`logical`	Converts numerical data to logical data, with nonzero values becoming `true` and zero values becoming `false`.
`poly`	Converts a list of roots of a polynomial into the polynomial coefficients.
`root`	Calculates the roots of a polynomial expressed as a series of coefficients.
`switch` construct	Selects a block of statements to execute from a set of mutually exclusive choices based on the result of a single expression.
`try/catch` construct	A special construct used to trap errors. It executes the code in the `try` block. If an error occurs, execution stops immediately and transfers to the code in the `catch` construct.

4.9 Exercises

4.1 Evaluate the following MATLAB expressions.

(a) `5 >= 5.5`
(b) `34 < 34`
(c) `xor( 17 - pi < 15, pi < 3)`
(d) `true > false`
(e) `~~(35 / 17) == (35 / 17)`
(f) `(7 <= 8) == (3 / 2 == 1)`
(g) `17.5 && (3.3 > 2.)`

4.2 The tangent function is defined as $\tan\theta = \sin\theta/\cos\theta$. This expression can be evaluated to solve for the tangent as long as the magnitude of cos θ is not too near to 0. (If cos θ is 0, evaluating the equation for tan θ will produce the nonnumerical value `Inf`.) Assume that θ is given in *degrees*, and write the MATLAB statements to evaluate tan θ as long as the magnitude of cos θ is greater than or equal to 10^{-20}. If the magnitude of cos θ is less than 10^{-20}, write out an error message instead.

4.3 The following statements are intended to alert a user to dangerously high oral thermometer readings (values are in degrees Fahrenheit). Are they correct or incorrect? If they are incorrect, explain why and correct them.

```
if temp < 97.5
   disp('Temperature below normal');
elseif temp > 97.5
   disp('Temperature normal');
elseif temp > 99.5
   disp('Temperature slightly high');
elseif temp > 103.0
   disp('Temperature dangerously high');
end
```

4.4 The cost of sending a package by an express delivery service is \$15.00 for the first two pounds and \$5.00 for each pound or fraction thereof over 2 pounds. If the package weighs more than 70 pounds, a \$15.00 excess weight surcharge is added to the cost. No package over 100 pounds will be accepted. Write a program that accepts the weight of a package in pounds and computes the cost of mailing the package. Be sure to handle the case of overweight packages.

4.5 In Example 4.3, we wrote a program to evaluate the function $f(x,y)$ for any two user-specified values x and y, where the function $f(x,y)$ was defined as follows:

$$f(x, y) = \begin{cases} x + y & x \geq 0 \text{ and } y \geq 0 \\ x + y^2 & x \geq 0 \text{ and } y < 0 \\ x^2 + y & x < 0 \text{ and } y \geq 0 \\ x^2 + y^2 & x < 0 \text{ and } y < 0 \end{cases} \tag{4.5}$$

The problem was solved by using a single `if` construct with four code blocks to calculate $f(x,y)$ for all possible combinations of x and y. Rewrite program `funxy` to use nested `if` constructs, where the outer construct evaluates the value of x and the inner constructs evaluate the value of y.

4.6 Write a MATLAB program to evaluate the function

$$y(x) = \ln \frac{1}{1 - x} \tag{4.6}$$

for any user-specified value of x, where x is a number < 1.0 (note that ln is the natural logarithm, the logarithm to the base e). Use an `if` structure to verify that the value passed to the program is legal. If the value of x is legal, calculate $y(x)$. If not, write a suitable error message and quit.

4.7 Write a program that allows a user to enter a string containing a day of the week ('Sunday', 'Monday', 'Tuesday', etc.) and uses a `switch` construct to convert the day to its corresponding number, where Sunday is considered the first day of the week and Saturday is considered the last day of the week. Print out the resulting day number. Also, be sure to handle the case of an illegal day name with an `otherwise` statement! (*Note*: Be sure to use the `'s'` option on function `input` so that the input is treated as a string.)

4.8 Suppose that a student has the option of enrolling for a single elective during a term. The student must select a course from a limited list of options: "English," "History," "Astronomy," or "Literature." Construct a fragment of MATLAB code that will prompt the student for his or her choice, read in the choice, and use the answer as the switch expression for a `switch` construct. Be sure to include a default case to handle invalid inputs.

4.9 Suppose that a polynomial equation has the following six roots: -6, -2, $1 + i\sqrt{2}$, $1 - i\sqrt{2}$, 2, and 6. Find the coefficients of the polynomial.

4.10 Find the roots of the polynomial equation

$$y(x) = x^6 - x^5 - 6x^4 + 14x^3 - 12x^2 \tag{4.7}$$

Plot the resulting function, and compare the observed roots to the calculated roots. Also, plot the location of the roots on a complex plane.

4.11 **Income Tax** The author of this book now lives in Australia. In 2009, individual citizens and residents of Australia paid the following income taxes:

Taxable Income (in A$)	Tax on This Income
\$0–\$6,000	None
\$6,001–\$34,000	15¢ for each \$1 over \$6,000
\$34,001–\$80,000	\$4,200 plus 30¢ for each \$1 over \$34,000
\$80,001–\$180,000	\$18,000 plus 40¢ for each \$1 over \$80,000
Over \$180,000	\$58,000 plus 45¢ for each \$1 over \$180,000

In addition, a flat 1.5 percent Medicare levy is charged on all income. Write a program to calculate how much income tax a person will owe based on this information. The program should accept a total income figure from the user and calculate the income tax, Medicare levy, and total tax payable by the individual.

4.12 **Income Tax** In 2002, individual citizens and residents of Australia paid the following income taxes:

Taxable Income (in A$)	Tax on This Income
\$0–\$6,000	None
\$6,001–\$20,000	17¢ for each \$1 over \$6,000
\$20,001–\$50,000	\$2,380 plus 30¢ for each \$1 over \$20,000
\$50,001–\$60,000	\$11,380 plus 42¢ for each \$1 over \$50,000
Over \$60,000	\$15,580 plus 47¢ for each \$1 over \$60,000

In addition, a flat 1.5 percent Medicare levy was charged on all income. Write a program to calculate how much *less* income tax a person paid on a given amount of income in 2009 than he or she would have paid in 2002.

4.13 **Refraction** When a ray of light passes from a region with an index of refraction n_1 into a region with a different index of refraction n_2, the light ray is bent (see Figure 4.9). The angle at which the light is bent is given by *Snell's law*:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2 \tag{4.8}$$

where θ_1 is the angle of incidence of the light in the first region and θ_2 is the angle of incidence of the light in the second region. Using Snell's law, it is possible to predict the angle of incidence of a light ray in Region 2 if the angle of incidence θ_1 in Region 1 and the indices of refraction n_1 and n_2 are known. The equation to perform this calculation is

$$\theta_2 = \sin^{-1}\left(\frac{n_1}{n_2} \sin \theta_1\right) \tag{4.9}$$

5.4 Write an M-file to evaluate the equation $y(x) = x^2 - 4x + 5$ for all values of x between -1 and 3, in steps of 0.1. Do this twice, once with a `for` loop and once with vectors. Plot the resulting function using a 3-point-thick dashed red line.

5.5 Write an M-file to calculate the factorial function n!, as defined in Example 5.2. Be sure to handle the special case of 0!. Also, be sure to report an error if n is negative or not an integer.

5.6 Examine the following `for` statements and determine how many times each loop will be executed.

(a) `for ii = -32768:32767`
(b) `for ii = 32768:32767`
(c) `for kk = 2:4:3`
(d) `for jj = ones(5,5)`

5.7 Examine the following `for` loops and determine the value of `ires` at the end of each of the loops, and also the number of times each loop executes.

(a)
```
ires = 0;
for index = -12:12
   ires = ires + 1;
end
```

(b)
```
ires = 0;
for index = 10:-2:1
   if index == 6
      continue;
   end
   ires = ires + index;
end
```

(c)
```
ires = 0;
for index = 10:-2:1
   if index == 6
      break;
   end
   ires = ires + index;
end
```

(d)
```
ires = 0;
for index1 = 10:-2:1
   for index2 = 2:2:index1
      if index2 == 6
         break
      end
      ires = ires + index2;
   end
 end
```

of income for taxable incomes from \$0 to \$300,000 in increments of \$1,000. Note that the effective tax rate is defined as

$$\text{effective tax} = \frac{\text{actual tax paid}}{\text{actual taxable income}} \times 100\% \tag{5.19}$$

5.27 Fibonacci Numbers The nth Fibonacci number is defined by the following recursive equations:

$$\begin{aligned} f(1) &= 1 \\ f(2) &= 2 \\ f(n) &= f(n-1) + f(n-2) \end{aligned} \tag{5.20}$$

Therefore, $f(3) = f(2) + f(1) = 2 + 1 = 3$ and so forth for higher numbers. Write an M-file to calculate and write out the nth Fibonacci number for $n > 2$, where n is input by the user. Use a `while` loop to perform the calculation.

5.28 Current through a Diode The current flowing through the semiconductor diode shown in Figure 5.16 is given by the equation

$$i_D = I_0\left(e^{\frac{qv_D}{kT}} - 1\right) \tag{5.21}$$

where

i_D = the voltage across the diode, in volts
v_D = the current flow through the diode, in amps
I_0 = the leakage current of the diode, in amps
q = the charge on an electron, 1.602×10^{-19} coulombs
k = Boltzmann's constant, 1.38×10^{-23} joule/K
T = temperature, in kelvins (K)

The leakage current I_0 of the diode is 2.0 μA. Write a program to calculate the current flowing through this diode for all voltages from −1.0 V to +0.6 V, in 0.1 V steps. Repeat this process for the following temperatures: 75 °F, 100 °F, and 125 °F. Create a plot of the current as a function of applied voltage, with the curves for the three different temperatures appearing as different colors.

5.29 Tension on a Cable A 100-kg object is to be hung from the end of a rigid 2-m horizontal pole of negligible weight, as shown in Figure 5.17. The pole is attached to a wall by a pivot and is supported by a 2-m cable that is attached to the wall at a higher point. The tension on this cable is given by the equation

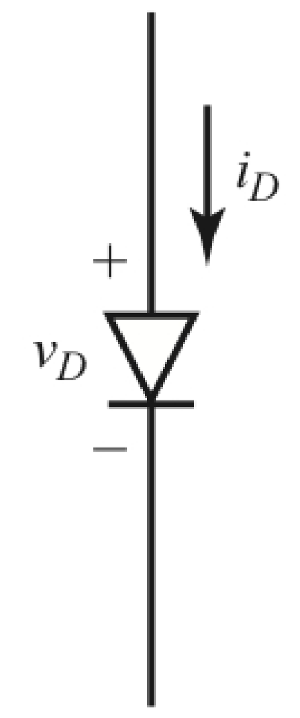

Figure 5.16 A semiconductor diode.