

ELECTROMAGNETICS

MAGNETISM - is a natural phenomenon whereby attraction or repulsion takes place. It is also a property possessed by iron, steel, nickel, cobalt and certain other magnetic materials and alloys wherein these materials can produce or can conduct magnetic line of force capable of interacting with other fields (electric or magnetic).

- **Magnetism** is a property of materials that respond to an applied magnetic field.

TYPES OF MAGNETISM

- **Ferromagnetism** - Permanent magnets have persistent magnetic fields caused by ferromagnetism. That is the strongest and most familiar type of magnetism.
- **Para magnetism** - attracted to a magnetic field
- **Diamagnetism** - repulsed by a magnetic field
- **Non-magnetic substances** - Substances that are negligibly affected by magnetic fields. They include copper, aluminum, gases, and plastic. Pure oxygen exhibits magnetic properties when cooled to a liquid state.

Brief History

- Mineral discovered around 800 BC in the town of Magnesia (now Manisa, Turkey) was found to have a wondrous property.
- It could attract pieces of iron towards it.
- The mineral is called **Magnetite** (after the place where it discovered).
- It was found that thin strips of magnetite always align themselves in particular direction when suspended freely in air.
- For this property, it was given the name "**Lead stone**" or **lodestone**. It was found out that it is mainly composed of oxide of iron (Fe_2O_3). This is now known as **magnet**.
- William Gilberts - did the first detailed study of magnetism and its properties in 1600.

ELECTROMAGNETISM - is magnetism produced by an electric current rather than by a natural magnet. It is the force that causes the interaction between electrically charged particles, are in which this happens are called electromagnetic fields.

- Manifests both electric fields and magnetic fields.
- A changing magnetic field generates an electric fields; conversely a changing magnetic field generates an electric fields, and is called electromagnetic induction, and is the basis of operation for electrical generators, induction motors and transformers.
- In 1820 Hans Christian Oersted (1777-1851 Danish) demonstrated that magnetism was related to electricity by bringing a wire carrying an electric current close to a magnetic compass which caused a deflection of the compass needle (always at right angle with respect to the conductor). It is now known that whenever current flows there will be an associated magnetic field in the surrounding space, or more generally that the movement of any charged particle will produce a magnetic field.



Magnetic Poles, Forces, and Fields

- Every magnet has two poles. This is where most of its magnetic strength is most powerful. These poles are called north and south or north-seeking and south-seeking poles. The poles are called this as when a magnet is hung or suspended the magnet lines up in a north - south direction.
- When the north pole of one magnet is placed near the north pole of another magnet, the poles are repelled. When the south poles of two magnets are placed near one another, they also are repelled from one another. When the north and south poles of two magnets are placed near one another, they are attracted to one another.
- The attraction repelling of two magnets towards one another depends on how close they are to each other and how strong the magnetic force is within the magnet. The further apart of the magnets are the less they are attracted or repelled to one another.
- When a magnet is broken into little pieces, a north pole will appear at one of the broken faces and a south pole. Each piece, regardless of how big or small, has its own north and south poles. They are around a magnet can also behave like a magnet. This is called a magnetic field. The larger the magnet and the closer the object to the magnet, the greater the force of the magnetic field.

Magnetic Materials

- The term magnetism is derived from Magnesia, the name of a region in Asia Minor where lodestone, a naturally magnetic iron ore, was found in ancient times. Iron is not the only material that is easily magnetized when placed in a magnetic field; others include nickel and cobalt.
- Magnets can also be formed that are called electromagnets. A simple electromagnet is formed with a battery and copper wire coiled around a metal rod such as a nail. There is evidence that there is an electrical basis for magnetism.

How do you demagnetize a magnet?

- **Heating, Hammering and/or Jarring**

Heating a magnet past its Curie point will destroy the long range ordering. In the case of heating, energy is provide to the magnetic dipoles causing them to free themselves from the initial order, thus destroying or reducing the ordering of the magnetic dipoles. This causes the magnetic poles to point in different direction in space. So on average along any direction you have very little magnetic poles alignment. Since magnetism arise from such alignment, in this case we have very little or no magnetization. Similarly when we hammer or drop the magnet many times on the floor, the vibration induced on the magnet causes the magnetic dipoles to randomize. Hammering and/or Jarring, such activity will destroy the long range ordering within the magnet.

Fundamentals Of Engineering Electromagnetics Lecture Notes

Constantine A. Balanis



Fundamentals Of Engineering Electromagnetics Lecture Notes:

Introduction to Engineering Electromagnetic Fields Korada Umashankar, 1989 This is a textbook designed to provide analytical background material in the area of Engineering Electromagnetic Fields for the senior level undergraduate and preparatory level graduate electrical engineering students It is also an excellent reference book for researchers in the field of computational electromagnetic fields The textbook covers Static Electric and Magnetic Fields The basic laws governing the Electrostatics Magnetostatics with engineering examples are presented which are enough to understand the fields and the electric current and charge sources Dynamic Electromagnetic Fields The Maxwell s equations in Time Domain and solutions the Maxwell s equations in Frequency Domain and solutions Extensive approaches are presented to solve partial differential equations satisfying electromagnetic boundary value problems Foundation to electromagnetic field radiation guided wave propagation is discussed to expose at the undergraduate level application of the Maxwell s equations to practical engineering problems

Electromagnetics for Engineering Students Part I Sameir M. Ali Hamed, 2017-09-20 Electromagnetics for Engineering Students starts with an introduction to vector analysis and progressive chapters provide readers with information about dielectric materials electrostatic and magnetostatic fields as well as wave propagation in different situations Each chapter is supported by many illustrative examples and solved problems which serve to explain the principles of the topics and enhance the knowledge of students In addition to the coverage of classical topics in electromagnetics the book explains advanced concepts and topics such as the application of multi pole expansion for scalar and vector potentials an in depth treatment for the topic of the scalar potential including the boundary value problems in cylindrical and spherical coordinates systems metamaterials artificial magnetic conductors and the concept of negative refractive index Key features of this textbook include detailed and easy to follow presentation of mathematical analyses and problems a total of 681 problems 162 illustrative examples 88 solved problems and 431 end of chapter problems an appendix of mathematical formulae and functions Electromagnetics for Engineering Students is an ideal textbook for first and second year engineering students who are learning about electromagnetism and related mathematical theorems

Handbook of Engineering Electromagnetics Rajeev Bansal, 2004-09-01 Engineers do not have the time to wade through rigorously theoretical books when trying to solve a problem Beginners lack the expertise required to understand highly specialized treatments of individual topics This is especially problematic for a field as broad as electromagnetics which propagates into many diverse engineering fields The time h

Solved Problems in Electromagnetics Félix Salazar Bloise, Rafael Medina Ferro, Ana Bayón Rojo, Francisco Gascón Latasa, 2016-10-19 This book presents the fundamental concepts of electromagnetism through problems with a brief theoretical introduction at the beginning of each chapter The present book has a strong didactic character It explains all the mathematical steps and the theoretical concepts connected with the development of the problem It guides the reader to understand the employed procedures to learn to solve the exercises

independently The exercises are structured in a similar way The chapters begin with easy problems increasing progressively in the level of difficulty This book is written for students of physics and engineering in the framework of the new European Plans of Study for Bachelor and Master and also for tutors and lecturers [Advanced Engineering Electromagnetics](#) Constantine A. Balanis,2012-01-24 Balanis second edition of Advanced Engineering Electromagnetics a global best seller for over 20 years covers the advanced knowledge engineers involved in electromagnetic need to know particularly as the topic relates to the fast moving continually evolving and rapidly expanding field of wireless communications The immense interest in wireless communications and the expected increase in wireless communications systems projects antenna microwave and wireless communication points to an increase in the number of engineers needed to specialize in this field In addition the Instructor Book Companion Site contains a rich collection of multimedia resources for use with this text Resources include Ready made lecture notes in Power Point format for all the chapters Forty nine MATLAB programs to compute plot and animate some of the wave phenomena Nearly 600 end of chapter problems that s an average of 40 problems per chapter 200 new problems 50% more than in the first edition A thoroughly updated Solutions Manual 2500 slides for Instructors are included [Balanis' Advanced Engineering Electromagnetics](#) Constantine A. Balanis,2024-01-31 Balanis Advanced Engineering Electromagnetics The latest edition of the foundational guide to advanced electromagnetics Balanis third edition of Advanced Engineering Electromagnetics a global best seller for over 30 years covers the advanced knowledge engineers involved in electromagnetics need to know particularly as the topic relates to the fast moving continuously evolving and rapidly expanding field of wireless communications The immense interest in wireless communications and the expected increase in wireless communications systems projects antennas microwaves and wireless communications points to an increase in the number of engineers needed to specialize in this field Highlights of the 3rd Edition include A new chapter on Artificial Impedance Surfaces AIS contains material on current and advanced EM technologies including the exciting and fascinating topic of metasurfaces for Control and broadband RCS reduction using checkerboard designs Optimization of antenna fundamental parameters such as input impedance directivity realized gain amplitude radiation pattern Leaky wave antennas using 1 D and 2 D polarization diverse holographic high impedance metasurfaces for antenna radiation control and optimization Associated MATLAB programs for the design of checkerboard metasurfaces for RCS reduction and metasurface printed antennas and holographic L WA for radiation control and optimization Throughout the book there are Additional examples numerous end of chapter problems and PPT notes Fifty three MATLAB computer programs for computations graphical visualizations and animations Nearly 4 500 multicolor PowerPoint slides are available for self study or lecture use

Electromagnetics and Network Theory and their Microwave Technology Applications Stefan Lindenmeier,Robert Weigel,2011-07-13 This volume provides a discussion of the challenges and perspectives of electromagnetics and network theory and their microwave applications in all aspects It collects the most interesting contribution of the symposium

dedicated to Professor Peter Russer held in October 2009 in Munich

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David K. Cheng, 2014-03-20 Fundamental of Engineering Electromagnetics not only presents the fundamentals of electromagnetism in a concise and logical manner but also includes a variety of interesting and important applications While adapted from his popular and more extensive work Field and Wave Electromagnetics this text incorporates a number of innovative pedagogical features Each chapter begins with an overview which serves to offer qualitative guidance to the subject matter and motivate the student Review questions and worked examples throughout each chapter reinforce the student s understanding of the material Remarks boxes following the review questions and margin notes throughout the book serve as additional pedagogical aids

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Electromagnetic Fields R. Meena Kumari, 2008 This Book Offers Comprehensive Coverage Of The Subject Electromagnetism With A Clear Exposition Of The Theory Along With Practical Application The Presentation Is Very Simple To Facilitate The Independent Learning By The Readers For Each Topic There Are A Large Number Of Solved Examples So As To Aid The Readers In Grasping The Concepts The Revised Edition Includes Expanded Coverage Of Some Topics In Electrostatic And Magnetostatics A New Section On Circuit Theory And Field Theory A Complete New Set Of Solved Problems In Chapter 7 This Book Would Serve As A Useful Text For The Students Preparing For Be Amie M Sc Physics And For Various Competitive Exams Concerning The Subject

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Zoya B. Popović, Branko D. Popović, 2000 Modern Introductory Electromagnetics relates physical principles to engineering

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web for this task students will create and solve a problem that addresses a situation involving exponential growth or decay students imagine that the school s math department is

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web students must decide in each case which growth law is being described this task serves as a good lead in to the section where students start comparing linear and exponential

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web use the properties of exponents including rational exponents and manipulate algebraic statements involving radicals discriminate between equations and identities in this

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web oct 3 2022 as we mentioned in section 6 1 exponential and logarithmic functions are used to model a wide variety of behaviors in the real world in the examples that follow

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web understand that a function from one set called the domain to another set called the range assigns to each element of the domain exactly one element of the range if f is a

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web why the purpose of this instructional task is to provide an opportunity for students to use and interpret the meaning of a

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web im commentary this task gives a variety of real life contexts which could be modeled by a linear or exponential function the key distinguishing feature between the two is

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web this lesson unit is intended to help you assess how well students are able to interpret exponential and linear functions and in particular to identify and help students who

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web performance task 1 suppose you invest dollars to earn an annual interest rate of percent as a decimal after years the value of the investment with interest compounded yearly is the value with interest compounded continuously is

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web in all three performance tasks students practice modeling with exponential functions through creating exponential function tables exponential function graphs

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web the core elements of performance required by this task are work with graphs and equations of linear and non linear functions based on these credit for specific aspects

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web mrs betz this is a performance task with two parts each including a rubric part one is about exponential decay and part two covers exponential growth students will