Electrical Circuits

Course Code:

EE 211

Course Period:

Autumn

Course Type:

Core

Credits:

4

Theoric:

3

Practice:

0

ECTS:

7

Course Language:

English

Course Content:

Electrical variables, circuit elements, circuits. Current and voltage measurements. Definition of charge, flux, power and energy. General 2-terminal, multi-terminal and multi-port circuit elements; R, L and C; their electrical features. Commonly used 2-terminal, 2-port and 3-terminal circuit elements and their electrical features. Modeling of physical circuit elements by ideal circuit elements. Kirchhoff’s current equations for nodes and for Gaussian Surfaces. Kirchhoff’s voltage equations for the loops and meshes. Power and energy conservation theorems in electrical circuits. Time domain analysis of linear resistive circuits using basic circuit equations and, node-voltages and mesh-currents methods. Resistive voltage and current dividers. Equivalent circuits. Source transformations. Modelling. Circuit functions. Circuit theorems. 2-port parameters. Their use in resistive circuit analysis. Time domain analysis of linear resistive 1st-order dynamic circuits (RL- and RC- circuits) by the use of state-variables method. Laboratory experiments.

Course Methodology:

1: Lecture by instructor, 2: Lecture by instructor with class discussion, 3: Problem solving by instructor, 4: Use of simulations, 5: Problem solving assignment, 6: Reading assignment, 7: Laboratory work, 8: Term research paper, 9: Presentation by guest

Course Evaluation Methods:

A: Written exam, B: Multiple-choice exam C: Take-home quiz, D: Experiment report, E: Homework, F: Project, G: Presentation by student,

Course Learning Outcomes	**Detailed Program Outcomes**	**Teaching Methods**	**Assessment Methods**
1-Ability to **define** electrical variables (current, voltage, charge, flux, power and energy), electrical circuit elements and electrical circuits.	1a	1,3,5,6	A
2-Ability to **define** circuit elements (2-terminal, 2-port, 3 terminal, resistor, inductor, capacitor) and their electrical features (linear/nonlinear, time variant/invariant, active/passive).	1a	1,3,5,6	A
3-Ability to **write** Kirchhoff's current equations for nodes and for Gaussian Surfaces.	2a	1,3,5,6	A
4-Ability to **write** Kirchhoff's voltage equations for loops and meshes.	2a	1,3,5,6	A
5-Ability to **use** the power and energy conservation theorems in electrical circuits.	2a	1,3,5,6	A
6-Ability to **implement** basic electrical circuits in the laboratory using standard circuit elements and units.	4a, 4b, 5b, 6a, 6c, 7c, 7e, 9b	1,3,5,6	A,D
7-Ability to **analyze** linear resistive circuits by using basic circuit equations (independent current, independent voltage and element defining equations) and circuit analysis methods (node-voltages and loop- currents).	2b	1,3,5,6	A

8-Ability to **analyze** linear resistive circuits by using resistive voltage and current dividers, equivalent circuits, source transformations, modeling (modeling of physical circuit elements by ideal circuit elements), circuit functions (input and transfer), circuit theorems (Superposition, Thevenin, Norton, Maximum power transfer, Reciprocity) and two-port circuit parameters.	2b	1,3,5,6	A
9-Ability to **analyze** 1st-order linear dynamic circuits (RL and RC) in time domain using the method of state-variables.	2b	1,3,5,6	A

Week	Topics	Study Materials
1	Electrical variables (current, voltage, charge, fluxes, power and energy).Their units in SI. Circuit elements and Electric circuits. Measurement devices. Current and voltage measurements by ammeter and voltmeter.	Chapters 1, 2
2	Definitions of charge, fluxes, power and energy in terms of current and voltage.	Chapters 1, 2
3	2-terminal, multi–terminal, multi-port circuit elements. Resistors, inductors and capacitors. Definitions of electrical features of circuit elements: linear/nonlinear, time varying/time-invariant, active/passive circuit elements. Equivalent circuits.	Chapters 2,7
4	Definitions of commonly used ideal 2-terminal, 2-port and 3-terminal circuit elements. Their electrical features. Independent and dependent voltage and current sources, practical voltage and current sources, linear passive resistor, negative resistor, diode, opening and closing switches, ideal transformer, negative converters. Gyrator. Operational amplifier. Transformer. Modeling of physical circuit elements by the ideal circuit elements. Equivalent circuits.	Chapters 1,2,5,6,11,14
5	Kirchhoff’s current equations for the nodes and Gaussian surfaces.	Chapter 3
6	Kirchhoff’s voltage equations for the loops and meshes. Gaussian closed surfaces.	Chapter 3
7	Power and energy conservation theorems in electrical circuits.	Chapter 11
8	Time domain analysis of linear resistive circuits using basic circuit equations (independent current equations, independent voltage equations and defining equations of circuit elements).	Chapter 4
9	Time domain analysis of linear resistive circuits using node-voltage method.	Chapter 4

10	Time domain analysis of linear resistive circuits using mesh-current method.	Chapter 4
11	Time domain analysis of linear resistive circuits using resistive voltage and current dividers, equivalent circuits, source transformations and modelling (modelling of physical circuit elements by ideal circuit elements).	Chapters 3,5
12	Time domain analysis of resistive circuits using circuit functions (input and transfer). Circuit theorems (Superposition, Thevenin, Norton, Maxsimum Power Transfer, Reciprocity).	Chapters 5,13
13	Time domain analysis of linear resistive circuits using 2-port circuit parameters.	Chapter 7
14	Time domain analysis of linear resistive 1st-order dynamic circuits (RL- and RC- circuits) by the use of state-variable method.	Chapters 8,9

Textbook	Richard C. Dorf, and James A. Svoboda, 'Introduction to Electrical Circuits', John and Wiley, New York, 9th addition. ISBN:978-1-118-32182-9
Additional Resources	James W. Nilsson, and Susan A. Riedel, *'Electric Circuits'*, Last Edition, Pearson Prentice Hall, 2004.

Documents	Laboratory experiment sheets
Assignments	Homework problems
Exams	Previous exam problems and their solutions

IN-TERM STUDIES	**NUMBER**	**PERCENTAGE**
Midterms	2	40/60
Laboratory experiments	7	20/60
Homework assignments	17	-
Total		**60/60**
CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE	1	40
CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE		60
Total		**100**

COURSE'S CONTRIBUTION TO PROGRAM OUTCOMES

No	Program Learning Outcomes	check √
1a	Adequate knowledge in mathematics, science and engineering subjects pertaining to the relevant discipline,	√
1b	Ability to use theoretical and applied knowledge in these areas in complex engineering problems.	
2a	Ability to identify, formulate, and solve complex engineering problems,	√
2b	Ability to select and apply proper analysis and modeling methods for this purpose.	√
3a	Ability to design a complex system, process, device or product under realistic constraints and conditions, in such a way as to meet the desired result,	
3b	Ability to apply modern design methods for this purpose.	
4a	Ability to devise, select and use modern techniques and tools needed for analyzing and solving complex problems encountered in engineering practice.	√
4b	Ability to employ information technologies effectively.	√
5a	Ability to design experiments for investigating complex engineering problems or discipline specific research questions,	
5b	Ability to conduct experiments, gather data, analyze and interpret results for investigating complex engineering problems or discipline specific research questions.	√
6a	Ability to work efficiently in intra-disciplinary teams,	√
6b	Ability to work efficiently in multi-disciplinary teams,	
6c	Ability to work individually.	√
7a	Ability to communicate effectively in Turkish, both orally and in writing,	
7b	Knowledge of a minimum of one foreign language,	
7c	Ability to write effective reports and comprehend written reports, prepare design and production reports,	√
7d	Ability to make effective presentations,	
7e	Ability to give and receive clear and intelligible instructions.	√
8a	Recognition of the need for lifelong learning, ability to access information, ability to follow developments in science and technology,	
8b	Ability to continue to educate him/herself.	

9a	Consciousness to behave according to ethical principles and professional and ethical responsibility.	
9b	Knowledge on standards used in engineering practice.	√
10a	Knowledge about business life practices such as project management, risk management, change management.	
10b	Awareness in entrepreneurship and innovation.	
10c	Knowledge about sustainable development.	
11a	Knowledge about the global and social effects of engineering practices on health, environment, and safety,	
11b	Knowledge about contemporary issues of the century reflected into the field of engineering.	
11c	Awareness of the legal consequences of engineering solutions.	

Activities	Quantity	Duration (Hour)	Total Workload (Hour)
Course Duration	14	3	42
Hours for off-the-classroom study (Pre-study, practice)	14	3	42
Exercises and Solutions	17	3	51
Mid-terms	2	1	2
Final examination	1	2	2
Laboratory	7	2	14
Pre-laboratory	7	2	14
Total Work Load			167
Total Work Load / 25 (h)			6.68
ECTS Credit of the Course			7