

1.51. (a) We have

$$e^{i\theta} = \cos \theta + j \sin \theta, \quad (E1.51-1)$$

and

$$e^{-i\theta} = \cos \theta - j \sin \theta. \quad (E1.51-2)$$

Summing eqs. (E1.51-1) and (E1.51-2) we get

$$\cos \theta = \frac{1}{2}(e^{i\theta} + e^{-i\theta}).$$

(b) Subtracting eq. (E1.51-2) from (E1.51-1) we get

$$\sin \theta = \frac{1}{2j}(e^{i\theta} - e^{-i\theta}).$$

(c) We now have $e^{i(\theta+\phi)} = e^{i\theta}e^{i\phi}$. Therefore,

$$\begin{aligned} \cos(\theta + \phi) + j \sin(\theta + \phi) &= (\cos \theta \cos \phi - \sin \theta \sin \phi) + j(\sin \theta \cos \phi + \cos \theta \sin \phi). \end{aligned} \quad (E1.51-3)$$

Putting $\theta = \phi$ in eq. (E1.51-3), we get

$$\cos 2\phi + j \sin 2\phi = \cos^2 \phi - \sin^2 \phi + j 2 \cos \phi \sin \phi.$$

Putting $\theta = -\phi$ in eq. (E1.51-3), we get

$$1 + j \sin^2 \phi = \cos^2 \phi.$$

Adding the two above equations and simplifying,

$$\cos^2 \phi = \frac{1}{2}(1 + \cos 2\phi).$$

(d) Repeating the real parts in eq. (E1.51-3) with arguments $(\theta + \phi)$ and $(\theta - \phi)$ we get

$$\cos(\theta + \phi) + \cos(\theta - \phi) = \cos \theta \cos \phi - \sin \theta \sin \phi + \cos \theta \cos \phi + \sin \theta \sin \phi.$$

and

$$\cos(\theta - \phi) = \cos \theta \cos \phi + \sin \theta \sin \phi.$$

Subtracting the two above equations, we obtain

$$\sin \theta \sin \phi = \frac{1}{2}[\cos(\theta + \phi) - \cos(\theta - \phi)].$$

(e) Repeating imaginary parts in eq. (E1.51-3), we get

$$\sin(\theta + \phi) - \sin(\theta - \phi) = \sin \theta \cos \phi + \cos \theta \sin \phi + \sin \theta \cos \phi - \cos \theta \sin \phi.$$

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(a) Since $x_1 + 3x_2 > 0$ and $-1 \leq \cos(\theta_1 - \theta_2) \leq 1$,

$$\begin{aligned} |z_1| - |z_2| &= |x_1 e^{j\theta_1} - x_2 e^{j\theta_2}| \\ &\leq |x_1 - x_2| + |x_2 \cos(\theta_1 - \theta_2)| \\ &\leq |x_1 - x_2| + |x_2| \\ &= |x_1 + x_2|. \end{aligned}$$

and

$$|z_1| + |z_2| = |x_1| + |x_2| \leq |x_1 + x_2| \leq |z_1 - z_2|.$$

1.52. (a) For $a = 1$, it is fairly obvious that

$$\sum_{n=0}^{\infty} a^n = N.$$

For $a \neq 1$, we may write

$$(1 - a) \sum_{n=0}^{\infty} a^n = \sum_{n=0}^{\infty} a^n - \sum_{n=1}^{\infty} a^n = 1 - a^N.$$

Therefore,

$$\sum_{n=0}^{\infty} a^n = \frac{1 - a^N}{1 - a}.$$

(b) For $|a| < 1$,

$$\lim_{N \rightarrow \infty} a^N = 0.$$

Therefore, from the result of the previous part,

$$\lim_{N \rightarrow \infty} \sum_{n=0}^N a^n = \sum_{n=0}^{\infty} a^n = \frac{1}{1 - a}.$$

(c) Differentiating both sides of the result of part (b) w.r.t. a , we get

$$\begin{aligned} \frac{d}{da} \left(\sum_{n=0}^{\infty} a^n \right) &= \frac{d}{da} \left(\frac{1}{1 - a} \right) \\ \sum_{n=0}^{\infty} n a^{n-1} &= \frac{1}{(1 - a)^2}. \end{aligned}$$

(d) We may write

$$\sum_{n=0}^{\infty} n a^n = a^2 \sum_{n=2}^{\infty} n a^{n-2} = \frac{a^2}{1 - a} \quad \text{for } |a| < 1.$$

1.53. (a) The desired sum is

$$\sum_{n=0}^{\infty} j^n e^{j\theta n} = \frac{1 - (-j)e^{j\theta}}{1 - (-j)e^{j\theta}} = 1 + j.$$

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1.53. (a) $e^{j\theta} = \cos \theta + j \sin \theta$

(b) $e^{j\theta} = \cos \theta + j \sin \theta$

(c) $e + e^{j\theta} = \cos \theta + j \sin \theta + e = \cos \theta + 2e + j \sin \theta$

(d) $e - e^{j\theta} = \cos \theta + j \sin \theta - e = 2e - \cos \theta - j \sin \theta$

(e) $(e_1 + e_2)^2 = 4e_1 e_2 + e_1^2 + e_2^2 = 4e + 2e + 2e = 12e$

(f) Consider $\cos \theta e^{j\theta}$ for $\theta > 0$.

$$\cos \theta e^{j\theta} = (\cos \theta \cos \theta - \sin \theta \sin \theta) + j \cos \theta \sin \theta = \cos^2 \theta - \sin^2 \theta + j 2 \cos \theta \sin \theta.$$

For $\theta < 0$, $e = \cos \theta$. Therefore,

$$\cos \theta e^{j\theta} = (\cos \theta \cos \theta + \sin \theta \sin \theta) + j \cos \theta \sin \theta = \cos^2 \theta + \sin^2 \theta + j \cos \theta \sin \theta = \cos \theta e^{j\theta}.$$

(g) For $\theta = 0$,

$$\left(\frac{e}{2} \right)^2 = \frac{e^2}{4} \cos^2 \theta + \frac{e^2}{4} \sin^2 \theta = \frac{e^2}{4}$$

(h) From (c), we get

$$N \cos \left(\frac{\theta}{2} \right) = \frac{1}{2} \left[\left(\frac{e}{2} \right) + \left(\frac{e}{2} \right) \right].$$

Using (g) in this, we get

$$N \cos \left(\frac{\theta}{2} \right) = \frac{1}{2} \left[\left(\frac{e}{2} \right) + \left(\frac{e}{2} \right) \right] = \frac{1}{2} \left[\frac{e \cos^2 \theta + e \sin^2 \theta}{2} \right].$$

1.54. (a) $(x_1 + x_2)^2 = x_1^2 + x_2^2 + 2x_1 x_2 = x_1^2 + x_2^2 + 2|x_1 x_2|$.

(b) Let $x_1 = x_2 = a$ and $a = e^{j\theta}$. Then,

$$\begin{aligned} |x_1 + x_2|^2 &= |e^{j\theta} + e^{j\theta}|^2 = 4|e^{j\theta}|^2 = 4 \\ &= |e^{j\theta} + e^{j\theta}|^2 = 4|e^{j\theta}|^2 = 4 \end{aligned}$$

(c) $|z| = |x_1 e^{j\theta_1} + x_2 e^{j\theta_2}| = |x_1| + |x_2| = 2$

(d) $|z_1 z_2| = |x_1 x_2 e^{j(\theta_1 + \theta_2)}| = |x_1 x_2| = |x_1| |x_2| = 2$

(e) Since $a = a + jx$, $|a| = \sqrt{a^2 + x^2}$. By the triangle inequality,

$$|a - (-x)| = |a| + |x| \leq \sqrt{a^2 + x^2} + |x| = |a|$$

and

$$|a + (-x)| = |a| - |x| \leq \sqrt{a^2 + x^2} = |a|.$$

(f) $|x_1 + x_2| \leq |x_1| + |x_2| = 2|e^{j\theta}| + 2|e^{j\theta}| = 4|e^{j\theta}| = 4$

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(a) The desired sum is

$$\sum_{n=0}^{\infty} j^n e^{j\theta n} = \frac{1 - (-j)e^{j\theta}}{1 - (-j)e^{j\theta}} = -1 + j.$$

(b) The desired sum is

$$\sum_{n=0}^{\infty} (1 + j)^n e^{j\theta n} = \frac{1}{1 - (1 + j)e^{j\theta}} = \frac{1}{2} + j \frac{1}{2}.$$

(c) The desired sum is

$$\sum_{n=0}^{\infty} (1 + j)^n e^{j\theta n} = (1 + j)^2 e^{j\theta} \sum_{n=0}^{\infty} (1 + j)^n e^{j\theta n} = -\frac{1}{2} \left[\frac{1}{2} + j \frac{1}{2} \right].$$

(d) The desired sum is

$$\sum_{n=0}^{\infty} \cos(n\theta) = \frac{1}{2} \sum_{n=0}^{\infty} e^{jn\theta} + \frac{1}{2} \sum_{n=0}^{\infty} e^{-jn\theta} = \frac{1}{2}(1 + 2) + \frac{1}{2}(1 - 2) = 1.$$

(e) The desired sum is

$$\begin{aligned} \sum_{n=0}^{\infty} (1 + j)^n \cos(n\theta) &= \frac{1}{2} \sum_{n=0}^{\infty} (1 + j)^n e^{jn\theta} + \frac{1}{2} \sum_{n=0}^{\infty} (1 + j)^n e^{-jn\theta} \\ &= \frac{1}{2} \left[\frac{1}{2} + j \frac{1}{2} \right] + \frac{1}{2} \left[\frac{1}{2} - j \frac{1}{2} \right] = \frac{1}{2}. \end{aligned}$$

1.56. (a) The desired integral is

$$\int_0^{\infty} e^{-\alpha x} dx = \frac{e^{-\alpha x}}{-\alpha} \Big|_0^{\infty} = \frac{1}{\alpha}.$$

(b) The desired integral is

$$\int_0^{\infty} e^{-\alpha x} dx = \frac{e^{-\alpha x}}{-\alpha} \Big|_0^{\infty} = -\frac{1}{\alpha} (0 - 1) = \frac{1}{\alpha}.$$

(c) The desired integral is

$$\int_0^{\infty} e^{-\alpha x} dx = \frac{e^{-\alpha x}}{-\alpha} \Big|_0^{\infty} = -\frac{1}{\alpha} (0 - 1) = \frac{1}{\alpha}.$$

(d) The desired integral is

$$\int_0^{\infty} e^{-\alpha x} dx = \frac{e^{-\alpha x}}{-\alpha} \Big|_0^{\infty} = -\frac{1}{\alpha} (0 - 1) = \frac{1}{\alpha}.$$

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Anthony S. Fauci



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Discrete-Time Signals and Systems Oktay Alkin, 2025-03-27 Drawing on author's 30 years of teaching experience Discrete Time Signals and Systems A MATLAB Integrated Approach represents a novel and comprehensive approach to understanding signals and systems theory Many textbooks use MATLAB as a computational tool but Alkin's text employs MATLAB both computationally and pedagogically to provide interactive visual reinforcement of fundamental concepts important in the study of discrete time signals and systems In addition to 204 traditional end of chapter problems and 160 solved examples the book includes hands on MATLAB modules consisting of 108 MATLAB based homework problems and projects coordinated with the traditional end of chapter problems 44 live scripts and GUI based interactive apps that animate key figures and bring core concepts to life Downloadable MATLAB code for most of the solved examples 92 fully detailed MATLAB exercises that involve step by step development of code to simulate the relevant signal and or system being discussed including some case studies on topics such as real time audio processing synthesizers electrocardiograms sunspot numbers etc The ebook version includes clickable links that allow running MATLAB code associated with solved examples and exercises in a browser using the online version of MATLAB It also includes audio and video files for some of the examples Each module or application is linked to a specific segment of the text to ensure seamless integration between learning and doing The aim is to not simply give the student just another toolbox of MATLAB functions but to use the development of MATLAB code as part of the learning process or as a litmus test of students understanding of the key concepts All relevant MATLAB code is freely available from the publisher In addition a solutions manual figures presentation slides and other ancillary materials are available for instructors with qualifying course adoption [Computer Explorations in Signals and](#)

Systems Using MATLAB John R. Buck, Michael M. Daniel, Andrew Singer, 2002 For undergraduate courses on Signals and Linear Systems This book contains a comprehensive set of computer exercises of varying levels of difficulty covering the fundamentals of signals and systems The exercises require the reader to compare answers they compute in MATLAB R with results and predictions made based on their understanding of the material The book is compatible with any introductory course or text on signals and systems

Introduction to Random Signals and Applied Kalman Filtering with Matlab Exercises and Solutions Robert Grover Brown, Patrick Y. C. Hwang, 1997 In this updated edition the main thrust is on applied Kalman filtering Chapters 1-3 provide a minimal background in random process theory and the response of linear systems to random inputs The following chapter is devoted to Wiener filtering and the remainder of the text deals with various facets of Kalman filtering with emphasis on applications Starred problems at the end of each chapter are computer exercises The authors believe that programming the equations and analyzing the results of specific examples is the best way to obtain the insight that is essential in engineering work

Nonlinear Dynamics and Chaos with Student Solutions Manual Steven H. Strogatz, 2018-09-21 This textbook is aimed at newcomers to nonlinear dynamics and chaos especially students taking a first course in the subject The presentation stresses analytical methods concrete examples and geometric intuition The theory is developed systematically starting with first order differential equations and their bifurcations followed by phase plane analysis limit cycles and their bifurcations and culminating with the Lorenz equations chaos iterated maps period doubling renormalization fractals and strange attractors

Signal Processing Techniques for Communication K.C. Raveendranathan, 2024-10-30 The reference text discusses signal processing tools and techniques used for the design testing and deployment of communication systems It further explores software simulation and modeling tools like MATLAB GNU Octave Mathematica and Python for modeling simulation and detailed analysis leading to comprehensive insights into communication systems The book explains topics such as source coding pulse demodulation systems and the principle of sampling and aliasing This book Discusses modern techniques including analog and digital filter design and modulation principles including quadrature amplitude modulation and differential phase shift keying Covers filter design using MATLAB system simulation using Simulink signal processing toolbox linear time invariant systems and non linear time variant systems Explains important pulse keying techniques including Gaussian minimum shift keying and quadrature phase shift keying Presents signal processing tools and techniques for communication systems design modeling simulation and deployment Illustrates topics such as software defined radio SDR systems spectrum sensing and automated modulation sensing The text is primarily written for senior undergraduates graduate students and academic researchers in the fields of electrical engineering electronics and communication engineering computer science and engineering

Contemporary Linear Systems Using MATLAB Robert D. Strum, Donald E. Kirk, 1994 This is a title in the PWS series BookWare Companion Series It is a set of correlated self contained courseware modules covering fundamental concepts in engineering and applied

mathematics Students work through example problems electronically and are encouraged to experiment with problems and data in an electronic lab setting Each BookWare Companion features a software script for the electronic examples based on a popular applications software package for the IBM PC or the Macintosh and a printed volume containing computer based exploration exercises and a variety of learning aids and hints The text bolstered by illustrative examples 200 problems and MATLAB exploration exercises on the accompanying data disk should enable students to work with linear systems problems in a virtual laboratory at the computer changing problem values at will in a what if fashion

Multirate Filtering for Digital Signal Processing: MATLAB Applications Milic, Ljiljana,2009-01-31 This book covers basic and the advanced approaches in the design and implementation of multirate filtering Provided by publisher *Symbolic and Knowledge-based Signal Processing* Alan V. Oppenheim,Syed Hamid Nawab,1992 Aimed at signal processors and computer scientists this book of self contained discussions explores how computer science can enhance the performance of signal processing systems and their design

Digital Signal Processing David J. DeFatta,Joseph G. Lucas,William S. Hodgkiss,1988-03-22 Provides a new methodology for performing system design of signal processing applications offering easy to follow procedures which can be implemented on personal computers Topics covered include a structured approach to filter design with closed form equations for classical IIR filter implementations in 2nd order cascaded stages radix 4 overlap FFT processing gain computation procedure and results for popular windows and comprehensive finite arithmetic analysis procedure for cascaded implementations Multirate processing is covered along with a system design of a high resolution detection application showing the procedure for analyzing the hardware and software architecture requirements BASIC routines are provided for several DSP operations

Adaptive Digital Filters and Signal Analysis Maurice Bellanger,1987 This text emphasizes the intricate relationship between adaptive filtering and signal analysis highlighting stochastic processes signal representations and properties analytical tools and implementation methods

ICASSP '95 ,1995 **Proceedings** American Society for Engineering Education. Conference,1995

Digital Processing of Signals Maurice Bellanger,1989-05-25 An introductory textbook which examines the principles of digital processing compares the merits of various techniques and aims to present the most valuable results in a form suitable for implementation in system design Each chapter contains exercises to test the reader s understanding

Modern Medicine, Its Theory and Practice: Diseases of the nervous system Sir William Osler,1910

Modern Medicine, Its Theory and Practice: Diseases of the nervous system, diseases of the locomotor system Sir William Osler,Thomas McCrae,1915

The Cumulative Book Index ,1998 A world list of books in the English language

Subject Guide to Books in Print ,1993

Fortran 77 with Numerical Methods for Engineers and Scientists D. M. Etter,1992

Computers in Education Journal ,1997

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