COURSE DETAILS

"FONDAMENTI DI CIRCUITI"

SSD ING-IND/31

DEGREE PROGRAMME: BACHELOR DEGREE IN COMPUTER ENGINEERING

ACADEMIC YEAR: 2023-2024

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: MULTIPLE STUDY COURSE
PHONE:
EMAIL:

GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE (IF APPLICABLE): N.A.
MODULE (IF APPLICABLE): N.A.
CHANNEL (IF APPLICABLE): N.A.
YEAR OF THE DEGREE PROGRAMME (I, II, III): II
SEMESTER (I, II): I
CFU: 9

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Analisi matematica I.

PREREQUISITES (IF APPLICABLE)

None.

LEARNING GOALS

The course aims to provide students with the basics of circuit theory under conditions stationary, sinusoidal and periodic operation and linear dynamic circuits of the first and second order; to introduce systematically the general properties of the circuit model, the main theorems and the main methodologies of analysis.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The training course provides students with the basic knowledge and methodological tools necessary to analyze linear circuits, in conditions of stationary, sinusoidal and periodic operation and to analyze linear dynamic circuits of the first and second order. The student will be able to recognize the limits of validity and the main implications of the fundamental theorems of circuits.

Applying knowledge and understanding

The student must demonstrate to be able to solve linear circuits, under steady state operating conditions, sinusoidal and periodic and linear dynamical circuits of the first and second order, identifying the most appropriate solution method, and using where necessary the main circuit theorems. The student must be able to expose the basic concepts of circuit theory and to derive the main theorems correctly using disciplinary language.

COURSE CONTENT/SYLLABUS

1. THE LAWS OF ELECTROMAGNETISM

Electric charge, electric current, current density. Electric field, magnetic field, Lorentz force. The laws of electromagnetism in vacuum in integral form. Law of conservation of the office. {The laws of electromagnetism in matter in integral form}. Electric field work, energy stored in the electric field, energy stored in the magnetic field, Electric power, electrical energy. Unit of measurement.

2. THE CIRCUIT MODEL

Electrical circuits in slowly changing conditions. Bipole: electric current intensity, electrical voltage, electrical power, electrical energy. User and generator convention. Bipole circuits: Kirchhoff's laws. Canonical bipoles: resistor, switch, independent generators, capacitor, inductor. Real generators. Active bipoles, passive bipoles, dissipative bipoles and conservative bipoles. {Circuit model frequency limits.}

3. CIRCUIT EQUATIONS

Simple resistive circuit; nonlinear resistive circuit and graphic solution method; {Newton Raphson's algorithm}; linear dynamic circuits of the first order, steady state and sinusoidal. Graph of a circuit, subgraph, connected graph, shaft, coshaft, mesh, {cutting set}; planar graphs and rings; set of fundamental meshes {and fundamental cut set}; incidence matrix and reduced incidence matrix, {mesh matrix and reduced mesh matrix}, Kirchhoff equations in matrix form, independent Kirchhoff equations, the system of fundamental equations. Node potentials; {Mesh currents}. Conservation of virtual powers (Tellegen's theorem); conservation of electrical powers.

4. RESISTIVE CIRCUITS

Bipole equivalent, resistors in series, resistors in parallel; voltage and current dividers, series and parallel of ideal generators and pathological cases, equivalence of real generators; linear resistive circuits, overlapping effects; Thevénin-Norton equivalent generator; non-amplification of voltages {and currents}. Star-triangle transformation.

5. MULTI-TERMINAL CIRCUIT ELEMENTS
N-poles, descriptive currents and voltages, double bipoles, door condition. electrical power consumption; linear controlled generators, ideal transformer; Gyrator, double bipoles of resistors, reciprocity theorem, resistance matrix, conductance matrix, {hybrid matrices, transmission matrix}mutually coupled circuits (transformer), characteristic relations, perfect coupling, equivalent circuits. {Connecting double bipoles in parallel and cascade series}. Synthesis of double bipoles: T-configurations and π.

6. STEADY CIRCUITS
Circuits in permanent regime. Steady state circuits. Sinusoidal circuits. Fasors, symbolic method; complex numbers. Impedance, impedance circuits, impedance circuit properties. Complex power, medium power, reactive power. Phasor diagrams of elementary bipoles. Complex power preservation, average power and reactive power. Bipoles of impedances; networks on a periodic basis. Resonant circuit, quality factor, power and energy balances, {universal resonance curves}. Frequency response of a circuit; filters. {Three-phase star center shift systems and Millmann formula, power measurement and Aron insertion.}

7. LINEAR DYNAMIC CIRCUITS
Equations of state of first-order circuits, equations of state of second-order circuits, associated resistive circuit. Continuity of state quantities; solution of circuits of the first and second order. Free evolution, forced evolution, natural modes of evolution, natural frequency, time constant, transient term, permanent term, dissipative circuit, time-variant circuit, {impulsive forcing circuit}; solution of second-order circuits, RLC series circuit, parallel RLC circuit, aperiodic natural modes, oscillating natural modes, RC circuits and second-order RL circuits. {Impulse response and convolution integral, operator impedances, network function, and analysis in the Laplace domain. Introduction to circuit simulation and the use of SPICE.}

N.B. The choice between the topics listed in {curly braces} may vary depending on the choices of teachers in each channel.

READINGS/BIBLIOGRAPHY

Reference texts
M. de Magistris, G. Miano, "*Circuiti*", II edition, SPRINGER, settembre 2009.

Testi Di Consultazione

[1] L.O. Chua, C.A. Desoer, E.S. Kuh, "*Circuiti Lineari E Non Lineari*", Jackson, 1991.
[2] G. Miano, "*Lezioni Di Elettrotecnica*", Ed. Cuen, 1998;
[3] L. De Menna, "*Elettrotecnica*", Ed. Pironti, Napoli, 1998.
[4] I.D. Mayergoyz, W. Lawson, "*Elementi Di Teoria Dei Circuiti*", Utet, 2000.
[5] H. A. Haus, J.R. Melcher, "*Electromagnetic Fields And Energy*", Prentice Hall, 1989 (For further exercises)

Exercises

[1] S. Bobbio, L. De Menna, G. Miano, L. Verolino, "*Quaderno N ° 1: Circuiti In Regime Stazionario*", Ed. Cuen, Napoli, 1998.
[2] "*Quaderno N ° 2: Circuiti In Regime Sinusoidale*", Ed. Cuen, Napoli, 1998.
[3] "*Quaderno N ° 3: Circuiti In Evoluzione Dinamica: Analisi Nel Dominio Del Tempo*", Ed. Cuen, Napoli, 1998.
[4] S. Bobbio, "*Esercizi Di Elettrotecnica*", Ed. Cuen, Napoli, 1995.

Mooc
Open and Mass Online Course (Mooc) available on https://www.federica.eu/

TEACHING METHODS

Lectures (about 60%) and frontal exercises (about 40%).

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to:	Multiple choice answers	
	Open answers	
	Numerical exercises	X

b) Evaluation pattern: