1. Record Nr. UNINA9911006987003321 Autore Cooray Vernon Titolo Lightning Electromagnetics: Return Stroke Modelling and Electromagnetic Radiation, Volume 1 Stevenage:,: Institution of Engineering & Technology,, 2023 Pubbl/distr/stampa ©2022 **ISBN** 1-83724-489-8 1-5231-5543-4 1-78561-540-8 Edizione [2nd ed.] Descrizione fisica 1 online resource (332 pages) Collana **Energy Engineering Series** Altri autori (Persone) RachidiFarhad RubinsteinMarcos Disciplina 551.5632 Soggetti Electromagnetic waves Electromagnetism Lingua di pubblicazione Inglese **Formato** Materiale a stampa Livello bibliografico Monografia Intro -- Title -- Copyright -- Contents -- About the editors --Nota di contenuto Acknowledgements -- 1 Basic electromagnetic theory - a summary --1.1 Introduction -- 1.2 The nomenclature -- 1.3 Coordinate systems -- 1.4 Important vector relationships -- 1.4.1 The scalar product of vectors -- 1.4.2 The vector product of two vectors -- 1.4.3 Vector field

Acknowledgements -- 1 Basic electromagnetic theory - a summary -- 1.1 Introduction -- 1.2 The nomenclature -- 1.3 Coordinate systems -- 1.4 Important vector relationships -- 1.4.1 The scalar product of vectors -- 1.4.2 The vector product of two vectors -- 1.4.3 Vector field -- 1.4.4 The Nabla operator and its operations -- 1.4.5 Important vector identities -- 1.4.6 Relationship between the Curl of a vector field and the line integral of that vector field around a closed path -- 1.4.7 The flux of a vector field through a surface -- 1.4.8 Relationship between the divergence of a vector field and the flux of that vector field through a closed surface -- 1.4.9 Divergence theorem -- 1.4.10 Stokes theorem -- 1.5 Static electric fields -- 1.5.1 Coulomb's law -- 1.5.2 Electric field produced by static charges is a conservative field -- 1.5.3 Gauss's law -- 1.5.4 Electric scalar potential -- 1.5.5 Poisson and Laplace equations -- 1.6 Electric currents, charge conservation, and static magnetic fields -- 1.6.1 Electric current -- 1.6.2 Conservation of electric charge -- 1.6.3 Re-distribution of excess charge placed inside

a conducting body -- 1.6.4 Magnetic field produced by a current element - Biot-Savarts law -- 1.6.5 Gauss's law for magnetic fields --1.6.6 Amperes law -- 1.6.7 Boundary conditions for the static magnetic field -- 1.6.8 Vector potential -- 1.6.9 Force on a charged particle --1.7 Energy density of an electric field -- 1.8 Electrodynamics - time varying electric and magnetic fields -- 1.8.1 Faraday's law -- 1.8.2 Maxwell's modification of Ampere's law - the displacement current term -- 1.8.3 Energy density in a magnetic field -- 1.9 Summary of the laws of electricity -- 1.10 Wave equation. 1.11 Maxwell's prediction of electromagnetic waves -- 1.12 Plane wave solution -- 1.12.1 The electric field of the plane wave -- 1.12.2 The magnetic field of the plane wave -- 1.12.3 Energy transported by a plane wave - Poynting's theorem -- 1.13 Maxwell's equations and plane waves in different media (summary) -- 1.13.1 Vacuum -- 1.13.2 Isotropic and linear dielectric and magnetic media -- 1.13.3 Conducting media -- 1.14 Retarded potentials -- 1.15 Electromagnetic fields of a current element - electric dipole -- 1.16 Electromagnetic fields of a lightning return stroke -- References -- 2 Application of electromagnetic fields of accelerating charges to obtain the electromagnetic fields of engineering return stroke models -- 2.1 Introduction -- 2.2 Electromagnetic fields of a moving charge -- 2.3 Electromagnetic fields of a propagating current pulse -- 2.4 Electromagnetic fields generated by a current pulse propagating from one point in space to another along a straight line with uniform velocity and without attenuation -- 2.4.1 The electric radiation field generated from S1 -- 2.4.2 The electric radiation field generated from S2 -- 2.4.3 The static field generated by the accumulation of charge at S1 -- 2.4.4 The static field generated by the accumulation of positive charge at S2 -- 2.4.5 The velocity field generated as the current pulse propagates along the channel element -- 2.4.6 Magnetic radiation field generated from S1 -- 2.4.7 Magnetic radiation field generated from S2 -- 2.4.8 Magnetic velocity field generated as the current pulse propagate along the channel element -- 2.5 Effect of change in current on the radiation field -- 2.6 Effect of change in speed on the radiation field -- 2.7 Electromagnetic fields of return strokes simulated by different models -- 2.7.1 Electromagnetic fields of modified transmission line model. 2.7.2 Electromagnetic fields of CG type model -- 2.7.3 CD type models -- 2.8 Concluding remarks -- References -- 3 Basic features of engineering return stroke models -- 3.1 Introduction -- 3.2 Current propagation models (CP models) -- 3.2.1 Basic concept -- 3.2.2 Most general description -- 3.3 Current generation models (CG models) --3.3.1 Basic concept -- 3.3.2 Expression for the current at any height --3.4 Current dissipation models (CD models) -- 3.4.1 General description -- 3.4.2 Expression for the current at any height -- 3.5 Comparison of CG and CD -- 3.5.1 Generalization of any model to current generation type -- 3.6 Generalization of any model to a current dissipation type model -- 3.7 Current dissipation models and the modified transmission line models -- 3.8 Unification of engineering return stroke models -- 3.9 Concluding remarks -- References -- 4 Electromagnetic models of lightning return strokes -- 4.1 Introduction -- 4.2 General approach to finding the current distribution along a vertical perfectly conducting wire above ground -- 4.2.1 Current distribution along a vertical perfectly conducting wire above ground --4.2.2 Mechanism of attenuation of current wave in the absence of ohmic losses -- 4.3 Representation of the lightning return-stroke channel -- 4.3.1 Type 1: a perfectly conducting/resistive wire in air above ground -- 4.3.2 Type 2: a wire loaded by additional distributed series inductance in air above ground -- 4.3.3 Type 3: a wire

a wire coated by a dielectric material in air above ground -- 4.3.5 Type 5: a wire coated by a fictitious material having high relative permittivity and high relative permeability in air above ground -- 4.3.6 Type 6: two wires having additional distributed shunt capacitance in air. 4.4 Comparison of model-predicted current distributions and electromagnetic fields for different channel representations -- 4.4.1 Comparison of distributions of current for different channel representations -- 4.4.2 Comparison of model-predicted electric and magnetic fields with measurements -- 4.5 Excitations used in electromagnetic models of the lightning return stroke -- 4.5.1 Closing a charged vertical conducting wire at its bottom end with a specified circuit -- 4.5.2 Lumped voltage source -- 4.5.3 Lumped current source -- 4.5.4 Comparison of current distributions along a vertical perfectly conducting wire excited by different sources -- 4.6 Numerical procedures used in electromagnetic models of the lightning return stroke -- 4.6.1 Methods of moments (MoMs) in the time and frequency domains -- 4.6.2 Finite-difference time-domain (FDTD) method --4.6.3 Comparison of current distributions along a vertical perfectly conducting wire calculated using different numerical procedures with those predicted by Chen's analytical equation -- 4.7 Applications of electromagnetic models of the lightning return stroke -- 4.7.1 Strikes to flat ground -- 4.7.2 Strikes to free-standing tall object -- 4.7.3 Strikes to overhead power transmission lines -- 4.7.4 Strikes to overhead power distribution lines -- 4.7.5 Strikes to wire-mesh-like structures -- 4.8 Summary -- References -- 5 Antenna models of lightning return-stroke: an integral approach based on the method of moments -- 5.1 Introduction -- 5.2 General formulation -- 5.2.1 Time-domain formulation -- 5.2.2 Frequency-domain formulation --5.3 Numerical treatment -- 5.3.1 Method of moments -- 5.3.2 Timedomain formulation -- 5.3.3 Frequency-domain formulation for uniform soil -- 5.3.4 Lossy half-space problem -- 5.3.5 Frequencydomain formulation for stratified media. 5.3.6 Green's functions for stratified media -- 5.4 Various AT models -- 5.4.1 Time-domain AT model -- 5.4.2 Time-domain AT model with inductive loading -- 5.4.3 Time-domain AT model with nonlinear loading -- 5.4.4 Frequency-domain AT model -- 5.4.5 Frequencydomain AT model with distributed current source -- 5.5 Numerical results -- 5.5.1 Time-domain AT model -- 5.5.2 Time-domain AT model with inductive loading -- 5.5.3 Time-domain AT model with nonlinear loading -- 5.5.4 Frequency-domain AT model -- 5.5.5 Frequency-domain AT model with distributed current source -- 5.6 Summary -- References -- 6 Transmission line models of the lightning return stroke -- 6.1 Introduction -- 6.2 Review of transmission line models of the lightning return stroke -- 6.2.1 Discharge-type models -- 6.2.2 Lumped excitation Models -- 6.3 Return-stroke model and calculation of channel parameters per unit length -- 6.3.1 Channel inductance and capacitance -- 6.3.2 Effect of corona on the calculation of channel parameters -- 6.3.3 Calculation of the channel resistance --6.4 Computed results -- 6.4.1 Channel currents -- 6.4.2 Predicted electromagnetic fields -- 6.5 Summary and conclusion -- References -- 7 Measurements of lightning-generated electromagnetic fields --7.1 Introduction -- 7.2 Electric field mill or generating voltmeter -- 7.3 Plate or whip antenna -- 7.3.1 Measurement of electric field -- 7.3.2 Measurement of the derivative of the electric field -- 7.4 Measurements of the three electric field components in space -- 7.5 Crossed loop antennas to measure the magnetic field -- 7.6 Magnetic field measurements using anisotropic magnetoresistive (AMR) sensors --

embedded in a dielectric (other than air) above ground -- 4.3.4 Type 4:

7.7 Narrowband measurements -- References -- 8 HF and VHF electromagnetic radiation from lightning -- 8.1 Introduction -- 8.2 Information analysis and discussion.

8.2.1 Significance of lightning-related HF-VHF Emission.

Sommario/riassunto

Understanding lightning is of importance due to the increase in extreme weather events. The 2nd edition of this classic work has been thoroughly updated and revised, with new content on EM radiation at various wavelengths. Volume 1 treats electrodynamics, whilst volume 2 addresses effects and modelling.