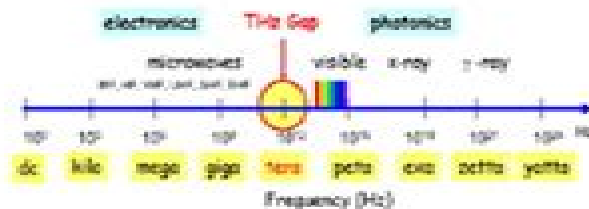


Chapter 7: Plane Electromagnetic Waves and Wave Propagation

T-Ray: Next frontier in Science and Technology

Terahertz wave (or **T-ray**), which is electromagnetic radiation in a frequency interval from 0.1 to 10 THz, lies a frequency range with rich science but limited technology.



$$1 \text{ THz} \sim 1 \text{ ps} \sim 300 \mu\text{m} \sim 33 \text{ cm}^{-1} \sim 4.1 \text{ meV} \sim 47.6 \text{ }^\circ\text{K}$$

1

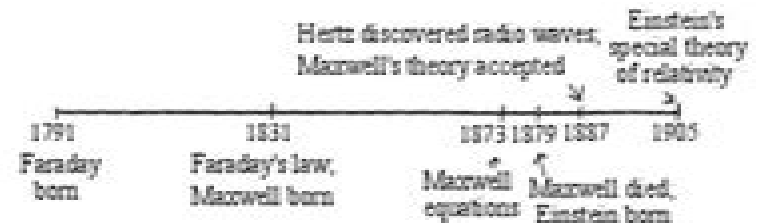
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Faraday : Time-varying magnetic field generates electric field

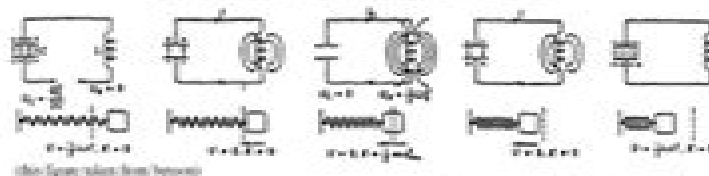


Maxwell : Time-varying electric field generates magnetic field

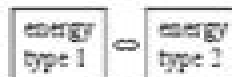


2

A Note about Oscillatory Behavior:



Common feature of oscillatory behavior:



⇒ Oscillations require $\left\{ \begin{array}{l} \text{energy storing mechanisms} \\ \text{energy exchange mechanism(s)} \end{array} \right.$

| example | energy storing mechanisms | energy exchange mechanism(s) | medium |
|--------------------|---|--------------------------------|-----------------|
| mass-spring system | $\frac{1}{2}mv^2, \frac{1}{2}kx^2$ | restoring force | mass & spring |
| LC oscillator | $\frac{1}{2}LI^2, \frac{1}{2}CV^2$ | Q, I | L, C , & wire |
| EM wave | $\frac{E^2}{2\mu}, \frac{B^2}{2\epsilon}$ | $\frac{dB}{dt}, \frac{dE}{dt}$ | not required |

Organization of Lecture Notes on Ch. 7:

In Jackson, plane waves in dielectric media are treated in Secs. 7.1 and 7.2. Various special cases (plasma medium and high-frequency limit) are treated in Sec. 7.5. Plane waves in conductors are treated in Sec. 5.18 [e.g. Eqs. (5.163)-(5.169)] and Sec. 8.1 [e.g. Eqs. (8.9), (8.10), (8.12), (8.14), and (8.15)] by methods different from those in Secs. 7.1 and 7.2.

Here, we will cover these sections in Jackson with a unified treatment of plane waves in both dielectrics and conductors, and at all frequencies. Equations in Jackson will be examined in greater detail, but in somewhat different order. So, in the lecture notes, the three sections on these materials will be numbered Secs. I, II, and III rather than following Jackson's section numbers. However, Secs. 7.3, 7.4, 7.8, and 7.9 of Jackson will be followed closely in subsequent lecture notes (and numbered as in Jackson).

We begin with a derivation of the generalized dielectric constant ϵ/ϵ_0 , which is applicable to both dielectric and conducting media.

4

Chapter 7 Plane Electromagnetic Waves An Historical

Jessica J Manson



Chapter 7 Plane Electromagnetic Waves An Historical:

An Introduction to Classical Electromagnetic Radiation Glenn S. Smith,1997-08-13 This book provides a thorough description of classical electromagnetic radiation starting from Maxwell's equations and moving on to show how fundamental concepts are applied in a wide variety of examples from areas such as classical optics antenna analysis and electromagnetic scattering Throughout the author interweaves theoretical and experimental results to help give insight into the physical and historical foundations of the subject A key feature of the book is that pulsed and time harmonic signals are presented on an equal footing Mathematical and physical explanations are enhanced by a wealth of illustrations over 300 and the book includes more than 140 problems It can be used as a textbook for advanced undergraduate and graduate courses in electrical engineering and physics and will also be of interest to scientists and engineers working in applied electromagnetics A solutions manual is available on request for lecturers adopting the text

Bibliography of X-ray Literature and Research (1896-1897), with an Historical Retrospect and a Chapter 'Practical Hints'. Charles E.S. Phillips,1897

Electromagnetic Waves Carlo G. Someda,1998-05-12 This book provides a comprehensive treatment of electromagnetic waves The author's approach is thoroughly modern and unlike many others this text offers a unified view of electromagnetic waves and their applications in telecommunications radar and photonics The extensive coverage of Electromagnetic Waves begins with Maxwell's equations and takes students on the journey from the wave and Helmholtz equations through polarization plane waves and wave beams and packets to antennas transmission lines and waveguides Completing the treatment are chapters devoted to diffraction and an introduction to the theory of coherence The author strikes an effective balance of the teach through concepts and teach by example approaches The book is filled with exercises current applications and exercises that solidify students understanding and bring relevance to the material It forms an outstanding text for senior undergraduates and graduate level students in electrical engineering and physics

Einstein's Space-Time Rafael Ferraro,2007-09-23 This excellent textbook offers a unique take on relativity theory setting it in its historical context Ideal for those interested in relativity and the history of physics the book contains a complete account of special relativity that begins with the historical analysis of the reasons that led to a change in our view of space and time Its aim is to foster a deep understanding of relativistic spacetime and its consequences for Dynamics

Modern Electromagnetic Scattering Theory with Applications Andrey V. Osipov,Sergei A. Tretyakov,2017-04-17 This self contained book gives fundamental knowledge about scattering and diffraction of electromagnetic waves and fills the gap between general electromagnetic theory courses and collections of engineering formulas The book is a tutorial for advanced students learning the mathematics and physics of electromagnetic scattering and curious to know how engineering concepts and techniques relate to the foundations of electromagnetics

Classical Electrodynamics John David Jackson,1962 Problems after each chapter

Electromagnetic Composites Handbook, Second Edition Rick Moore,2016-04-18 Theoretical computational and

experimental electromagnetic modeling and characterization This engineering and scientific handbook offers extensive coverage of electromagnetic modeling and characterization of composite materials from the theoretical computational and experimental points of view You will get unique data for non conducting dielectrics semiconducting conducting and magnetic materials and composites composed of two or more molecularly distinct compounds The goal of the book is to contribute to current and visionary electromagnetic composite applications and extend the existing database for composites

Electromagnetic Composites Handbook Models Measurement and Characterization is presented in a clear hierarchical style progressing from basic concepts through simple and more complex models and finally to data verifying the models Provides a large collection of tabulated data for more than 300 complex composite materials Information presented will aid in the development of multifunctional material designs The data is a direct extension from Arthur Von Hippel s landmark *Dielectric Materials and Application* Engineering Electromagnetics Explained Lakshman Kalyan,2025-02-20 Engineering

Electromagnetics Explained is a comprehensive textbook designed to provide students with a solid foundation in the principles and applications of electromagnetics Written by leading experts this book covers fundamental concepts theoretical frameworks and practical applications in engineering We start with basic principles of electromagnetism including Coulomb s Law Gauss s Law and Maxwell s Equations then delve into advanced topics such as electromagnetic waves transmission lines waveguides antennas and electromagnetic compatibility EMC Key Features Clear and concise explanations of fundamental electromagnetics concepts Numerous examples and illustrations to aid understanding Practical applications and real world examples demonstrating electromagnetics relevance in engineering Comprehensive coverage of topics including transmission lines waveguides antennas and EMC End of chapter problems and exercises to reinforce learning This textbook is suitable for undergraduate and graduate students in electrical engineering electronics and communication engineering and related disciplines It serves as an essential resource for courses on electromagnetics electromagnetic field theory and electromagnetic compatibility Additionally practicing engineers and researchers will find this book a valuable reference for understanding and applying electromagnetics principles in their work *Æther* Hugh Woods,1906 **Students' Guide to**

Submarine Cable Testing H. K. C. Fisher,1908 The Electric Furnace in Iron and Steel Production John Baker

Cannington Kershaw,1907 *Microwave Engineering* David M. Pozar,2012-04-13 The 4th edition of this classic text provides a thorough coverage of RF and microwave engineering concepts starting from fundamental principles of electrical engineering with applications to microwave circuits and devices of practical importance Coverage includes microwave network analysis impedance matching directional couplers and hybrids microwave filters ferrite devices noise nonlinear effects and the design of microwave oscillators amplifiers and mixers Material on microwave and RF systems includes wireless communications radar radiometry and radiation hazards A large number of examples and end of chapter problems test the reader s understanding of the material The 4th edition includes new and updated material on systems noise active

devices and circuits power waves transients RF CMOS circuits and more **Electricity Meters: Their Construction and Management** Charles Henry William Gerhardt, 1906 **The Alternating Current Commutator Motor** Rudolf Goldschmidt, 1909 Microwave Journal , 1998 **Inquiry Into Physics** Vernon J. Ostdiek, 1999-10 **Introduction to Optics and Optical Imaging** Craig Scott, 1998 With a focus on providing a working knowledge of optical systems and their principles of operation this book employs today's most important methods for optical analysis geometrical ray optics reflection integral techniques and the Abbe plane wave spectrum technique This thoughtfully organized text uses fundamental electromagnetics as its underlying framework allowing for a comprehensive understanding of both classical and modern optics theory Understanding the theories presented in this book is an essential step for readers who want to produce effective design using current software The author has carefully incorporated practical mathematics throughout for readers who want to further their analytical understanding of the material INTRODUCTION TO OPTICS AND OPTICAL IMAGING will be an indispensable guide for advanced undergraduate engineering students practicing engineers and optical scientists seeking a comprehensive background in physical optics Proceedings of the IRE. , 1961 **Neighbor Vs. Neighbor** Mark Warda, 1991 Optics News , 1987 Includes a directory of members in one issue each year

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