CHAPTER 8 ❑ MATLAB EXERCISES

1. MATLAB handles complex numbers and matrices in much the same way as real ones. The imaginary unit $i = \sqrt{-1}$ is a built-in constant. For instance, the complex number $2 - 3i$ would be represented as $2 - 3 * i$ in MATLAB. You can verify the result of Example 5, Section 8.2, by entering the matrix A,

$$A = [2 - i \quad -5 + 2 * i \ ; \ 3 - i \quad -6 + 2 * i]$$

and then typing **inv(A).**

Use MATLAB to perform the following matrix operations, given

$$A = \begin{bmatrix} 1 & 2 - i \\ 2 + i & i \end{bmatrix}, \ B = \begin{bmatrix} 3i & 4 \\ -4 & -i \end{bmatrix}, \ \text{and} \ C = \begin{bmatrix} i & -i & 0 \\ 2 & 0 & 2 + 3i \end{bmatrix}.$$

(a) AB (b) $3iC$ (c) A^{-1}

(d) C^TC (e) $|A + B|$ (f) $iAB^2 + (1 - i)CC^T$

2. Use MATLAB to solve the system of linear equations $A\mathbf{x} = \mathbf{b}$.

(a) $A = \begin{bmatrix} i & 2 - i \\ 3 - 2i & 0 \end{bmatrix}, \ \mathbf{b} = \begin{bmatrix} 1 + i \\ 6 - 4i \end{bmatrix}$

(b) $A = \begin{bmatrix} 1 & 0 & i \\ -2 & i + 1 & -i \\ 1 - i & 0 & -1 \end{bmatrix}, \ \mathbf{b} = \begin{bmatrix} i \\ 0 \\ 2 - i \end{bmatrix}$

3. For a complex matrix A, the MATLAB command **A'** produces the complex conjugate transpose A^* of A. Use this command to determine which of the following matrices are Hermitian and which are normal.

(a) $\begin{bmatrix} i & 1 \\ 1 & -i \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} 3 - 4i & 2 \\ 1 + i & 4 - i \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & i \\ 0 & i & 2 \end{bmatrix}$

4. The MATLAB command [**P,D**] = **eig**(**A**) will produce a diagonal matrix D containing the eigenvalues of the complex matrix A, and a matrix P containing the corresponding eigenvectors. For instance, if

$$A = \begin{bmatrix} 3 & 2 - i & -3i \\ 2 + i & 0 & 1 - i \\ 3i & 1 + i & 0 \end{bmatrix}$$

is the matrix from Example 7, Section 8.5, then the command [**P, D**] = **eig**(**A**) yields

$$P = \begin{bmatrix} 0.7792 + 0.0000i & -0.4472 + 0.2236i & -0.2870 - 0.2460i \\ 0.3438 + 0.2063i & 0.1118 - 0.3354i & -0.2050 + 0.8199i \\ 0.0229 + 0.4813i & 0.1118 + 0.7826i & 0.2870 + 0.2460i \end{bmatrix}$$

and

$$D = \begin{bmatrix} 6.0000 + 0.0000i & 0 & 0 \\ 0 & -2.0000 + 0.0000i & 0 \\ 0 & 0 & -1.0000 - 0.0000i \end{bmatrix},$$

which is equivalent to the solution given in the text. Use this procedure to diagonalize the following matrices.

(a) $A = \begin{bmatrix} 1 & i \\ i & 1 \end{bmatrix}$ (b) $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & i \\ 0 & i & 2 \end{bmatrix}$ (c) $\begin{bmatrix} 1 & 1+i & 1-i \\ 1-i & 0 & i \\ 1+i & -i & 0 \end{bmatrix}$