electronics Engineering Department

EE 202
CIRCUIT THEORY II

Instructors

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Section 2: Emre Tuna,	E-113,	web page
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Section 4: Melda Yüksel Turgut,	D-112,	web page
Section 5: Eren Balevi,	C-103,	web page
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Reference Texts

- Fundamentals of Electric Circuits, C. K. Alexander and M. N. O. Sadiku, McGraw-Hill, 2016.
- Chua, L. O., Desoer, C. A., & Kuh, E. S. (1987). Linear and Nonlinear Circuits.

Lecture Notes/Videos

- EE 202 Circuit Theory II, Emre Tuna, https://odtuclass.metu.edu.tr.

Lectures and Office Hours

All lectures will be face to face unless otherwise is announced on ODTUCLASS. Please consult with your section instructor for office hours.

Grading

Two midterm examinations (30% each) and final examination (40%).

Final Examination Policy

A student

i. missing any midterm examination without a valid excuse,
ii. having an average of less than 20 over 100 in two midterm examinations

will not be admitted to the final examination and will receive the NA grade.

Make-up Examination Policy

A make-up exam compensates for a single missing exam. Students missing more than one exam have to take multiple make-up exams. Make-up exams can take place before or after the final exam. Please follow the announcements on ODTUCLASS.

Course Outline

I. Coupled Inductors (2 Hrs.)

1. Linear time-invariant (LTI) coupled (mutual) inductors; power and energy; passivity; initial condition models; series and parallel connections of branches; equivalent models.
2. Analysis of simple circuits with LTI coupled inductors.
3. Time-varying and nonlinear coupled inductors.

II. State Equations (8 Hrs.)

1. State-space formulation of dynamic circuits.
2. Complex frequency; complex exponential function.
3. Natural frequencies.
   Bounded/unbounded responses; modes and mode excitation.
4. Particular solutions for complex exponential inputs.
   Phasors; KVL and KCL in the phasor domain; phasor domain elements, impedance and admittance; phasor domain circuits.
5. State transition matrix. Zero-input and zero-state solutions.

III. Analysis of LTI Dynamic Circuits (8 Hrs.)

1. Laplace transformation.
   Real rational functions; poles and zeros; partial fraction expansion.
2. Solution to state-equation by Laplace transformation.
3. Node, modified (polynomial) node, and mesh analyses.

IV. Sinusoidal Steady-State (SSS) Analysis (12 Hrs.)

1. Periodic functions; average and effective values.
2. Responses of LTI dynamic circuits to sinusoidal excitations; transient/steady-state responses.
3. Analysis of phasor domain circuits; phasor diagrams.
4. Passive one-ports: resistive, inductive, and capacitive one-ports.
5. Superposition in the SSS.
6. Instantaneous, average, complex, real, reactive, and apparent powers; power factor; conservation of power.
7. Power calculations in the SSS; superposition in power calculations.
8. Power factor correction.
9. Maximum power transfer.

V. Balanced Three-Phase Circuits (6 Hrs.)

1. Three-phase voltage sources and loads; Y and Δ connections.
2. Analysis of balanced three-phase circuits; phasor diagrams.
3. Power calculations.

VI. Complex Frequency Domain Analysis (8 Hrs.)

1. Complex frequency domain voltages and currents; KVL and KCL in the complex frequency domain; complex frequency domain elements, impedance and admittance; complex frequency domain circuits.
2. Analysis of complex frequency domain circuits.
3. System functions: input and transfer functions; impulse response and convolution integral; step response; SSS response.
4. Two-port circuits: impedance, admittance, hybrid, chain, and scattering representations.

VII. Frequency Response (12 Hrs.)

1. Frequency response functions; magnitude, phase, and group-delay characteristics.
2. First order lowpass, highpass, and allpass passive LC filters.
   Second order lowpass, highpass, bandpass, bandstop, and allpass passive LC and active RC filters.
3. Parallel and series resonance; resonant frequency, quality factor, resonant circuits with finite-Q capacitors and inductors.
4. Magnitude and frequency scalings.
5. Bode plots.