Following Exercise questions are IMPORTANT!
2.4, 2.5, 2.13, 2.14, 2.16 ,2.17, 2.18, 2.19, 2.22, 2.23, 2.27, 2.28,2.29,2.30,2.31

D2.1 (a). $Q_A = -20\mu C$ located at A(-6,4,7) ,$Q_B = 50\mu C$ located at B(5,8,-2)
Find $\vec{R}_{AB}$

$$\vec{R}_{AB} = (5 - (-6)\hat{a}_x + (8 - 4)\hat{a}_y + (-2 - 7)\hat{a}_z = 11\hat{a}_x + 4\hat{a}_y - 9\hat{a}_z$$

(b). $\mid \vec{R}_{AB} \mid = \sqrt{(11^2) + 4^2 + (-9)^2} = 14.76m$

(c). $\vec{F}_{AB} = Q_A Q_B \vec{R}_{AB}/4\pi\epsilon_o \mid \vec{R}_{AB} \mid^3 = (-20 \times 10^{-6} \times 50 \times 10^{-6}(11\hat{a}_x + 4\hat{a}_y - 9\hat{a}_z))/(4\pi \times (10^{-9}/36\pi) \mid 14.76 \mid^3)$
$\Rightarrow \vec{F}_{AB} = 30.76\hat{a}_x + 11.184\hat{a}_y - 25.16\hat{a}_z mN$

(d). $\vec{F}_{AB} = Q_A Q_B \vec{R}_{AB}/4\pi\epsilon_o \mid \vec{R}_{AB} \mid^3 = (-20 \times 10^{-6} \times 50 \times 10^{-6}(11\hat{a}_x + 4\hat{a}_y - 9\hat{a}_z))/(4\pi \times 8.85 \times 10^{-12} \mid 14.76 \mid^3)$
$\Rightarrow \vec{F}_{AB} = 30.72\hat{a}_x + 11.169\hat{a}_y - 25.13\hat{a}_z mN$

D2.2(a). $Q_A = -0.3\mu C$ located at A(25,-30,15) in cm ,$Q_B = 0.5\mu C$ located at B(-10,8,12)

Find $\vec{E}$ at the origin O(0,0,0).
Let $\vec{E}$ at the origin is denoted by $\vec{E}_o$ and it will be the sum of $\vec{E}_A$ ($\vec{E}$ due to Q_A located at point A)
and $\vec{E}_B$ ($\vec{E}$ due to Q_B located at point B)
$\vec{E}_A = Q_A\vec{R}_{OA}/4\pi\epsilon_o \mid \vec{R}_{OA} \mid^3$
$\vec{R}_{OA} = (0 - 25)\hat{a}_x + (0 - (-30)\hat{a}_y + (0 - 15)\hat{a}_z = (-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)cm$
$\mid \vec{R}_{OA} \mid = \sqrt{(-25)^2 + (30)^2 + (-15)^2} = 41.83cm$
$\vec{E}_A = (-0.3 \times 10^{-6}) \times (-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z) \times 10^{-2}/4\pi \times 8.85 \times 10^{-12} \times \mid 41.83 \times 10^{-2} \mid^3 = -368.55(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)$
$\vec{E}_B = Q_B\vec{R}_{OB}/4\pi\epsilon_o \mid \vec{R}_{OB} \mid^3$
$\vec{R}_{OB} = (0 - (-10))\hat{a}_x + (0 - 8)\hat{a}_y + (0 - 12)\hat{a}_z = (10\hat{a}_x - 8\hat{a}_y - 12\hat{a}_z)cm$
$\mid \vec{R}_{OB} \mid = \sqrt{(10)^2 + (-8)^2 + (-12)^2} = 17.55cm$
$\vec{E}_B = (0.5 \times 10^{-6}) \times (-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z) \times 10^{-2}/4\pi \times 8.85 \times 10^{-12} \times \mid 17.55 \times 10^{-2} \mid^3 = 8317.36(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)$
$\vec{E}_o = \vec{E}_A + \vec{E}_B = (-368.55(-25\hat{a}_x + 30\hat{a}_y - 15\hat{a}_z)) + 8317.36(10\hat{a}_x - 8\hat{a}_y - 12\hat{a}_z) = (92.3\hat{a}_x - 77.6\hat{a}_y - 94.2\hat{a}_z)KV/m$

(b). Find $\vec{E}$ at the point P(15,20,50).
It is the same as part(a) but this time we have to calculate $\vec{R}_{PA}$ and $\vec{R}_{PB}$ and the rest of the problem is similar to part(a)

D2.3 (a).
$\Sigma_0^5((1 + (-1)^m)/(m^2 + 1)) = (1 + (-1)^0)/(0^2 + 1) + (1 + (-1)^1)/(1^2 + 1) + (1 + (-1)^2)/(2^2 + 1) + (1 + (-1)^3)/(3^2 + 1) + (1 + (-1)^4)/(4^2 + 1) + (1 + (-1)^5)/(5^2 + 1) = 2 + 0 + 2/5 + 0 + 2/17 + 0 = 2.52$

(b). Similar to the part(a)

D2.4 (a). $0.1 \leq (\mid x \mid, \mid y \mid, \mid z \mid) \leq 0.2$, given ranges of x,y and z co-ordinates doesnot constitute a cubical volume so $dv = 0 \Rightarrow Q = \int_{vol} \rho_v dv = 0$

(b). Differential volume in cylindrical co-ordinates is given by $dv = \rho d\rho d\phi dz$, we have $Q = \int_{vol} \rho_v dv$
$\Rightarrow Q = \int_{vol}(\rho^2 z^2 \sin(0.6\phi))\rho d\rho d\phi dz = \int_0^{0.1} \int_0^{\pi} \int_2^4 (\rho^2 z^2 \sin(0.6\phi))\rho d\rho d\phi dz = \int_0^{0.1} \rho^3 d\rho \int_0^{\pi} (\sin(0.6\phi))d\phi \int_2^4 dz$
$\Rightarrow Q = \mid \rho^4/4 \mid_0^{0.1} \times \mid (-\cos(0.6\phi))/0.6 \mid_0^{\pi} \times \mid z \mid_2^4 = \mid (0.1)^4/4 \mid \times \mid (-\cos(108^o) - (-\cos(0)))/0.6 \mid \times \mid (64 - 8)/3 \mid$
$\Rightarrow Q = \mid (0.1)^4/4 \mid \times \mid (1.31)/0.6 \mid \times \mid 56/3 \mid = 1.018mC$

Engineering Electromagnetics 7th Edition Chapter Problems Solutions

Yeon Ho Lee

Engineering Electromagnetics 7th Edition Chapter Problems Solutions:

   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

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structures available the applications covered in this book are made to some of the most basic and practical antenna configurations Among these antenna configurations are linear dipoles loops arrays broadband antennas aperture antennas horns microstrip antennas and reflector antennas The text contains sufficient mathematical detail to enable undergraduate and beginning graduate students in electrical engineering and physics to follow the flow of analysis and design Readers should have a basic knowledge of undergraduate electromagnetic theory including Maxwell s equations and the wave equation introductory physics and differential and integral calculus Presents new sections on flexible and conformal bowtie Vivaldi antenna antenna miniaturization antennas for mobile communications dielectric resonator antennas and scale modeling Provides color and gray scale figures and illustrations to better depict antenna radiation characteristics Includes access to a companion website housing MATLAB programs Java based applets and animations Power Point notes Java based interactive questionnaires and a solutions manual for instructors Introduces over 100 additional end of chapter problems Antenna Theory Analysis and Design Fourth Edition is designed to meet the needs of senior undergraduate and beginning graduate level students in electrical engineering and physics as well as practicing engineers and antenna designers Constantine A Balanis received his BSEE degree from the Virginia Tech in 1964 his MEE degree from the University of Virginia in 1966 his PhD in Electrical Engineering from The Ohio State University in 1969 and an Honorary Doctorate from the Aristotle University of Thessaloniki in 2004 From 1964 to 1970 he was with the NASA Langley Research Center in Hampton VA and from 1970 to 1983 he was with the Department of Electrical Engineering of West Virginia University In 1983 he joined Arizona State University and is now Regents Professor of Electrical Engineering Dr Balanis is also a life fellow of the IEEE **Applied Electromagnetics** Stuart M. Wentworth,2025-09-09 A timely and authoritative update to a leading text on the applied electromagnetics of transmission lines In the newly revised second edition of Applied Electromagnetics Early Transmission Lines Approach experienced engineer and professor Stuart Wentworth delivers an up to date and authoritative discussion of the electromagnetic foundations of signal transmission The book explains practical applications for wireless systems transmission lines waveguides including optical fiber and antennas Wentworth provides a detailed theoretical grounding of the subject and combines it with hands on MATLAB simulations available on the web that help students understand critical concepts Brand new end of chapter problems at a broad range of difficulty levels Many more drill and example problems Worked solutions provided on the companion website Extensively updated material as well as entirely new material on metamaterials and patch antennas Perfect for undergraduate students of electrical engineering Applied Electromagnetics Early Transmission Lines Approach will also benefit researchers and educators in electrical engineering **Numerical Techniques in Electromagnetics, Second Edition** Matthew N.O. Sadiku,2000-07-12 As the availability of powerful computer resources has grown over the last three decades the art of computation of electromagnetic EM problems has also grown exponentially Despite this dramatic growth however the EM community lacked a

comprehensive text on the computational techniques used to solve EM problems The first edition of Numerical Techniques in Electromagnetics filled that gap and became the reference of choice for thousands of engineers researchers and students The Second Edition of this bestselling text reflects the continuing increase in awareness and use of numerical techniques and incorporates advances and refinements made in recent years Most notable among these are the improvements made to the standard algorithm for the finite difference time domain FDTD method and treatment of absorbing boundary conditions in FDTD finite element and transmission line matrix methods The author also added a chapter on the method of lines Numerical Techniques in Electromagnetics continues to teach readers how to pose numerically analyze and solve EM problems give them the ability to expand their problem solving skills using a variety of methods and prepare them for research in electromagnetism Now the Second Edition goes even further toward providing a comprehensive resource that addresses all of the most useful computation methods for EM problems   Circuit Oriented Electromagnetic Modeling Using the PEEC Techniques Albert Ruehli,Giulio Antonini,Lijun Jiang,2017-05-25 Bridges the gap between electromagnetics and circuits by addressing electrometric modeling EM using the Partial Element Equivalent Circuit PEEC method This book provides intuitive solutions to electromagnetic problems by using the Partial Element Equivalent Circuit PEEC method This book begins with an introduction to circuit analysis techniques laws and frequency and time domain analyses The authors also treat Maxwell s equations capacitance computations and inductance computations through the lens of the PEEC method Next readers learn to build PEEC models in various forms equivalent circuit models non orthogonal PEEC models skin effect models PEEC models for dielectrics incident and radiate field models and scattering PEEC models The book concludes by considering issues like stability and passivity and includes five appendices some with formulas for partial elements Leads readers to the solution of a multitude of practical problems in the areas of signal and power integrity and electromagnetic interference Contains fundamentals applications and examples of the PEEC method Includes detailed mathematical derivations Circuit Oriented Electromagnetic Modeling Using the PEEC Techniques is a reference for students researchers and developers who work on the physical layer modeling of IC interconnects and Packaging PCBs and high speed links

Wavelet Applications in Engineering Electromagnetics Tapan K. Sarkar,Magdalena Salazar-Palma,Michael C. Wicks,2002 Written from an engineering perspective this unique resource describes the practical application of wavelets to the solution of electromagnetic field problems and in signal analysis with an even handed treatment of the pros and cons A key feature of this book is that the wavelet concepts have been described from the filter theory point of view that is familiar to researchers with an electrical engineering background The book shows you how to design novel algorithms that enable you to solve electrically large electromagnetic field problems using modest computational resources It also provides you with new ideas in the design and development of unique waveforms for reliable target identification and practical radar signal analysis The book includes more then 500 equations and covers a wide range of topics from numerical methods to signal processing

aspects   Modern Antenna Handbook Constantine A. Balanis,2011-09-20 The most up to date comprehensive treatment of classical and modern antennas and their related technologies Modern Antenna Handbook represents the most current and complete thinking in the field of antennas The handbook is edited by one of the most recognizable prominent and prolific authors educators and researchers on antennas and electromagnetics Each chapter is authored by one or more leading international experts and includes cover age of current and future antenna related technology The information is of a practical nature and is intended to be useful for researchers as well as practicing engineers From the fundamental parameters of antennas to antennas for mobile wireless communications and medical applications Modern Antenna Handbook covers everything professional engineers consultants researchers and students need to know about the recent developments and the future direction of this fast paced field In addition to antenna topics the handbook also covers modern technologies such as metamaterials microelectromechanical systems MEMS frequency selective surfaces FSS and radar cross sections RCS and their applications to antennas while five chapters are devoted to advanced numerical computational methods targeted primarily for the analysis and design of antennas   **The Finite Element Method in Heat Transfer and Fluid Dynamics** J. N. Reddy,D.K. Gartling,2010-04-06 As Computational Fluid Dynamics CFD and Computational Heat Transfer CHT evolve and become increasingly important in standard engineering design and analysis practice users require a solid understanding of mechanics and numerical methods to make optimal use of available software Considered to be among the very best in the field this masterwork from renowned experts J N Reddy and D K Gartling is the latest version of a book that has long been relied upon by practicing engineers researchers and graduate students Noted for its powerful methodology and clear explanations of the subject this third edition contains considerably more workable exercises and examples associated with problems in heat conduction incompressible viscous flow and convection heat transfer It also uses applied examples to illustrate applications of FEM in thermal and fluid design analysis   **Issues in Electronics Research and Application: 2011 Edition** ,2012-01-09 Issues in Electronics Research and Application 2011 Edition is a ScholarlyEditions eBook that delivers timely authoritative and comprehensive information about Electronics Research and Application The editors have built Issues in Electronics Research and Application 2011 Edition on the vast information databases of ScholarlyNews You can expect the information about Electronics Research and Application in this eBook to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Issues in Electronics Research and Application 2011 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at http www ScholarlyEditions com   Introduction to Subsurface Imaging Bahaa Saleh,2011-03-17 Describing and evaluating the basic principles and methods

of subsurface sensing and imaging Introduction to Subsurface Imaging is a clear and comprehensive treatment that links theory to a wide range of real world applications in medicine biology security and geophysical environmental exploration It integrates the different sensing techniques acoustic electric electromagnetic optical x ray or particle beams by unifying the underlying physical and mathematical similarities and computational and algorithmic methods Time domain spectral and multisensor methods are also covered whilst all the necessary mathematical statistical and linear systems tools are given in useful appendices to make the book self contained Featuring a logical blend of theory and applications a wealth of color illustrations homework problems and numerous case studies this is suitable for use as both a course text and as a professional reference **Computational Electromagnetics for RF and Microwave Engineering** David B. Davidson,2005-02-24 The numerical approximation of Maxwell s equations Computational Electromagnetics CEM has emerged as a crucial enabling technology for radio frequency microwave and wireless engineering The three most popular full wave methods the Finite Difference Time Domain Method the Method of Moments and the Finite Element Method are introduced in this book by way of one or two dimensional problems Commercial or public domain codes implementing these methods are then applied to complex real world engineering problems and a careful analysis of the reliability of the results obtained is performed along with a discussion of the many pitfalls which can result in inaccurate and misleading solutions The book will empower readers to become discerning users of CEM software with an understanding of the underlying methods and confidence in the results obtained It also introduces readers to the art of code development Aimed at senior undergraduate graduate students taking CEM courses and practising engineers in the industry **Light-Matter Interaction** John Weiner,Frederico Nunes,2017-01-26 Light matter interaction is pervasive throughout the disciplines of optical and atomic physics condensed matter physics electrical engineering and now increasingly in biology and medicine with frequency and length scales extending over many orders of magnitude Deep earth and sea communications use frequencies of a few tens of Hz and X ray imaging requires sources oscillating at hundreds of petaHz This book provides advanced undergraduates graduate students and researchers from diverse disciplines with the principal tools required to understand and contribute to rapidly advancing developments in light matter interaction centred at optical frequencies and length scales from a few hundred nanometres to a few hundredths of a nanometre This book deploys an arsenal of powerful analytic tools to render this multidisciplinary subject in unique form not encountered in standard Physics or Electrical Engineering text books This new edition has been substantially expanded with almost 200 pages of new material Several new and extended chapters treat momentum flow between fields and matter metamaterials and atom optical forces applied to atomic and molecular cooling and trapping **Introduction to Electromagnetic Engineering** Roger F. Harrington,2003-01-01 This study of electromagnetic theory introduces students to a broad range of quantities and concepts imparting the necessary vector analysis and associated mathematics and reinforcing its teachings with several elementary

field problems Based on circuit theory rather than on the classical force relationship approach the text uses the theory of electric circuits to provide a system of experiments already familiar to the electrical engineer a series of field concepts are then introduced as a logical extension of circuit theory Virtually unobtainable elsewhere this text was written by a prominent professor whose recognition includes the prestigious IEEE Electromagnetics Award It is appropriate for advanced undergraduate and graduate students with a background in calculus and circuit theory 176 Figures 9 Tables *Evolution of Knowledge Science* Syed V. Ahamed,2016-10-25 Evolution of Knowledge Science Myth to Medicine Intelligent Internet Based Humanist Machines explains how to design and build the next generation of intelligent machines that solve social and environmental problems in a systematic coherent and optimal fashion The book brings together principles from computer and communication sciences electrical engineering mathematics physics social sciences and more to describe computer systems that deal with knowledge its representation and how to deal with knowledge centric objects Readers will learn new tools and techniques to measure enhance and optimize artificial intelligence strategies for efficiently searching through vast knowledge bases as well as how to ensure the security of information in open easily accessible and fast digital networks Author Syed Ahamed joins the basic concepts from various disciplines to describe a robust and coherent knowledge sciences discipline that provides readers with tools units and measures to evaluate the flow of knowledge during course work or their research He offers a unique academic and industrial perspective of the concurrent dynamic changes in computer and communication industries based upon his research The author has experience both in industry and in teaching graduate level telecommunications and network architecture courses particularly those dealing with applications of networks in education Presents a current perspective of developments in central display signal and graphics processor units as they apply to designing knowledge systems Offers ideas and methodologies for systematically extending data and object processing in computing into other disciplines such as economics mathematics and management Provides best practices and designs for engineers alongside case studies that illustrate practical implementation ideas across multiple domains **Numerical Techniques in Electromagnetics with MATLAB** Matthew N.O. Sadiku,2018-10-08 Despite the dramatic growth in the availability of powerful computer resources the EM community lacks a comprehensive text on the computational techniques used to solve EM problems The first edition of Numerical Techniques in Electromagnetics filled that gap and became the reference of choice for thousands of engineers researchers and students This third edition of the bestselling text reflects the continuing increase in awareness and use of numerical techniques and incorporates advances and refinements made in recent years Most notable among these are the improvements made to the standard algorithm for the finite difference time domain FDTD method and treatment of absorbing boundary conditions in FDTD finite element and transmission line matrix methods The author also has added a chapter on the method of lines Numerical Techniques in Electromagnetics with MATLAB Third Edition continues to teach readers how to pose numerically analyze and solve EM problems to give them the

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