**19.** $12/(s^2(s+3))$

**21.** $tu(t-1)$

**23.** $\sin(\omega t + \theta)$

**25.** $3t^2 + t^3$

**27.** $e^{-2t}(3\cos t - 2\sin t)$

**29.** $y = e^{-2t}(13\cos t + 11\sin t) + 10t - 8$

**31.** $e^{-t} + u(t-\pi)[1.2\cos t - 3.6\sin t + 2e^{-t+\pi} - 0.8e^{2t-2\pi}]$

**33.** $0\ (0 \leqq t \leqq 2), \quad 1 - 2e^{-(t-2)} + e^{-2(t-2)} \quad (t > 2)$

**35.** $y_1 = 4e^t - e^{-2t}, \quad y_2 = e^t - e^{-2t}$

**37.** $y_1 = \cos t - u(t-\pi)\sin t + 2u(t-2\pi)\sin^2 \tfrac{1}{2}t,$
$y_2 = -\sin t - 2u(t-\pi)\cos^2 \tfrac{1}{2}t + u(t-2\pi)\sin t$

**39.** $y_1 = (1/\sqrt{10})\sin\sqrt{10}t, \quad y_2 = -(1/\sqrt{10})\sin\sqrt{10}t$

**41.** $1 - e^{-t}\ (0 < t < 4), \quad (e^4 - 1)e^{-t} \quad (t > 4)$

**43.** $i(t) = e^{-4t}(\tfrac{3}{26}\cos 3t - \tfrac{10}{39}\sin 3t) - \tfrac{3}{26}\cos 10t + \tfrac{8}{65}\sin 10t$

**45.** $5i_1' + 20(i_1 - i_2) = 60, \quad 30i_2' + 20(i_2' - i_1') + 20i_2 = 0,$
$i_1 = -8e^{-2t} + 5e^{-0.8t} + 3, \quad i_2 = -4e^{-2t} + 4e^{-0.8t}$

## Problem Set 7.1, page 261

**3.** $3 \times 3, \quad 3 \times 4, \quad 3 \times 6, \quad 2 \times 2, \quad 2 \times 3, \quad 3 \times 2$

**5.** $\mathbf{B} = \tfrac{1}{5}\mathbf{A}, \quad \tfrac{1}{10}\mathbf{A}$

**7.** No, no, yes, no, no

**9.** $\begin{bmatrix} 0 & 6 & 12 \\ 18 & 15 & 15 \\ 3 & 0 & -9 \end{bmatrix}, \begin{bmatrix} 0 & 2.5 & 1 \\ 2.5 & 1.5 & 2 \\ -1 & 2 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 8.5 & 13 \\ 20.5 & 16.5 & 17 \\ 2 & 2 & -10 \end{bmatrix}$, undefined

**11.** $\begin{bmatrix} 0 & 26 \\ 34 & 32 \\ 28 & -10 \end{bmatrix}$, same, $\begin{bmatrix} 5.4 & 0.6 \\ -4.2 & 2.4 \\ -0.6 & 0.6 \end{bmatrix}$, same

**13.** $\begin{bmatrix} 70 & 28 \\ -28 & 56 \\ 14 & 0 \end{bmatrix}$, same, $-\mathbf{D}$, undefined

**15.** $\begin{bmatrix} 5.5 \\ 33.0 \\ -11.0 \end{bmatrix}$, same, undefined, undefined

**17.** $\begin{bmatrix} -4.5 \\ -27.0 \\ 9.0 \end{bmatrix}$

## Problem Set 7.2, page 270

**5.** $10, \ n(n+1)/2$

**7.** $\mathbf{0}, \quad \mathbf{I}, \quad \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$

**11.** $\begin{bmatrix} 10 & -14 & -6 \\ -5 & 7 & -12 \\ -5 & -1 & -4 \end{bmatrix}$, same, $\begin{bmatrix} 10 & -5 & -15 \\ -14 & 7 & -33 \\ -2 & -4 & -4 \end{bmatrix}$, same

**13.** $\begin{bmatrix} 1 & 2 & 0 \\ 2 & 13 & -6 \\ 0 & -6 & 4 \end{bmatrix}$, $\begin{bmatrix} -9 & -5 \\ 3 & -1 \\ 4 & 0 \end{bmatrix}$, undefined, $\begin{bmatrix} -9 & 3 & 4 \\ -5 & -1 & 0 \end{bmatrix}$

**15.** Undefined, $\begin{bmatrix} 8 \\ -4 \\ -3 \end{bmatrix}$, $[7 \quad -1 \quad 3]$, same

**17.** $\begin{bmatrix} -30 & -18 \\ 45 & 9 \\ 5 & -7 \end{bmatrix}$, undefined, $\begin{bmatrix} 22 \\ 4 \\ -12 \end{bmatrix}$, undefined

**19.** Undefined, $\begin{bmatrix} 10.5 \\ 0 \\ -3 \end{bmatrix}$, $\begin{bmatrix} 7 \\ -3 \\ 1 \end{bmatrix}$, same

**25.** **(d)** $\mathbf{AB} = (\mathbf{AB})^{\mathsf{T}} = \mathbf{B}^{\mathsf{T}}\mathbf{A}^{\mathsf{T}} = \mathbf{BA}$; etc.
**(e)** *Answer.* If $\mathbf{AB} = -\mathbf{BA}$.
**29.** $\mathbf{p} = [85 \quad 62 \quad 30]^{\mathsf{T}}$, $\mathbf{v} = [44{,}920 \quad 30{,}940]^{\mathsf{T}}$

## Problem Set 7.3, page 280

**1.** $x = -2, \quad y = 0.5$
**3.** $x = 1, \quad y = 3, \quad z = -5$
**5.** $x = 6, \quad y = -7$
**7.** $x = -3t, \quad y = t$ arb., $\quad z = 2t$
**9.** $x = 3t - 1, \quad y = -t + 4, \quad z = t$ arb.
**11.** $w = 1, \quad x = t_1$ arb., $\quad y = 2t_2 - t_1, \quad z = t_2$ arb.
**13.** $w = 4, \quad x = 0, \quad y = 2, \quad z = 6$
**17.** $I_1 = 2, \quad I_2 = 6, \quad I_3 = 8$
**19.** $I_1 = (R_1 + R_2)E_0/(R_1R_2)$ A, $\quad I_2 = E_0/R_1$ A, $\quad I_3 = E_0/R_2$ A
**21.** $x_2 = 1600 - x_1, \quad x_3 = 600 + x_1, \quad x_4 = 1000 - x_1$. No
**23.** C: $3x_1 - x_3 = 0$, H: $8x_1 - 2x_4 = 0$, O: $2x_2 - 2x_3 - x_4 = 0$, thus
$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

## Problem Set 7.4, page 287

**1.** 1; $[2 \quad -1 \quad 3]$; $[2 \quad -1]^{\mathsf{T}}$
**3.** 3; $\{[3 \quad 5 \quad 0], \quad [0 \quad 3 \quad 5], \quad [0 \quad 0 \quad 1]\}$
**5.** 3; $\{[2 \quad -1 \quad 4], \quad [0 \quad 1 \quad -46], \quad [0 \quad 0 \quad 1]\}$; $\{[2 \quad 0 \quad 1], \quad [0 \quad 3 \quad 23], \quad [0 \quad 0 \quad 1]\}$

**7.** 2; [8 0 4 0], [0 2 0 4]; [8 0 4], [0 2 0]
**9.** 3; [9 0 1 0], [0 9 8 9], [0 0 1 0]
**11. (c)** 1
**17.** No
**19.** Yes
**21.** No
**23.** Yes
**25.** Yes
**27.** 2, [−2 0 1], [0 2 1]
**29.** No
**31.** No
**33.** 1, solution of the given system $c[1 \quad \frac{10}{3} \quad 3]$, basis $[1 \quad \frac{10}{3} \quad 3]$
**35.** 1, $[4 \quad 2 \quad \frac{4}{3} \quad 1]$

## Problem Set 7.7, page 300

**7.** $\cos(\alpha + \beta)$
**9.** 1
**11.** 40
**13.** 289
**15.** −64
**17.** 2
**19.** 2
**21.** $x = 3.5, \quad y = -1.0$
**23.** $x = 0, \quad y = 4, \quad z = -1$
**25.** $w = 3, \quad x = 0, \quad y = 2, \quad z = -2$

## Problem Set 7.8, page 308

**1.** $\begin{bmatrix} 1.20 & 4.64 \\ 0.50 & 3.60 \end{bmatrix}$
**3.** $\begin{bmatrix} 54 & 0.9 & -3.4 \\ 2 & 0.2 & -0.2 \\ -30 & -0.5 & 2 \end{bmatrix}$
**5.** $\begin{bmatrix} 1 & 0 & 0 \\ -2 & 1 & 0 \\ 3 & -4 & 1 \end{bmatrix}$
**7.** $\mathbf{A}^{-1} = \mathbf{A}$
**9.** $\begin{bmatrix} 0 & 0 & \frac{1}{2} \\ \frac{1}{8} & 0 & 0 \\ 0 & \frac{1}{4} & 0 \end{bmatrix}$
**11.** $(\mathbf{A}^2)^{-1} = (\mathbf{A}^{-1})^2 = \begin{bmatrix} 3.760 & 22.272 \\ 2.400 & 15.280 \end{bmatrix}$
**15.** $\mathbf{A}\mathbf{A}^{-1} = \mathbf{I}, \quad (\mathbf{A}\mathbf{A}^{-1})^{-1} = (\mathbf{A}^{-1})^{-1}\mathbf{A}^{-1} = \mathbf{I}$. Multiply by **A** from the right.

## Problem Set 7.9, page 318

**1.** $[1 \quad 0]^T, \quad [0 \quad 1]^T; \quad [1 \quad 0]^T, \quad [0 \quad -1]^T; \quad [1 \quad 1]^T, \quad [-1 \quad 1]^T$
**3.** 1, $[1 \quad 11 \quad -7]^T$
**5.** No
**7.** Dimension 2, basis $xe^{-x}, e^{-x}$
**9.** 3; basis $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}$
**11.** $x_1 = 5y_1 - y_2, \quad x_2 = 3y_1 - y_2$
**13.** $x_1 = 2y_1 - 3y_2, \quad x_2 = -10y_1 + 16y_2 + y_3, \quad x_3 = -7y_1 + 11y_2 + y_3$

**15.** $\sqrt{26}$

**17.** $\sqrt{5}$

**19.** 1

**21.** $k = -20$

**23.** $\mathbf{a} = [3 \quad 1 \quad -4]^\mathsf{T}, \quad \mathbf{b} = [-4 \quad 8 \quad -1]^\mathsf{T}, \quad \|\mathbf{a} + \mathbf{b}\| = \sqrt{107} \leqq 5.099 + 9$

**25.** $\mathbf{a} = [5 \quad 3 \quad 2]^\mathsf{T}, \quad \mathbf{b} = [3 \quad 2 \quad -1]^\mathsf{T}, \quad 90 + 14 = 2(38 + 14)$

## Chapter 7 Review Questions and Problems, page 318

**11.** $\begin{bmatrix} -1 & 6 & 1 \\ -18 & 8 & -7 \\ -13 & -2 & -7 \end{bmatrix}, \quad \begin{bmatrix} 1 & 18 & 13 \\ -6 & -8 & 2 \\ -1 & 7 & 7 \end{bmatrix}$

**13.** $[21 \quad -8 \quad -31]^\mathsf{T}, \quad [21 \quad -8 \quad 31]$

**15.** 197, 0

**17.** $-5, \quad \det \mathbf{A}^2 = (\det \mathbf{A})^2 = 25, \quad 0$

**19.** $\begin{bmatrix} -2 & -12 & -12 \\ -12 & 16 & -9 \\ -12 & -9 & -14 \end{bmatrix}$

**21.** $x = 4, \quad y = -2, \quad z = 8$

**23.** $x = 6, \quad y = 2t + 2, \quad z = t$ arb.

**25.** $x = 0.4, \quad y = -1.3, \quad z = 1.7$

**27.** $x = 10, \quad y = -2$

**29.** Ranks 2, 2, $\infty$

**31.** Ranks 2, 2, 1

**33.** $I_1 = 16.5$ A, $I_2 = 11$ A, $I_3 = 5.5$ A

**35.** $I_1 = 4$ A, $I_2 = 5$ A, $I_3 = 1$ A

## Problem Set 8.1, page 329

**1.** $3, [1 \quad 0]^\mathsf{T}; \quad -0.6, [0 \quad 1]^\mathsf{T}$

**3.** $-4, [2 \quad 9]^\mathsf{T}; \quad 3, [1 \quad 1]^\mathsf{T}$

**5.** $-3i, [1 \quad -i]; \quad 3i, [1 \quad i], i = \sqrt{-1}$

**7.** $\lambda^2 = 0, \quad [1 \quad 0]^\mathsf{T}$

**9.** $0.8 + 0.6i, [1 \quad -i]^\mathsf{T}; \quad 0.8 - 0.6i, [1 \quad i]^\mathsf{T}$

**11.** $-(\lambda^3 - 18\lambda^2 + 99\lambda - 162)/(\lambda - 3) = -(\lambda^2 - 15\lambda + 54); \quad 3, [2 \quad -2 \quad 1]^\mathsf{T};$
$6, [1 \quad 2 \quad 2]^\mathsf{T}; \quad 9, [2 \quad 1 \quad -2]^\mathsf{T}$

**13.** $-(\lambda - 9)^3; \quad 9, [2 \quad -2 \quad 1]^\mathsf{T}$, defect 2

**15.** $(\lambda + 1)^2(\lambda^2 + 2\lambda - 15); \quad -1, [1 \quad 0 \quad 0 \quad 0]^\mathsf{T}, [0 \quad 1 \quad 0 \quad 0]^\mathsf{T};$
$-5, [-3 \quad -3 \quad 1 \quad 1]^\mathsf{T}, 3, [3 \quad -3 \quad 1 \quad -1]^\mathsf{T}$

**17.** $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$. Eigenvalues $i, -i$. Corresponding eigenvectors are complex, indicating that no direction is preserved under a rotation.

**19.** $\begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}; \quad 1, \begin{bmatrix} 0 \\ 1 \end{bmatrix}; \quad 0, \begin{bmatrix} 1 \\ 0 \end{bmatrix}$. A point onto the $x_2$-axis goes onto itself, a point on the $x_1$-axis onto the origin.

**23.** Use that real entries imply real coefficients of the characteristic polynomial.