1.51. (a) We have
$$e^{j\theta} = \cos\theta + j\sin\theta \qquad (51.56-1)$$
and
$$e^{-j\theta} = \cos\theta - j\sin\theta \qquad (51.51-2)$$

Summing eqs. (51.51-1) and (51.51-2), we get
$$\cos\theta = \frac{1}{2}\left(e^{j\theta} + e^{-j\theta}\right).$$

(b) Subtracting eq. (51.51-2) from (51.51-1), we get
$$\sin\theta = \frac{1}{2j}\left(e^{j\theta} - e^{-j\theta}\right).$$

(c) We now have $e^{j(\theta+\phi)} = e^{j\theta}e^{j\phi}$. Therefore,
$$\cos(\theta+\phi) + j\sin(\theta+\phi) = (\cos\theta\cos\phi - \sin\theta\sin\phi) + j(\sin\theta\cos\phi + \cos\theta\sin\phi) \qquad (51.51-3)$$

Putting $\phi = \theta$ in eq. (51.51-3), we get
$$\cos 2\theta = \cos^2\theta - \sin^2\theta.$$

Putting $\phi = -\theta$ in eq. (51.51-3), we get
$$1 = \cos^2\theta + \sin^2\theta.$$

Adding the two above equations and simplifying,
$$\cos^2\theta = \frac{1}{2}(1 + \cos 2\theta).$$

(d) Equating the real parts in eq. (51.51-3) with arguments $(\theta+\phi)$ and $(\theta-\phi)$, we get
$$\cos(\theta+\phi) = \cos\theta\cos\phi - \sin\theta\sin\phi$$
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) Equating imaginary parts in eq. (51.51-3), we get
$$\sin(\theta+\phi) = \sin\theta\cos\phi + \cos\theta\sin\phi.$$

(g) Since $r_1 > 0, r_2 > 0$ and $-1 \le \cos(\theta_1 - \theta_2) \le 1$,
$$|z_1 - z_2|^2 = r_1^2 + r_2^2 - 2r_1 r_2$$
$$\le r_1^2 + r_2^2 + 2r_1 r_2 \cos(\theta_1 - \theta_2)$$
$$= |z_1 + z_2|^2.$$
and
$$|z_1| + |z_2|^2 = r_1^2 + r_2^2 + 2r_1 r_2 \ge |z_1 + z_2|^2.$$

1.54. (a) For $a = 1$, it is fairly obvious that
$$\sum_{n=0}^{N-1} a^n = N.$$

For $a \ne 1$, we may write
$$(1 - a)\sum_{n=0}^{N-1} a^n = \sum_{n=0}^{N-1} a^n - \sum_{n=0}^{N-1} a^{n+1} = 1 - a^N.$$

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

(b) For $|a| < 1$,
$$\lim_{N\to\infty} a^N = 0.$$

Therefore, from the result of the previous part,
$$\lim_{N\to\infty}\sum_{n=0}^{N-1} a^n = \sum_{n=0}^{\infty} a^n = \frac{1}{1 - a}.$$

(c) Differentiating both sides of the result of part (b) w.r.t. a, we get
$$\frac{d}{da}\left(\sum_{n=0}^{\infty} a^n\right) = \frac{d}{da}\left(\frac{1}{1-a}\right)$$
$$\sum_{n=0}^{\infty} n a^{n-1} = \frac{1}{(1-a)^2}.$$

(d) We may write
$$\sum_{n=0}^{\infty} n a^n = a\sum_{n=0}^{\infty} n a^{n-1} = \frac{a}{(1-a)^2} \text{ for } |a| < 1.$$

1.55. (a) The desired sum is
$$\sum_{n=0}^{\infty} \qquad = \frac{1 - }{ } = 1 + j.$$

1.52. (a) ...

(b) ...

(c) ...

(d) ...

(e) ...

(f) Consider $\{a x_1, a x_2\}^*$ for $a > 0$.

For $a < 0$, ...

(g) For $|z_2| \ne 0$,
$$\left(\frac{z_1}{z_2}\right)^* = \frac{z_1^*}{z_2^*}.$$

(h) From (c), we get
$$\Re e\left(\frac{z_1}{z_2}\right) = \frac{1}{2}\left[\left(\frac{z_1}{z_2}\right) + \left(\frac{z_1}{z_2}\right)^*\right]$$

Using (g) on this, we get
$$\Re e\left(\frac{z_1}{z_2}\right) = \frac{1}{2}\left[\left(\frac{z_1}{z_2}\right) + \left(\frac{z_1^*}{z_2^*}\right)\right] = \frac{1}{2}\left[\frac{z_1 z_2^* + z_1^* z_2}{z_2 z_2^*}\right].$$

1.53. (a) ...

(b) Let $z_1 = x_1 + j y_1$ and $z_2 = x_2 + j y_2$. Then,
$$z_1 + z_2 = x(\;) \qquad = x_1 + x_2 = 2\Re e(z_1) = 2\Re e(z_2)$$

(c) $|z| = |r e^{j\theta}| = r = |r e^{-j\theta}| = |z^*|.$

(d) $|z_1 z_2| = |r_1 r_2 e^{j(\theta_1+\theta_2)}| = |r_1 r_2| = |r_1||r_2| = |z_1||z_2|.$

(e) Since $z = x + j y$, $|z| = \sqrt{x^2 + y^2}$. By the triangle inequality,
$$\Re e(z) = x \le \sqrt{x^2 + y^2} = |z|$$
and
$$\Im m(z) = y \le \sqrt{x^2 + y^2} = |z|.$$

(f) $|z_1 z_2^*| = |z_1||z_2^*| = 2\Re e(z_1 z_2^*) = |2 r_1 r_2 \cos\theta_r - \theta_2| \le 2 r_1 r_2 = 2|z_1||z_2|.$

(b) The desired sum is
$$\sum_{n=0}^{8} = \frac{1 - }{ } = (1 + j).$$

(c) The desired sum is
$$\sum_{n=0}^{\infty}(1/2)^n e^{-jn\pi} = \frac{1}{1 - (1/2)e^{-j\pi}} = \frac{4}{3} = r_0^2.$$

(d) The desired sum is
$$\sum_{n=0}^{\infty}(1/2)^n e^{-jn\pi} = (1/2)^2 e^{-j\pi}\sum_{n=0}^{\infty}(1/2)^n e^{-jn\pi} = \frac{1}{4}\left[\frac{4}{3} + r_k^2\right].$$

(e) The desired sum is
$$\sum_{n=0}^{\infty}\cos(\pi n/2) = \frac{1}{2}\sum_{n=0}^{\infty} + \frac{1}{2}\sum_{n=0}^{\infty} = \frac{1}{2}(1 + j) + \frac{1}{2}(1 - j) = 1.$$

(f) The desired sum is
$$\sum_{n=0}^{\infty}(1/2)^n\cos(\pi n/2) = \frac{1}{2}\sum_{n=0}^{\infty}(1/2)^n e^{jn\pi} + \frac{1}{2}\sum_{n=0}^{\infty}(1/2)^n e^{-jn\pi}$$
$$= \frac{4}{25} + \frac{2}{25} + \frac{4}{25} - \frac{2}{25} = \frac{4}{25}.$$

1.56. (a) The desired integral is
$$\int_0^\infty e \, dt = \frac{e}{j+2}\Big[\; = 0.$$

(b) The desired integral is
$$\int_0^\infty e \, dt = \frac{e}{j+2}\Big[\; = (1/)e \; - 1] = \frac{1}{2}.$$

(c) The desired integral is
$$\int_0^\infty e \, dt = \frac{e}{j+2}\Big[\; = (1/)e \; = -\frac{3}{2}.$$

(d) The desired integral is
$$\int_0^\infty e^{-(1+j)t} \, dt = \frac{e^{-(1+j)}}{-(1+j)}\Big[\; = \frac{1}{1+j} = \frac{1-j}{2}.$$

Exercises Signals And Systems Oppenheim Solutions

John R. Buck,Michael M. Daniel,Andrew Singer

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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

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