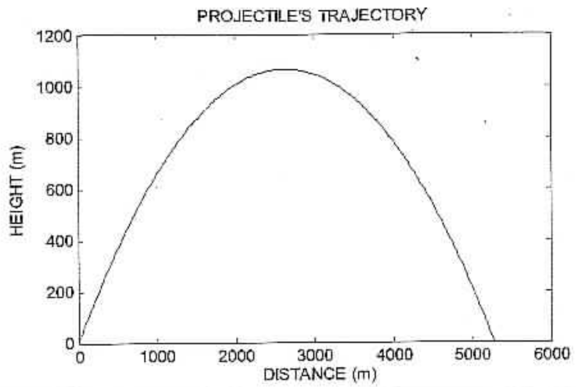
In addition, the following figure is created in the Figure Window:



6.13 PROBLEMS

1. The fuel efficiency of automobiles is measured in mi/Gal (miles per gallon) or in km/L (kilometers per liter). Write a MATLAB user-defined function that converts fuel efficiency values from mi/Gal (U.S. Gallons) to km/L. For the function name and arguments use `kmL=mgTOkm(mpg)`. The input argument `mpg` is the efficiency in mi/Gal, and the output argument `kmL` is the efficiency in km/L. Use the function in the Command Window to:
   a) Determine the fuel efficiency in km/L of a car that consumes 23 mi/Gal.
   b) Determine the fuel efficiency in km/L of a car that consumes 50 mi/Gal.

2. Write a user-defined MATLAB function, with two input and two output arguments, that determines the height in centimeters and mass in kilograms of a person from his height in inches and weight in pounds. For the function name and arguments use `[cm, kg] = STtoSI(in, lb)`. The input arguments are the height in inches and weight in pounds, and the output arguments are the height in centimeters and mass in kilograms. Use the function in the Command Window to:
   a) Determine in SI units the height and mass of a 5 ft. 11 in. person who weighs 181 lb.
   b) Determine your own height and weight in SI units.

3. Write a user-defined MATLAB function for the following math function:
$$y(x) = 0.9x^4 e^{-0.1x} - 15x^2 - 5x$$
   The input to the function is x and the output is y. Write the function such that x can be a vector.
   a) Use the function to calculate $y(-2)$, and $y(4)$.
   b) Use the function to make a plot of the function $y(x)$ for $-3 \le x \le 5$.

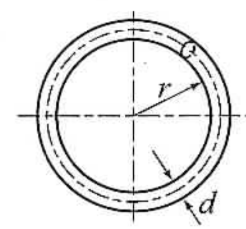
4. Write a user-defined MATLAB function that converts speed given in units of kilometer per hour to speed in units of ft per second. For the function name and arguments use `ftps = kmphTOfps(kmh)`. The input argument is the speed in km/h., and the output argument is the speed in ft/s. Use the function to convert 70 km/h to units of ft/s.

5. Write a user-defined MATLAB function for the following function:
$$r(\theta) = \sin(3\theta)\cos\theta$$
   The input to the function is θ (in radians) and the output is r. Write the function such that θ can be a vector.
   a) Use the function to calculate $r(\pi/4)$, and $r(5\pi/2)$.
   b) Use the function to plot (polar plot) $r(\theta)$ for $0 \le \theta \le 2\pi$.

6. Write a user-defined MATLAB function that calculates the local maximum or minimum of a quadratic function of the form: $f(x) = ax^2 + bx + c$. For the function name and arguments use `[x, y] = maxmin(a,b,c)`. The input arguments are the constants a, b, and c, and the output arguments are the coordinates x and y of the maximum or the minimum.
   Use the function to determine the maximum or minimum of the following functions:
   a) $f(x) = 2x^2 + 9x - 20$
   b) $f(x) = -3x^2 + 15x + 50$

7. The monthly payment M of a loan of amount P for N years and an annual interest rate r (in %) can be calculated by the formula:
$$M = P\frac{\frac{r}{1200}}{1 - \left(1 + \frac{r}{1200}\right)^{-12N}}$$
   Write a MATLAB user-defined function that calculates the monthly payment of a loan. For the function name and arguments use `M = amort(P,r,N)`. The inputs arguments are `P` the loan amount, `r` the annual interest rate in percent, and `N` the length of the loan in years. The output `M` is the amount of the monthly payment. Use the function to calculate the monthly payment of a 15-year mortgage of $260,000 with annual interest rate of 6.75%.

8. The weight W of a ring in a shape of a torus with an inner radius r and a diameter d is given by:
$$W = \gamma\frac{1}{4}\pi^2(2r + d)d^2$$
   where γ is the specific weight of the ring material. Write an anonymous function that calculates the weight

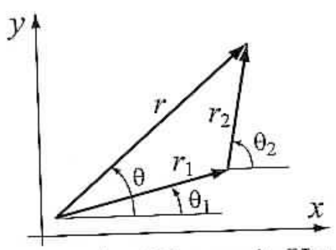


of the ring. The function should have three input arguments r, d, and γ. Use the anonymous function to calculate the weight of a gold ring ($\gamma = 0.696$ lb/in^3) with $r = 0.6$ in., $d = 0.092$ in.

9. Write a user-defined MATLAB function that determines the area of a triangle when the lengths of the sides are given. For the function name and arguments use `[Area] = triangle(a,b,c)`. Use the function to determine the area of triangles with the following sides:
   a) $a = 10, b = 15, c = 7$.
   b) $a = 6, b = 8, c = 10$.
   c) $a = 200, b = 75, c = 250$.

10. Write a user-defined MATLAB function that determines the unit vector in the direction of the line that connects two points (A and B) in space. For the function name and arguments use `n = unitvec(A,B)`. The input to the function are two vectors `A` and `B`, each of which has three elements which are the Cartesian coordinates of the corresponding point. The output is a vector with the three components of the unit vector in the direction from A to B. Use the function to determine the following unit vectors:
    a) In the direction from point (1.5, 2.1, 4) to point (11, 15, 9).
    b) In the direction from point (–11, 3, -2) to point (-13, -4, -5).
    c) In the direction from point (1, 0, 1) to point (0, 1, 1).

11. In polar coordinates a two-dimensional vector is given by its radius and angle (r, θ). Write a user-defined MATLAB function that adds two vectors that are given in polar coordinates. For the function name and arguments use:
    `[r th]= AddVecPol(r1,th1,r2,th2)`
    where the input arguments are (r_1, θ_1) and (r_2, θ_2), and the output arguments are the radius and angle of the result. Use the function to carry out the following additions:
    a) $r_1 = (5, 23°)$, $r_2 = (12, 40°)$. *b)* $r_1 = (6, 80°)$, $r_2 = (15, 125°)$.



12. Write a user-defined MATLAB function that gives a random integer number within a range between two numbers. For the function name and arguments use `n = randint(a,b)`, where the two input arguments `a` and `b` are the two numbers and the output argument `n` is the random number.
    Use the function in the Command Window for the following:
    a) Generate a random number between 1 and 49.
    b) Generate a random number between –35 and –2.

13. Write a user-defined MATLAB function that calculates the determinant of a 3×3 matrix by using the formula:

$$det = A_{11}\begin{vmatrix} A_{22} & A_{23} \\ A_{32} & A_{33} \end{vmatrix} - A_{12}\begin{vmatrix} A_{21} & A_{23} \\ A_{31} & A_{33} \end{vmatrix} + A_{13}\begin{vmatrix} A_{21} & A_{22} \\ A_{31} & A_{32} \end{vmatrix}$$

For the function name and arguments use `d3 = det3by3(A)`, where the input argument `A` is the matrix and the output argument `d3` is the value of the determinant. Write the code of `det3by3` such that it has a subfunction that calculates the 2×2 determinant. Use `det3by3` for calculating the determinants of:

a) $\begin{bmatrix} 1 & 3 & 2 \\ 6 & 5 & 4 \\ 7 & 8 & 9 \end{bmatrix}$ *b)* $\begin{bmatrix} -2.5 & 7 & 1 \\ 5 & -3 & -2.6 \\ 4 & 2 & -1 \end{bmatrix}$

14. Write a user-defined MATLAB function that calculates a student's final grade in a course using the scores from three midterm exams, a final exam, and six homework assignments. The midterms are graded on a scale from 0 to 100, and are each 15% of the final grade. The final exam is graded on a scale from 0 to 100, and is 45% of the final grade. The six homework assignments are graded each on a scale from 0 to 10. The homework assignments together are 10% of the final grade.

    For the function name and arguments use `g = fgrade(R)`. The input argument `R` is a matrix in which the elements in each row are the grades of one student. The first six columns are the homework grades (numbers between 0 and 10), the next three columns are the midterm grades (numbers between 0 and 100), and the last column is the final exam grade (a number between 0 and 100). The output from the function, `g`, is a column vector with the final grades for the course. Each row has the final grade of the student with the grades in the corresponding row of the matrix `R`.

    The function can be used to calculate the grades of any number of students. For one student the matrix `R` has one row. Use the function in the following cases:

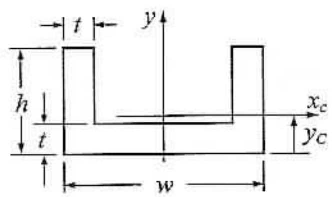
    a) Use the Command Window to calculate the grade of one student with the following grades: (8, 9, 6, 10, 9, 8, 76, 86, 91, 80).
    b) Write a program in a script file. The program asks the user to enter the students' grades in an array (each student a row). The program then calculates the final grades by using the function `fgrade`. Run the script file in the Command Window to calculate the grades of the following four students:
    Student A: 8, 10, 6, 9, 10, 9, 91, 71, 81, 85.
    Student B: 5, 5, 6, 1, 8, 6, 59, 72, 66, 59.
    Student C: 6, 8, 10, 4, 5, 9, 55, 65, 75 78.
    Student D: 7, 7, 8, 8, 9, 8, 83, 82, 81 84.

15. When n electrical resistors are connected in parallel, their equivalent resistance R_{Eq} can be determined from:

$$\frac{1}{R_{Eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$$

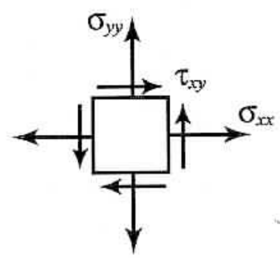
Write a user-defined MATLAB function that calculates R_{Eq}. For the function name and arguments use `REQ = req(R)`. The input to the function is a vector in which each element is a resistor value, and the output from the function is R_{Eq}. Use the function to calculate the equivalent resistance when the following resistors are connected in parallel: 50Ω, 75Ω, 300Ω, 60Ω, 500Ω, 180Ω, and 200Ω.

16. Write a user-defined function that determines the coordinate y_C of the centroid of the U-shaped cross-sectional area shown in the figure. For the function name and arguments use `yc = centroidU(w,h,t)`, where the input arguments `w`, `h`, and `t` are the dimensions shown in the figure, and the output argument `yc` is the coordinate y_C.



Use the function to determine y_C for an area with $w = 250$ mm, $h = 160$ mm, and $t = 26$ mm.

17. A two-dimensional state of stress at a point in a loaded material is defined by three components of stresses σ_{xx}, σ_{yy}, and τ_{xy}. The maximum and minimum normal stresses (principal stresses) at the point, σ_{max} and σ_{min}, are calculated from the stress components by:



$$\sigma_{\substack{max \\ min}} = \frac{\sigma_{xx} + \sigma_{yy}}{2} \pm \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \tau_{xy}^2}$$

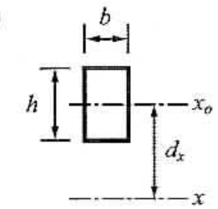
Write a user-defined MATLAB function that determines the principal stresses from the stress components. For the function name and arguments use `[Smax,Smin] = princstress(Sxx,Syy,Sxy)`. The input arguments are the three stress components, and the output arguments are the maximum and minimum stresses.

Use the function to determine the principal stresses for the following states of stress:

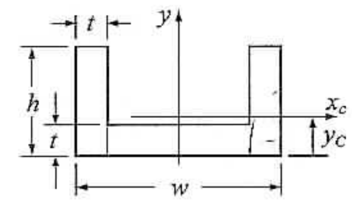
a) $\sigma_{xx} = -190$ MPa, $\sigma_{yy} = 145$ MPa, and $\tau_{xy} = 110$ MPa.

b) $\sigma_{xx} = 14$ ksi, $\sigma_{yy} = -15$ ksi, and $\tau_{xy} = 8$ ksi.

18. The area moment of inertia I_{x_o} of a rectangle about the axis x_o that passes through its centroid is: $I_{x_o} = \frac{1}{12}bh^3$. The moment of inertia about an axis x that is parallel to x_o is given by: $I_x = I_{x_o} + Ad_x^2$, where A is the area of the rectangle, and d_x is the distance between the two axes.



Write a MATLAB user-defined function that determines the area moment of inertia I_{x_C} of an "U" beam about the axis that passes through its centroid (see drawing). For the function name and arguments use `Ixc = IxcBeam(w,h,t)`. The input arguments to the function are the width `w`, the height `h`, and the thickness `t`. The output argument `Ixc` is I_{x_C}. For finding the coordinate y_C of the of the centroid use the user-defined function `centroidU` from Problem 16 as a subfunction inside `IxcBeam`.

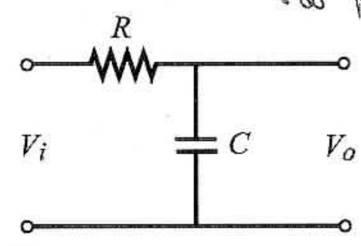


(The moment of inertia of a composite area is obtained by dividing the area into parts and adding the moment of inertia of the parts.)

Use the function to determine the moment of inertia of an "I" beam with $w = 320$ mm, $h = 180$ mm, and $t = 32$ mm.

do you mean U beam?

19. In a low-pass RC filter (a filter that passes signals with low frequencies), the ratio of the magnitude of the voltages is given by:



$$RV = \left|\frac{V_o}{V_i}\right| = \frac{1}{\sqrt{1 + (\omega RC)^2}}$$

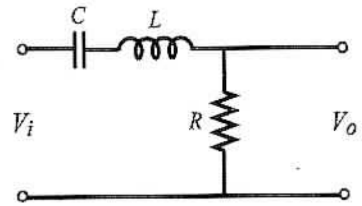
where ω is the frequency of the input signal.

Write a user-defined MATLAB function that calculates the magnitude ratio. For the function name and arguments use `RV = lowpass(R,C,w)`. The input arguments are: `R` the size of the resistor in Ω (ohms), `C` the size of the capacitor in F (Farads), and `w` the frequency of the input signal in rad/s. Write the function such that `w` can be a vector.

Write a program in a script file that uses the `lowpass` function to generate a plot of RV as a function of ω for $10^{-2} \le \omega \le 10^6$ rad/s. The plot has a logarithmic scale on the horizontal axis (ω). When the script file is executed, it asks the user to enter the values of R and C. Label the axes of the plot.

Run the script file with $R = 1200$ Ω, and $C = 8$ μF.

20. A band-pass filter passes signals with frequencies within a certain range. In this filter the ratio of the magnitude of the voltages is given by:



$$RV = \left|\frac{V_o}{V_i}\right| = \frac{\omega RC}{\sqrt{(1-\omega^2 LC)^2 + (\omega RC)^2}}$$

where ω is the frequency of the input signal.

Write a user-defined MATLAB function that calculates the magnitude ratio. For the function name and arguments use `RV = bandpass(R,C,L,w)`. The input arguments are: `R` the size of the resistor in Ω (ohms), `C` the size of the capacitor in F (Farads), `L` the inductance of the coil in H (Henrys), and `w` the frequency of the input signal in rad/s. Write the function such that `w` can be a vector.

Write a program in a script file that uses the `bandpass` function to generate a plot of RV as a function of ω for $10^{-2} \le \omega \le 10^7$ rad/s. The plot has a logarithmic scale on the horizontal axis (ω). When the script file is executed, it asks the user to enter the values of R, L, and C. Label the axes of the plot.

Run the script file for the following two cases:

a) $R = 1100\,\Omega$, and $C = 9\,\mu\text{F}$, $L = 7\,\text{mH}$.
b) $R = 500\Omega$, and $C = 300\mu\text{F}$, $L = 400\text{mH}$.

21. The dew point temperature T_d can be calculated (approximately) from the relative humidity RH and the actual temperature T by (http://www.paroscientific.com/dewpoint.htm):

$$T_d = \frac{b\,f(T,RH)}{a - f(T,RH)} \quad \text{with} \quad f(T,RH) = \frac{aT}{b+T} + \ln\left(\frac{RH}{100}\right)$$

where the temperature is in degrees Celsius, RH in %, $a = 17.27$, and $b = 237.7\,^{\circ}\text{C}$.

Write a user-defined MATLAB function that calculates the dew point temperature for a given temperature and relative humidity. For the function name and arguments use `Td = dewpoint(T,bRH)`, where the two input arguments `T` and `RH` are the temperature and relative humidity, respectively, and the output argument `Td` is the dew point temperature. Use the user-defined function `dewpoint` for calculating the dew point temperature for the following cases:

a) $T = 15\,^{\circ}\text{C}$, $RH = 40\%$.
b) $T = 35\,^{\circ}\text{C}$, $RH = 80\%$.

I believe this is a typo

Chapter 7

Programming in MATLAB

... unfortunately.

A computer program is a sequence of computer commands. In a simple program the commands are executed one after the other in the order that they are typed. In this book, for example, all the programs that have been presented so far, in script or function files, are simple programs. Many situations, however, require more sophisticated programs in which commands are not necessarily executed in the order that they are typed, or that different commands (or groups of commands) are executed when the program runs with different input variables. For example, a computer program that calculates the cost of mailing a package for the post office uses different mathematical expressions to calculate the cost depending on the weight and size of the package, the content (books are less expensive to mail), and the type of service (airmail, ground, etc.). In other situations there might be a need to repeat a sequence of commands several times within a program. For example, programs that solve equations numerically repeat a sequence of calculations until the error in the answer is smaller than some measure.

MATLAB provides several tools that can be used to control the flow of a program. Conditional statements (Section 7.2) and the `switch` structure (Section 7.3), make it possible to skip commands or to execute specific groups of commands in different situations. `For` loops and `while` loops (Section 7.4) make it possible to repeat a sequence of commands several times.

It is obvious that changing the flow of a program requires some kind of decision-making process within the program. The computer must decide whether to execute the next command or to skip one or more commands and continue at a different line in the program. The program makes these decisions by comparing values of variables. This is done by using relational and logical operators which are explained in Section 7.1.

It should also be noted that function files (Chapter 6) can be used in programming. A function file is a subprogram. When the program reaches the command line that has the function, it provides input to the function, and "waits" for the results. The function carries out the calculations, transfers the results back to