UNIVERSITÀ DI PISA

FOUNDATIONS OF ELECTROMAGNETICS

GIULIANO MANARA

Anno accademico	2021/22
CdS	TELECOMMUNICATIONS ENGINEERING
Codice	907II
CFU	6

Moduli	Settore/i	Tipo	Ore	Docente/i
FONDAMENTI DI ELETTROMAGNETISMO	ING-INF/02	LEZIONI	60	GIULIANO MANARA PAOLO NEPA

Prerequisites
Vector calculus, principal reference systems, differential operators, kinematics, electrostatics, magnetostatics. Differential equations.

Co-requisites
Phasors, circuit theory (lumped electrical models).

Teaching methods
Delivery: mixed modality (due to Covid-19)
a) face to face (see the timetable of the second year of the Laurea Triennale - Bachelor of Science - in Telecommunications Engineering on the School of Engineering website;
b) link to the virtual class:
https://teams.microsoft.com/l/channel/19%3aeKyClQ0v_d5nKt9eOF2kdjlHlaum3mbfq-s1LOJG1_01%40thread.tacv2/Generale?groupId=06fb53c8-2fc0-44ed-8da5-9d354041da0a&tenantId=c7456b31-a220-47f5-be52-473828670aa1

Syllabus
Differential form of Maxwell equations in time domain. Electric current continuity equation. Integral form of Mawell equations: electromagnetic induction law by Faraday-Lentz, Ampére's circuital law genralized by introducing the displacement current, Gauss' laws for electric and magnetic charges. Duality theorem.
Constitutive equations of a medium: linearity, homogeneity, isotropy/anisotropy, dispersivity, causality. Conduction, polarization, and magnetization phenomena. Time domain analysis of dielectrics, magnetic materials, and conductors.
Plane waves: electromagnetic fields associated to a uniform plane wave in time domain. Spherical waves and locally plane waves. Sinusoidal waves and wave polarization. Poynting vector and time-domain Poynting's theorem.
Electromagnetic field analysis in frequency domain. Phasor electromagnetic fields, polarization plane. Maxwell's equations in frequency domain. Frequency-domain plane waves: phase constant and wavelenght. Constitutive relations in frequency domain: models for the analysis of time-dispersive media. Analysis of propagation in a plasma: characteristics of ionospheric plasma. Plane waves in lossy media: equivalent dielectric constant, attenuation constant. Frequency-domain Poynting's theorem.
Analysis of propagationin dispersive media: dipersion (Brillouin) diagram, phase and group velocity.
Continuity conditions for electromagnetic fields at the interface between two different media. Plane waves at the interface between media with different elctromagnetic characteristics: reflection and refraction phenomena. Field penetration depth in a good conductor, skin effect,. Surface impedance, boundary conditions at the exterior surface of a PEC (Perfect Electric Conductor) and a PMC (Perfect Magnetic Conductor).
Plane waves at the interface between two different media: oblique incidence case. Relfection and refraction laws. Fresnel reflection coefficients. Total reflection phenomenon: critical angle. Brewster's angle.Fundamentals of Geometrical Optics (GO).

Assessment methods
Oral exam.

Additional web pages
Page of the course on the e-learning platform of the School of Engineering at the following address:
https://elearn.ing.unipi.it/user/index.php?id=2565

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