

Summer 2017 Math 152 MATLAB Assignments

Chapter 1

13. Given $\int x^2 \cos x dx = 2x \cos x + (x^2 - 2) \sin x$, calculate $\int_{\pi/6}^{\pi/3} x^2 \cos x dx$.
15. Let a and h be positive constants and consider the parabolic segment from $A(-a, 0)$ to $B(0, h)$ to $C(a, 0)$. Compute its arc length via the formula $L = \sqrt{a^2 + 4h^2} + \frac{a^2}{2h} \ln \left(\frac{2h}{a} + \sqrt{\left(\frac{2h}{a}\right)^2 + 1} \right)$ using $a = 8$ cm and $h = 13$ cm.
19. A triangle has angles $\alpha = 72^\circ$, $\beta = 43^\circ$, $\gamma = 65^\circ$, with opposite side lengths a , b , c , respectively. Its perimeter is $p = a + b + c = 114$ mm.
- (a) Calculate the side lengths.
 - (b) Calculate the radius r of the circle inscribed in the triangle using the formula $r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}}$, where $s = p/2$.
21. The arc length of an ellipse is approximated by $L = \pi \left(3(a+b) - \sqrt{(3a+b)(a+3b)} \right)$, where a and b are semi-axis lengths. Estimate the arc length using $a = 18$ cm and $b = 7$ cm.
23. You transport 777 people in buses that have 46 seats and vans that have 12 seats.
- (a) How many buses are needed if all are full?
 - (b) If enough vans are used to transport people not in buses, how many seats in vans remain empty?

Chapter 2

8. Create a row vector \mathbf{h} with 8 equally spaced elements starting with 68 and ending with 12.
9. Create a column vector \mathbf{M} with first element 6.4, increment 0.8, and last element 12.
23. Create row vector $\mathbf{vF}=5:7:61$. Then create \mathbf{vFrev} by reversing the order of the elements of \mathbf{vF} . [You'll find the `fliplr` command useful.]
33. Create vectors $\mathbf{d}=[6 -1 4 0 -2 5]$ and $\mathbf{e}=[7 5 9 0 1 3]$.

- (a) Create a 3×3 matrix whose first row consists of elements 2 through 4 of \mathbf{d} , second row consists of elements 3 through 5 of \mathbf{e} , and third row consists of elements 4 through 6 of \mathbf{d} .
- (b) Create a 4×2 matrix whose first column consists of elements 2 through 5 of \mathbf{d} and second column consists of elements 3 through 6 of vector \mathbf{e} .

45. Create matrices $\mathbf{A} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $\mathbf{B} = [1 \ 1]$, and $\mathbf{C} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ by using the **zeros**, **ones**, and **eye** commands. Then use these three matrices to create the matrix $\mathbf{D} = \begin{bmatrix} 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 \end{bmatrix}$.

Chapter 3

3. Calculate $y = (x + x\sqrt{x+3})(1 + 2x^2) - x^3$ for $x = -2, -1.5, -1, -0.5, 0, 0.5, 1, 1.5, 2$, by using element-by-element operations.
10. The angle θ between two vectors $\mathbf{u}_1 = [x_1 \ y_1 \ z_1]$ and $\mathbf{u}_2 = [x_2 \ y_2 \ z_2]$ is $\theta = \cos^{-1} \left(\frac{x_1 x_2 + y_1 y_2 + z_1 z_2}{\|\mathbf{u}_1\| \|\mathbf{u}_2\|} \right)$, where $\|\mathbf{u}_i\| = \sqrt{x_i^2 + y_i^2 + z_i^2}$. Given $\mathbf{u}_1 = [3.2 \ -6.8 \ 9]$ and $\mathbf{u}_2 = [-4 \ 2 \ 7]$, compute the angle between them in degrees using element-by-element multiplication together with **acosd**, **sum** and **sqrt**.
29. Create matrices $\mathbf{A} = \begin{bmatrix} 5 & -3 & 7 \\ 1 & 0 & -6 \\ -4 & 8 & 9 \end{bmatrix}$, $\mathbf{B} = \begin{bmatrix} 3 & 2 & -1 \\ 6 & 8 & -7 \\ 4 & 4 & 0 \end{bmatrix}$, and $\mathbf{C} = \begin{bmatrix} -9 & 8 & 3 \\ 1 & 7 & -5 \\ 3 & 3 & 6 \end{bmatrix}$.
- (a) Calculate $\mathbf{A} + \mathbf{B}$ and $\mathbf{B} + \mathbf{A}$ to show that addition of matrices is commutative.
 - (b) Calculate $\mathbf{A} * (\mathbf{B} * \mathbf{C})$ and $(\mathbf{A} * \mathbf{B}) * \mathbf{C}$ to show that multiplication of matrices is associative.
 - (c) Calculate $5(\mathbf{B} + \mathbf{C})$ and $5\mathbf{B} + 5\mathbf{C}$ to show that, when matrices are multiplied by a scalar, the multiplication is distributive.
 - (d) Calculate $(\mathbf{A} + \mathbf{B}) * \mathbf{C}$ and $\mathbf{A} * \mathbf{C} + \mathbf{B} * \mathbf{C}$ to show that matrix multiplication is distributive.

30. Use matrices from #29 to answer the following.

- (a) Does $\mathbf{A} * \mathbf{B} = \mathbf{B} * \mathbf{A}$?
- (b) Does $(\mathbf{B} * \mathbf{C})^{-1} = \mathbf{B}^{-1} * \mathbf{C}^{-1}$?
- (c) Does $(\mathbf{A}^{-1})^t = (\mathbf{A}^t)^{-1}$? [t signifies transpose]
- (d) Does $(\mathbf{A} + \mathbf{B})^t = \mathbf{A}^t + \mathbf{B}^t$?

34. Solve this system of linear equations.

$$\begin{aligned} 2a - 4b + 5c - 3.5d + 1.8e + 4f &= 52.52 \\ -1.5a + 3b + 4c - d - 2e + 5f &= -21.1 \\ 5a + b - 6c + 3d - 2e + 2f &= -27.6 \\ 1.2a - 2b + 3c + 4d - e + 4f &= 9.16 \\ 4a + b - 2c - 3d - 4e + 1.5f &= -17.9 \\ 3a + b - c + 4d - 2e + 4f &= -16.2 \end{aligned}$$

Chapter 4

5. The fuel tank on a go-kart is made of a half cylinder with radius 14 cm and is 36 cm long. Derive an expression for the volume V of fuel in liters (L) as a function of height h (cm). Create a vector for h ranging from 0 to 14 cm in 2-cm increments. Then calculate corresponding volumes to the nearest tenth of a liter. Display the results in a two-column table, with h in the first column and V in the second column.
13. The angle θ at which a viewer sees the picture on the screen of a movie theater depends on the distance x from the screen. Determine the angle in degrees for viewers sitting at distances of 20, 26, 32, 38, 44, 50, 56, 62, and 68 ft. (Diagram at end.)
14. A 144-cm wire is cut into 8 pieces and welded together to form a pyramid with $b = 1.9a$ in the rectangular base. Determine the dimensions a and b such that the pyramid's volume is maximized. Define $\mathbf{a}=4:0.01:14$ and use this vector for calculating volume $V = \frac{1}{3}abh$ (after expressing h in terms of a). Use the function **max** to determine the greatest volume. (Diagram at end.)
17. An airplane flies at $v = 350$ mi/h along the straight path shown. It is being tracked by a radar station $h = 1500$ ft below point A. The plane is at point A at time $t = 0$. For times $\mathbf{t}=0:0.5:6$ s, calculate θ and r . Make a 3-column table of these values. (Plot at end.)

25. Determine the quartic $f(x) = ax^4 + bx^3 + cx^2 + dx + e$ that passes through the five points $(-2.5, -62)$, $(-1.5, -7.2)$, $(-0.5, 8.3)$, $(1, 3.7)$, $(3, 45.7)$ by solving a linear system. Corroborate your result by graphing the quartic and the points on the same plot.

Chapter 5

7. For $f(x) = \sin(2x) \cos^2(0.5x)$, plot the function (solid line) and its derivative (dashed line) for $-\pi \leq x \leq 2\pi$ in one figure. Add a legend and label the axes.
14. Use **fplot** to graph $f(x) = x + \frac{1}{x^2-1}$ for $-4 \leq x \leq 4$.
18. Use **polarplot** to graph $\theta = n \cdot 135.7^\circ$, $r = \sqrt{n}$ for $n = 1, 2, \dots, 100$. Use circle markers to plot individual points.
26. Position of a particle along a straight line is given by $x = 8 - 4t^3 e^{-0.4t} + 2t^2$ in ft. Derive expressions for velocity $v = \frac{dx}{dt}$ and acceleration $a = \frac{dv}{dt}$. Graph position, velocity, and acceleration as functions of time in three different plots. Label all axes with appropriate units.
34. Sound waves combine to produce the phenomenon of beats. Plot the beating sound for $0 \leq t \leq 0.3$ s. Graph $y = 2 \cos\left(2\pi \left(\frac{f_1+f_2}{2}\right) t\right) \cos\left(2\pi \left(\frac{f_1-f_2}{2}\right) t\right)$ for the frequencies $f_1 = 130$ Hz and $f_2 = 120$ Hz.

Chapter 6

10. High temperatures in New York City and Denver during January 2014 are listed below in order of the days of the month.
- NYC = [33 33 18 29 40 55 19 22 32 37 58 54 51 52 45 41 45 39 36 45 33 18 19 19 28 34 44 21 23 30 39]
- DEN = [39 48 61 39 14 37 43 38 46 39 55 46 46 39 54 45 52 52 62 45 62 40 25 57 60 57 20 32 50 48 28]
- Write a MATLAB script file that determines and displays the following information.
- (a) the average temperature for the month in each city, rounded to the nearest degree
 - (b) the number of days that the temperature was above the average in each city
 - (c) the number of days that the temperature in Denver was higher than New York

12. Fibonacci numbers are those in the sequence $0, 1, 1, 2, 3, 5, 8, 11, \dots$ in which the first two numbers are 0 and 1 and successive numbers are the sum of the previous two numbers. Write a MATLAB script file that finds and displays the first 25 Fibonacci numbers.
20. A safe prime is a prime number that can be written in the form $2p + 1$ where p is also a prime number. Write a MATLAB script file that finds and displays all safe primes between 1 and 1000.
22. A Mersenne prime is a prime number that is equal to $2^n - 1$ where n is an integer. Write a MATLAB script file that finds and displays all Mersenne primes between 1 and 10000.
26. Write a MATLAB script file that finds a positive integer n such that the sum $1 + 2 + 3 + \dots + n$ is a number between 100 and 1000 whose three digits are identical. As output, the program displays the integer n along with the said sum.

Chapter 7

2. Write an anonymous MATLAB function for $r(\theta) = 3 \sin(3 \cos(0.5\theta))$ where θ is in radians.
- (a) Calculate $r(\pi/6)$ and $r(5\pi/6)$.
 - (b) Use the function to make a plot of $r(\theta)$ for $0 \leq \theta \leq 4\pi$ via **polarplot**.
11. Write an anonymous MATLAB function **GPA** that calculates grade point average on a scale of 0 to 5, where $A = 5$, $B = 4$, $C = 3$, $D = 2$, and $F = 0$. Arguments to the function are **G**, a string whose elements are letter grades, and **C**, a vector with corresponding credit hours. Output is the grade point average rounded to the nearest tenth. Use the function to calculate the average of a student whose record is:
- | Grade | A | B | F | C | B | A | D | A |
|--------------|---|---|---|---|---|---|---|---|
| Credit Hours | 4 | 3 | 3 | 2 | 3 | 4 | 3 | 3 |
12. Write an anonymous MATLAB function **theta** that determines the angle in degrees formed by the intersection of two lines. Inputs are three noncollinear points A , B , and C with B contained on both lines. Use the function to determine the angles between the two lines determined by these noncollinear points whose intersection is B .

- (a) $A(-5, -1, 6)$, $B(2.5, 1.5, -3.5)$, $C(-2.3, 8, 1)$

- (b) $A(-5.5, 0)$, $B(3.5, -6.5)$, $C(0, 7)$
21. Write a user-defined function that plots an ellipse with axes that are parallel to the x and y axes, given the coordinates of two vertices and another point that the ellipse passes through. For function name and arguments, use **ellipseplot(A,B,C)**. Here **A** and **B** are 2-element vectors containing vertex coordinates and **C** is a 2-element vector containing coordinates of the other point on the ellipse. Use the function to plot the ellipses containing these points.
- (a) $A(2, 3)$, $B(11, 3)$, $C(10, 4)$
 - (b) $A(2, 11)$, $B(2, -4)$, $C(4, 8)$
24. The harmonic mean of a set of n positive numbers x_1, x_2, \dots, x_n is $H = \frac{n}{\frac{1}{x_1} + \frac{1}{x_2} + \dots + \frac{1}{x_n}}$. Make a MATLAB anonymous function **H** that computes the harmonic mean, then use it to compute the equivalent resistance of resistors connected in parallel by computing the harmonic mean of said resistors. The resistors have resistances 250, 320, 550, 160, 1000, which are measured in ohms.

Chapter 8

2. Plot the polynomial $y = 0.7x^4 - 13.5x^2 + 6x - 37$ for $-5 \leq x \leq 5$. Use **polyval** and **plot**.
9. The product of three integers with a spacing of 3 between them, $\{n, n + 3, n + 6\}$, is 11,960. Use MATLAB's polynomial functions to determine to determine these integers.
13. A rectangular box *without* a top has surface area 2500 cm^2 . The length x of its base is 18 cm longer than its width.
- (a) Use MATLAB's polynomial functions to express the volume V of the box in terms of x .
 - (b) Plot V vs x for $5 \leq x \leq 35$ cm.
 - (c) Determine the length that maximizes the volume as well as said volume.
25. Growth data of a sunflower plant is given in the following table.

Day	7	21	35	49	63	77	91
Height (cm)	8.5	21	50	77	89	98	99

- (a) Curve-fit the data with a 3rd order polynomial. Use it to estimate the height at day 40.
- (b) Fit the data with linear and spline interpolations and use each to estimate the height at day 40.
- (c) On the same graph, plot the data (circle markers) along with the polynomial and interpolations.

30. The table below shows concentration C of a substance during a chemical reaction at various times t .

t (h)	0.5	1.0	1.5	2.0	2.5	3.0
C (g/L)	1.7	3.1	5.7	9.1	6.4	3.7

t (h)	3.5	4.0	4.5	5.0	5.5	6.0
C (g/L)	2.8	1.6	1.2	0.8	0.7	0.6

- (a) Model the data with an equation of the form $C_2(t) = \frac{1}{a_2t^2 + a_1t + a_0}$, the reciprocal of a 2nd order polynomial.
- (b) Model the data with an equation of the form $C_3(t) = \frac{1}{a_3t^3 + a_2t^2 + a_1t + a_0}$, the reciprocal of a 3rd order polynomial.
- (c) On the same graph, plot the data (circle markers) along with the fitted curves. Provide a legend.

Chapter 9

3. Determine the three roots of $x^3 - x^2e^{-0.5x} - 3x = -1$.
11. Use MATLAB's **fminbnd** command to find the minimum and maximum of $f(x) = \frac{2+(x-1.45)^2}{3+3.5(0.8x^2-0.6x+2)}$ and where they occur. Illustrate with a plot.

18. Use MATLAB's **integral** command to numerically evaluate these integrals.

- (a) $\int_0^3 \sqrt[4]{1+0.5x^3-x^2} dx$
- (b) $\int_0^8 \frac{x \cos x + 2x^2}{e^x} dx$

20. A rubber band is stretched by fixing one end and pulling on the other end. Measurements of the applied force at different displacements are given in the following table. Determine the work (in ft-lb) done by the force while stretching the rubber band. Use MATLAB's **trapz** command. (Be sure to convert inches into feet.)

x (in.)	0	0.4	0.8	1.2	1.6	2.0	2.4	2.8
F (lb)	0	0.85	1.30	1.60	1.87	2.14	2.34	2.52

34. Use MATLAB's **ode45** command to numerically solve $\frac{dy}{dx} = -x^2 + \frac{1}{4}x^3e^{-y}$, $y(1) = 1$, for $1 \leq x \leq 5$. Plot the numerical solution.

Chapter 10

(NONE: 3D graphics are done in Calculus 3.)

Chapter 11

2. Define x as symbolic. Create expressions $S_1 = x^2(4x^2 - 8x - 3) + 3(8x - 9)$ and $S_2(2x - 3)^2 + 4x$. Obtain the simplest form for each of the following expressions.

- (a) S_1S_2 (b) S_1/S_2 (c) $S_2 - S_1$
- (d) Use the subs command to evaluate (c) for $x = 6$.

14. Plot the circle $(x - 3)^2 + (y - 2)^2 = 9^2$ and the tangent line to the upper semicircle for $x = -3$. Use **implicit**.

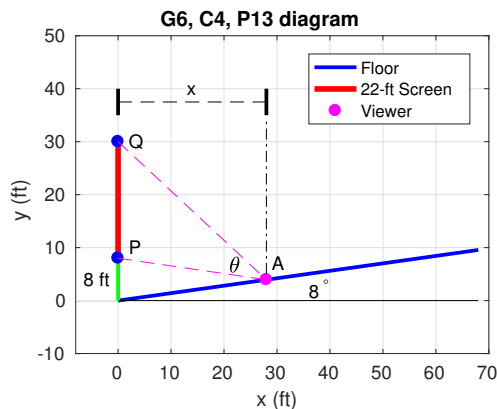
17. Symbolically evaluate these indefinite integrals.

- (a) $\int \frac{1}{x\sqrt{2x+4x^2}} dx$
- (b) $\int e^{-2x} \sin(3x) dx$

18. Symbolically evaluate the integral $\int_0^\pi \frac{6\sin^2x}{(3\sin x + 1)^2} dx$.

29. Symbolically solve the following initial value problem, then plot the solution for $0 \leq t \leq 7$.

$$y'' - 0.08y' + 0.6t = 0, \quad y(0) = 2, \quad y'(0) = 3$$



G6, C4, P14 diagram

