A variable can be defined as either a number or a string made up of the same digits. For example, as shown below, x is defined to be the number 536, and y is defined to be a string made up of the digits 536.

```
>> x=536
x =
   536
>> y='536'
y =
536
>>
```

The two variables are not the same even though they appear identical on the screen. Note that the characters 536 in the line below the x= are indented, while the characters 536 in the line below the y= are not indented. The variable x can be used in mathematical expressions, while the variable y cannot.

2.11 PROBLEMS

1. Create a row vector that has the following elements: 3, $4 \cdot 2.55$, $68/16$, 45, $\sqrt[3]{110}$, $\cos 25°$, and 0.05.

2. Create a row vector that has the following elements: $\frac{54}{3 + 4.2^2}$, 32, $6.3^2 - 7.2^2$, 54, $e^{3.7}$, and $\sin 66° + \cos\frac{3\pi}{8}$.

3. Create a column vector that has the following elements: 25.5, $\frac{(14 \tan 58°)}{(2.1^2 + 11)}$, $6!$, 2.7^4, 0.0375, and $\pi/5$.

4. Create a column vector that has the following elements: $\frac{32}{3.2^2}$, $\sin^2 35°$, 6.1, $\ln 29^2$, 0.00552, $\ln^2 29$, and 133.

5. Define the variables $x = 0.85$, $y = 12.5$, and then use them to create a column vector that has the following elements: y, y^x, $\ln(y/x)$, $y \cdot x$, and $x + y$.

6. Define the variables $a = 3.5$, $b = -6.4$, and then use them to create a row vector that has the following elements: a, a^2, a/b, $a \cdot b$, and $\sqrt{a}$.

7. Create a row vector in which the first element is 2 and the last element is 37, with an increment of 5 between the elements (2, 7, 12, … , 37).

8. Create a row vector with 9 equally spaced elements in which the first element is 81 and the last element is 12.

9. Create a column vector in which the first element is 22.5, the elements decrease with increments of –2.5, and the last element is 0. (A column vector can be created by the transpose of a row vector.)

10. Create a column vector with 15 equally spaced elements in which the first element is –21 and the last element is 12.

11. Using the colon symbol, create a row vector (assign it to a variable named `same`) with seven elements that are all –3.

12. Use a single command to create a row vector (assign it to a variable named `a`) with 9 elements such that the last element is 7.5 and the rest of the elements are 0s. Do not type the vector explicitly.

13. Use a single command to create a row vector (assign it to a variable named `b`) with 19 elements such that

```
b = 1 2 3 4 5 6 7 8 9 10 9 8 7 6 5 4 3 2 1
```

Do not type the vector explicitly.

14. Create a vector (name it `vecA`) that has 14 elements of which the first is 49, the increment is –3, and the last element is 10. Then, using the colon symbol, create a new vector (call it `vecB`) that has 8 elements. The first 4 elements are the first 4 elements of the vector `vecA`, and the last 4 are the last 4 elements of the vector `vecA`.

15. Create a vector (name it `vecC`) that has 16 elements of which the first is 13, the increment is 4 and the last element is 73. Then create the following two vectors:
    (*a*) A vector (name it `Codd`) that contains all the elements with odd index of `vecCodd` (*vecCodd*(1), *vecCodd*(3), etc; i.e., `Codd = 13 21 29 ... 69`).
    (*b*) A vector (name it `Ceven`) that contains all the elements with even index of `vecCodd` (*vecCodd*(2), *vecCodd*(4), etc; i.e., `Codd = 17 25 33 ... 73`).
    In both parts use vectors of odd and even numbers for the index of `Codd` and `Ceven`, respectively. Do not type the vectors explicitly.

16. Create the following matrix by using vector notation for creating vectors with constant spacing and/or the `linspace` command. Do not type individual elements explicitly.

$$A = \begin{bmatrix} 0 & 5 & 10 & 15 & 20 & 25 & 30 \\ 600 & 500 & 400 & 300 & 200 & 100 & 0 \\ 0 & 0.8333 & 1.6667 & 2.5 & 3.3333 & 4.1667 & 5 \end{bmatrix}$$

17. Create the following matrix by using vector notation for creating vectors with constant spacing and/or the `linspace` command. Do not type individual elements explicitly.

$$B = \begin{bmatrix} 1 & 0 & 3 \\ 2 & 0 & 3 \\ 3 & 0 & 3 \\ 4 & 0 & 3 \\ 5 & 0 & 3 \end{bmatrix}$$

18. Using the colon symbol, create a 4×6 matrix (assign it to a variable named `Anine`) in which all the elements are the number 9.

19. Create the following matrix by typing one command. Do not type individual elements explicitly.

$$C = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 8 \end{bmatrix}$$

20. Create the following matrix by typing one command. Do not type individual elements explicitly.

$$D = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 6 & 6 \\ 0 & 0 & 0 & 6 & 6 \end{bmatrix}$$

21. Create the following matrix by typing one command. Do not type individual elements explicitly.

$$E = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 2 & 3 \\ 0 & 0 & 4 & 5 & 6 \\ 0 & 0 & 7 & 8 & 9 \end{bmatrix}$$

22. Create the following matrix by typing one command. Do not type individual elements explicitly.

$$F = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 10 & 20 \\ 0 & 0 & 2 & 8 & 26 \\ 0 & 0 & 3 & 6 & 32 \end{bmatrix}$$

23. Create three row vectors:

$$a = \begin{bmatrix} 7 & 2 & -3 & 1 & 0 \end{bmatrix}, \quad b = \begin{bmatrix} -3 & 10 & 0 & 7 & -2 \end{bmatrix}, \quad c = \begin{bmatrix} 1 & 0 & 4 & -6 & 5 \end{bmatrix}$$

(*a*) Use the three vectors in a MATLAB command to create a 3×5 matrix in which the rows are the vectors *a*, *b*, and *c*.

(*b*) Use the three vectors in a MATLAB command to create a 5×3 matrix in which the columns are the vectors *a*, *b*, and *c*.

24. Create three row vectors:

$$a = \begin{bmatrix} 7 & 2 & -3 & 1 & 0 \end{bmatrix}, \quad b = \begin{bmatrix} -3 & 10 & 0 & 7 & -2 \end{bmatrix}, \quad c = \begin{bmatrix} 1 & 0 & 4 & -6 & 5 \end{bmatrix}$$

(*a*) Use the three vectors in a MATLAB command to create a 3×3 matrix such that the first, second, and third rows consist of the first three elements of the vectors *a*, *b*, and *c*, respectively.

(*b*) Use the three vectors in a MATLAB command to create a 3×3 matrix such that the first, second, and third columns consist of the last three elements of the vectors *a*, *b*, and *c*, respectively.

25. Create two row vectors:

$$a = \begin{bmatrix} -4 & 10 & 0.5 & 1.8 & -2.3 & 7 \end{bmatrix}, \quad b = \begin{bmatrix} 0.7 & 9 & -5 & 3 & -0.6 & 12 \end{bmatrix}$$

(*a*) Use the two vectors in a MATLAB command to create a 2×4 matrix such that the first row consists of elements 2 through 5 of vector *a*, and the second row consists of elements 3 through 6 of vector *b*.

(*b*) Use the two vectors in a MATLAB command to create a 3×4 matrix such that the first column consists of elements 2 through 4 of vector *a*, the second column consists of elements 4 through 6 of vector *a*, the third column consists of elements 1 through 3 of vector *b*, and the fourth column consists of elements 3 through 5 of vector *b*.

26. By hand (pencil and paper) write what will be displayed if the following commands are executed by MATLAB. Check your answers by executing the commands with MATLAB. (Parts (*b*), (*c*), and (*d*) use the vector that was defined in part (*a*).)

(*a*) `a=9:-3:0` (*b*) `b=[a a]` or `b=[a,a]` (*c*) `c=[a;a]`

(*d*) `d=[a' a']` or `d=[a',a']` (*e*) `e=[[a; a; a; a] a']`

27. The following vector is defined in MATLAB:

$$v = \begin{bmatrix} 15 & 0 & 6 & -2 & 3 & -5 & 4 & 9 & 1.8 & -0.35 & 7 \end{bmatrix}$$

By hand (pencil and paper) write what will be displayed if the following commands are executed by MATLAB. Check your answers by executing the commands with MATLAB.

(*a*) `a=v(2:5)` (*b*) `b=v([1,3:7,11])` (*c*) `c=v([10,2,9,4])`

28. The following vector is defined in MATLAB:

$$v = \begin{bmatrix} 15 & 0 & 6 & -2 & 3 & -5 & 4 & 9 & 1.8 & -0.35 & 7 \end{bmatrix}$$

By hand (pencil and paper) write what will be displayed if the following commands are executed by MATLAB. Check your answers by executing the commands with MATLAB.

(*a*) `a=[v([2 7:10]);v([3,5:7,2])]`

(*b*) `b=[v([3:5,8])' v([10 6 4 1])' v(7:-1:4)']`

29. Create the following matrix *A*.

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 7 & 8 & 9 & 10 & 11 & 12 \\ 13 & 14 & 15 & 16 & 17 & 18 \end{bmatrix}$$

Use the matrix *A* to:

(*a*) Create a six-element row vector named `ha` that contains the elements of the first row of *A*.

(*b*) Create a three-element row vector named `hb` that contains the elements of the sixth column of *A*.

(*c*) Create a six-element row vector named `hc` that contains the first three elements of the second row of *A* and the last three element of the third row of *A*.

30. Create the following matrix *B*.

$$B = \begin{bmatrix} 18 & 17 & 16 & 15 & 14 & 13 \\ 12 & 11 & 10 & 9 & 8 & 7 \\ 6 & 5 & 4 & 3 & 2 & 1 \end{bmatrix}$$

Use the matrix *B* to:

(*a*) Create a six-element column vector named `va` that contains the elements of the second and fifth columns of *B*.

(*b*) Create a seven-element column vector named `vb` that contains elements 3 through 6 of the third row of *B* and the elements of the second column of *B*.

(*c*) Create a nine-element column vector named `vc` that contains the elements of the second, fourth, and sixth columns of *B*.

31. Create the following vector C.

$$C = \begin{bmatrix} 0.7 & 1.9 & 3.1 & 4.3 & 5.5 & 6.7 & 7.9 & 9.1 & 10.3 & 11.5 & 12.7 & 13.9 & 15.1 & 16.3 & 17.5 \end{bmatrix}$$

Then use MATLAB's built-in `reshape` function and the transpose operation to create the following matrix D from the vector C:

$$D = \begin{bmatrix} 0.7 & 1.9 & 3.1 & 4.3 & 5.5 \\ 6.7 & 7.9 & 9.1 & 10.3 & 11.5 \\ 12.7 & 13.9 & 15.1 & 16.3 & 17.5 \end{bmatrix}$$

Use the matrix D to:

(*a*) Create a nine-element column vector named `ua` that contains the elements of the first, third, and fourth columns of D.

(*b*) Create an eight-element raw vector named `ub` that contains the elements of the second row of D and the third column of D.

(*c*) Create a six-element row vector named `uc` that contains the first three elements of the first row of D and the last three elements of the last row of D.

32. Create the following matrix E.

$$E = \begin{bmatrix} 0 & 0 & 0 & 0 & 2 & 2 & 2 \\ 0.7 & 0.6 & 0.5 & 0.4 & 0.3 & 0.2 & 0.1 \\ 2 & 4 & 6 & 8 & 10 & 12 & 14 \\ 22 & 19 & 16 & 13 & 10 & 7 & 4 \end{bmatrix}$$

(*a*) Create a 2×5 matrix F from the second and fourth rows, and the third through the seventh columns of matrix E.

(*b*) Create a 4×3 matrix G from all rows and the third through fifth columns of matrix E.

33. Create the following matrix H.

$$H = \begin{bmatrix} 1.7 & 1.6 & 1.5 & 1.4 & 1.3 & 1.2 \\ 22 & 24 & 26 & 28 & 30 & 32 \\ 9 & 8 & 7 & 6 & 5 & 4 \end{bmatrix}$$

(*a*) Create a 2×4 matrix G such that its first row includes the first two elements and the last two elements of the first row of H, and the second row of G includes the second through the fifth elements of the third row of H.

(*b*) Create a 3×3 matrix K such that the first, second, and third rows are the first, fourth, and sixth columns of matrix H.

34. The following matrix is defined in MATLAB:

$$M = \begin{bmatrix} 3 & 5 & 7 & 9 & 11 & 13 \\ 15 & 14 & 13 & 12 & 11 & 10 \\ 1 & 2 & 3 & 1 & 2 & 3 \end{bmatrix}$$

By hand (pencil and paper) write what will be displayed if the following commands are executed by MATLAB. Check your answers by executing the commands with MATLAB.

a) `A=M([1,2],[2,4,5])`
b) `B=M(:,[1:3,6])`
c) `C=M([1,3],:)`
d) `D=M([2,3],5)`

35. The following matrix is defined in MATLAB:

$$N = \begin{bmatrix} 33 & 21 & 9 & 14 & 30 \\ 30 & 18 & 6 & 18 & 34 \\ 27 & 15 & 6 & 22 & 38 \\ 24 & 12 & 10 & 26 & 42 \end{bmatrix}$$

By hand (pencil and paper) write what will be displayed if the following commands are executed by MATLAB. Check your answers by executing the commands with MATLAB.

(*a*) `A=[N(1,1:4)',N(2,2:5)']`
(*b*) `B=[N(:,3)' N(3,:)]`
(*c*) `C(3:4,5:6)=N(2:3,4:5)`

36. By hand (pencil and paper) write what will be displayed if the following commands are executed by MATLAB. Check your answers by executing the commands with MATLAB.

```
v=1:3:34
M=reshape(v,3,4)
M(2,:)=[]
M(:,3)=[]
N=ones(size(M))
```

37. Using the `zeros`, `ones`, and `eye` commands, create the following arrays:

(*a*) $\begin{bmatrix} 1 & 1 \\ 1 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$ (*b*) $\begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 1 \end{bmatrix}$ (*c*) $\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 \end{bmatrix}$

38. Using the `zeros`, `ones`, and `eye` commands create the following arrays:

$$(a)\ \begin{bmatrix} 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 \end{bmatrix} \qquad (b)\ \begin{bmatrix} 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 \end{bmatrix} \qquad (c)\ \begin{bmatrix} 1 & 1 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 \end{bmatrix}$$

39. Use the `eye` command to create the array A shown on the left below. Then use the colon to address elements in the arrays and the `eye` command to change A to match the array shown on the right.

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \qquad A = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{bmatrix}$$

40. Create a 2×2 matrix A in which all the elements are 1. Then reassign A to itself (several times) such that A will become:

$$A = \begin{bmatrix} 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 \end{bmatrix}$$