SEÇÃO 3

1. Para a matriz A, veja as respostas do Exercício 1 da Seção 2.

(a) $B = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$; (b) $B = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$; (c) $B = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$; (d) $B = \begin{pmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{2} \end{pmatrix}$; (e) $B = \begin{pmatrix} \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}$

2. (a) $\begin{pmatrix} 1 & 1 \\ -1 & -3 \end{pmatrix}$; (b) $\begin{pmatrix} 1 & 0 \\ -4 & -1 \end{pmatrix}$

3. (a) $\begin{pmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{pmatrix}$; (b) $\begin{pmatrix} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{pmatrix}$

4. $V = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 2 & -2 \\ 1 & 0 & 1 \end{pmatrix}$, $B = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

5. (a) $\begin{pmatrix} 0 & 0 & 2 \\ 0 & 1 & 0 \\ 0 & 0 & 2 \end{pmatrix}$; (b) $\begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 2 \end{pmatrix}$; (c) $\begin{pmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$; (d) $a_1 x + a_2 2^n (1 + x^2)$

6. (a) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 1 & -1 \end{pmatrix}$; (b) $\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$; (c) $\begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$

CAPÍTULO 5

SEÇÃO 1

1. (a) 0°; (b) 90°

2. (a) $\sqrt{14}$ (projeção escalar), $(2, 1, 3)^T$ (projeção vetorial); (b) $\mathbf{0}, \mathbf{0}$;

(c) $\frac{14\sqrt{13}}{13}$, $(\frac{42}{13}, \frac{28}{13})^T$; (d) $\frac{8\sqrt{21}}{21}$, $(\frac{8}{21}, \frac{16}{21}, \frac{32}{21})^T$

3. (a) $\mathbf{p} = (3, 0)^T$, $\mathbf{x} - \mathbf{p} = (0, 4)^T$, $\mathbf{p}^T(\mathbf{x} - \mathbf{p}) = 3 \cdot 0 + 0 \cdot 4 = 0$;

(c) $\mathbf{p} = (3, 3, 3)^T$, $\mathbf{x} - \mathbf{p} = (-1, 1, 0)^T$, $\mathbf{p}^T(\mathbf{x} - \mathbf{p}) = -1 \cdot 3 + 1 \cdot 3 + 0 \cdot 3 = 0$

4. (1,8, 3,6)

5. (1,4, 3,8)

6. 0,4

7. (a) $2x + 4y + 3z = 0$; (c) $z - 4 = 0$

8. $\frac{5}{3}$

9. $\frac{8}{7}$

SEÇÃO 2

1. (a) $\{(3, 4)^T\}$ é uma base para $I(A^T)$, $\{(-4, 3)^T\}$ é uma base para $N(A)$, $\{(1, 2)^T\}$ é uma base para $I(A)$, $\{(-2, 1)^T\}$ é uma base para $N(A^T)$;

(d) base para $I(A^T)$: $\{(1, 0, 0, 0)^T, (0, 1, 0, 0)^T, (0, 0, 1, 1)^T\}$, base para $N(A)$: $\{(0, 0, -1, 1)^T\}$, base para $I(A)$: $\{(1, 0, 0, 1)^T, (0, 1, 0, 1)^T, (0, 0, 1, 1)^T\}$, base para $N(A^T)$: $\{(1, 1, 1, -1)^T\}$.

2. (a) $\{(1, 1, 0)^T, (-1, 0, 1)^T\}$.

3. (b) O complemento ortogonal é gerado por $(-5, 3, 1)^T$.

4. $\{(-1, 2, 0, 1)^T, (2, -3, 1, 0)^T\}$ é uma base para $S^{\perp}$.

5. (a) $\mathbf{N} = (8, -2, 1)^T$; (b) $8x - 2y + z = 7$.

9. $\dim N(A) = n - r$, $\dim N(A^T) = m - r$.

SEÇÃO 3

1. $\|\mathbf{x}\|_2 = 2$, $\|\mathbf{y}\|_2 = 6$, $\|\mathbf{x} + \mathbf{y}\|_2 = 2\sqrt{10}$

2. (a) $\theta = \dfrac{\pi}{4}$; $\mathbf{p} = (\frac{4}{3}, \frac{1}{3}, \frac{1}{3}, 0)^T$

3. (b) $\|\mathbf{x}\| = 1$, $\|\mathbf{y}\| = 3$

4. (a) 0; (b) 5; (c) 7; (d) $\sqrt{74}$

7. (a) 1; (b) $\dfrac{1}{\pi}$; (c) $\frac{1}{6}$

8. (a) $\dfrac{\pi}{6}$; (b) $\mathbf{p} = \frac{3}{2}x$

11. (a) $\dfrac{\sqrt{10}}{2}$; (b) $\dfrac{\sqrt{34}}{4}$

15. (a) $\|\mathbf{x}\|_1 = 7$, $\|\mathbf{x}\|_2 = 5$, $\|\mathbf{x}\|_\infty = 4$; (b) $\|\mathbf{x}\|_1 = 4$, $\|\mathbf{x}\|_2 = \sqrt{6}$, $\|\mathbf{x}\|_\infty = 2$;
(c) $\|\mathbf{x}\|_1 = 3$, $\|\mathbf{x}\|_2 = \sqrt{3}$, $\|\mathbf{x}\|_\infty = 1$

16. $\|\mathbf{x} - \mathbf{y}\|_1 = 5$, $\|\mathbf{x} - \mathbf{y}\|_2 = 3$, $\|\mathbf{x} - \mathbf{y}\|_\infty = 2$

26. (a) Não é uma norma; (b) é norma; (c) é norma.

SEÇÃO 4

1. (a) $(2, 1)^T$; (c) $(1{,}6, 0{,}6, 1{,}2)^T$

2. (1a) $\mathbf{p} = (3, 1, 0)^T$, $\mathbf{r} = (0, 0, 2)^T$ (1c)
$\mathbf{p} = (3{,}4, 0{,}2, 0{,}6, 2{,}8)^T$, $\mathbf{r} = (0{,}6, -0{,}2, 0{,}4, -0{,}8)^T$

3. (a) $\{(1 - 2\alpha, \alpha)^T \mid \alpha \text{ real}\}$; (b) $\{(2 - 2\alpha, 1 - \alpha, \alpha)^T \mid \alpha \text{ real}]$

4. (a) $\mathbf{p} = (1, 2, -1)^T$, $\mathbf{b} - \mathbf{p} = (2, 0, 2)^T$;
(b) $\mathbf{p} = (3, 1, 4)^T$, $\mathbf{p} - \mathbf{b} = (-5, -1, 4)^T$

5. (a) $y = 1{,}8 + 2{,}9x$

6. $0{,}55 + 1{,}65x + 1{,}25x^2$

SEÇÃO 5

1. (a) e (d)

2. (b) $\mathbf{x} = -\dfrac{\sqrt{2}}{3}\mathbf{x}_1 + \dfrac{5}{3}\mathbf{x}_2$, $\|\mathbf{x}\| = \left[\left(-\dfrac{\sqrt{2}}{3}\right)^2 + \left(\dfrac{5}{3}\right)^2\right]^{1/2} =$
$= \sqrt{3}$

3. $\mathbf{p} = (\frac{23}{18}, \frac{41}{18}, \frac{8}{9})^T$, $\mathbf{p} - \mathbf{x} = (\frac{5}{18}, \frac{5}{18}, -\frac{10}{9})^T$

4. (b) $c_1 = y_1 \cos\theta + y_2 \operatorname{sen}\theta$, $c_2 = -y_1 \operatorname{sen}\theta + y_2 \cos\theta$

6. (a) 15; (b) $\|\mathbf{u}\| = 3, \|\mathbf{v}\| = 5\sqrt{2}$; (c) $\frac{\pi}{4}$

8. (b) (i) 0, (ii) $-\frac{\pi}{2}$, (iii) 0, (iv) $\frac{\pi}{8}$

17. (b) (i) $(2, -2)^T$, (ii) $(5, 2)^T$, (iii) $(3, 1)^T$

18. (a) $P = \begin{pmatrix} \frac{1}{2} & \frac{1}{2} & 0 & 0 \\ \frac{1}{2} & \frac{1}{2} & 0 & 0 \\ 0 & 0 & \frac{1}{2} & \frac{1}{2} \\ 0 & 0 & \frac{1}{2} & \frac{1}{2} \end{pmatrix}$

19. (b) $Q = \begin{pmatrix} \frac{1}{2} & -\frac{1}{2} & 0 & 0 \\ -\frac{1}{2} & \frac{1}{2} & 0 & 0 \\ 0 & 0 & \frac{1}{2} & -\frac{1}{2} \\ 0 & 0 & -\frac{1}{2} & \frac{1}{2} \end{pmatrix}$

23. (b) $\|1\| = \sqrt{2}, \|x\| = \frac{\sqrt{6}}{3}$; (c) $l(x) = \frac{9}{7}x$

SEÇÃO 6

1. (a) $\left\{\left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)^T, \left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)^T\right\}$; (b) $\left\{\left(\frac{2}{\sqrt{5}}, \frac{1}{\sqrt{5}}\right)^T, \left(-\frac{1}{\sqrt{5}}, \frac{2}{\sqrt{5}}\right)^T\right\}$

2. (a) $\begin{pmatrix} -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix} \begin{pmatrix} \sqrt{2} & \sqrt{2} \\ 0 & 4\sqrt{2} \end{pmatrix}$;

(b) $\begin{pmatrix} \frac{2}{\sqrt{5}} & -\frac{1}{\sqrt{5}} \\ \frac{1}{\sqrt{5}} & \frac{2}{\sqrt{5}} \end{pmatrix} \begin{pmatrix} \sqrt{5} & 4\sqrt{5} \\ 0 & 3\sqrt{5} \end{pmatrix}$

3. $\{(\frac{1}{3}, \frac{2}{3}, -\frac{2}{3})^T, (\frac{2}{3}, \frac{1}{3}, \frac{2}{3})^T, (-\frac{2}{3}, \frac{2}{3}, \frac{1}{3})^T\}$

4. $u_1(x) = \frac{1}{\sqrt{2}}, u_2(x) = \frac{\sqrt{6}}{2}x, u_3(x) = \frac{3\sqrt{10}}{4}\left(x^2 - \frac{1}{3}\right)$

5. (a) $\left\{\frac{1}{3}(2, 1, 2)^T, \frac{\sqrt{2}}{6}(-1, 4, -1)^T\right\}$;

(b) $Q = \begin{pmatrix} \frac{2}{3} & \frac{-\sqrt{2}}{6} \\ \frac{1}{3} & \frac{2\sqrt{2}}{3} \\ \frac{2}{3} & \frac{-\sqrt{2}}{6} \end{pmatrix}$; $R = \begin{pmatrix} 3 & \frac{5}{3} \\ 0 & \frac{\sqrt{2}}{3} \end{pmatrix}$; (c) $\mathbf{x} = \begin{pmatrix} 9 \\ -3 \end{pmatrix}$

6. (b) $\begin{pmatrix} \frac{3}{5} & -\frac{4}{5\sqrt{2}} \\ \frac{4}{5} & \frac{3}{5\sqrt{2}} \\ 0 & \frac{1}{\sqrt{2}} \end{pmatrix} \begin{pmatrix} 5 & 1 \\ 0 & 2\sqrt{2} \end{pmatrix}$; (c) $(2{,}1, 5{,}5)^T$

7. $\left\{\left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0, 0\right)^T, \left(\frac{\sqrt{2}}{3}, \frac{\sqrt{2}}{3}, -\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{6}\right)^T\right\}$

9. $\left\{\left(\frac{4}{5}, \frac{2}{5}, \frac{2}{5}, \frac{1}{5}\right)^T, \left(\frac{1}{5}, -\frac{2}{5}, -\frac{2}{5}, \frac{4}{5}\right)^T, \left(0, \frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}, 0\right)^T\right\}$

SEÇÃO 7

1. (a) $T_4 = 8x^4 - 8x^2 + 1$, $T_5 = 16x^5 - 20x^3 + 5x$;
(b) $H_4 = 16x^4 - 48x^2 + 12$, $H_5 = 32x^5 - 160x^3 + 120x$

2. $p_1(x) = x$, $p_2(x) = x^2 - \frac{4}{\pi} + 1$

4. $p(x) = (\operatorname{senh} 1)P_0(x) + \frac{3}{e}P_1(x), +5\left(\operatorname{senh} 1 - \frac{3}{e}\right)P_2(x)$,
$p(x) \approx 0{,}9963 + 1{,}1036x + 0{,}5367x^2$

6. (a) $U_0 = 1$, $U_1 = 2x$, $U_2 = 4x^2 - 1$

11. $p(x) = (x-2)(x-3) + (x-1)(x-3) + 2(x-1)(x-2)$

13. $1 \cdot f\left(-\frac{1}{\sqrt{3}}\right) + 1 \cdot f\left(\frac{1}{\sqrt{3}}\right)$

14. (a) Grau menor ou igual a 3; (b) a fórmula dá a resposta exata para a primeira integral. O valor aproximado da segunda integral é 1,5, enquanto a resposta exata é $\pi/2$.

CAPÍTULO 6

SEÇÃO 1

1. (a) $\lambda_1 = 5$, o auto-espaço é gerado por $(1, 1)^T$,
$\lambda_2 = -1$, o auto-espaço é gerado por $(1, -2)^T$;
(b) $\lambda_1 = 3$, o auto-espaço é gerado por $(4, 3)^T$,
$\lambda_2 = 2$, o auto-espaço é gerado por $(1, 1)^T$;
(c) $\lambda_1 = \lambda_2 = 2$, o auto-espaço é gerado por $(1, 1)^T$;
(d) $\lambda_1 = 3 + 4i$, o auto-espaço é gerado por $(2i, 1)^T$,
$\lambda_2 = 3 - 4i$, o auto-espaço é gerado por $(-2i, 1)^T$;
(e) $\lambda_1 = 2 + i$, o auto-espaço é gerado por $(1, 1 + i)^T$,
$\lambda_2 = 2 - i$, o auto-espaço é gerado por $(1, 1 - i)^T$;
(f) $\lambda_1 = \lambda_2 = \lambda_3 = 0$, o auto-espaço é gerado por $(1, 0, 0)^T$;
(g) $\lambda_1 = 2$, o auto-espaço é gerado por $(1, 1, 0)^T$,
$\lambda_2 = 1$, o auto-espaço é gerado por $(1, 0, 0)^T$, $(0, 1, -1)^T$;
(h) $\lambda_1 = 1$, o auto-espaço é gerado por $(1, 0, 0)^T$,
$\lambda_2 = 4$, o auto-espaço é gerado por $(1, 1, 1)^T$,
$\lambda_3 = -2$, o auto-espaço é gerado por $(-1, -1, 5)^T$;