# Summer 2017 Math 151
# MATLAB Assignments

## *Chapter 1*

**3.** Calculate

- (a) $\frac{23+\sqrt[3]{45}}{16\times 0.7}+\log_{10} 589006$
- (b) $(36.1-2.25\pi)\left(e^{2.3}+\sqrt{20}\right)$

**4.** Calculate

- (a) $\frac{3.8^2}{2.75-41\times 25}+\frac{5.2++1.8^5}{\sqrt{3.5}}$
- (b) $\frac{2.1\times 10^6-15.2\times 10^5}{3\times\sqrt[3]{6\times 10^{11}}}$ [Use exponential notation.]

**5.** Calculate

- (a) $\frac{\sin(0.2\pi)}{\cos(\pi/6)}+\tan 72^\circ$
- (b) $(\tan 64^\circ \cos 15^\circ)^2\times\frac{\sin^2 37^\circ}{\cos^2 20^\circ}$

**8.** Assign $x=6.5$ and $y=3.8$. Then evaluate

- (a) $\left(x^2+y^2\right)^{2/3}+\frac{xy}{y-x}$
- (b) $\frac{\sqrt{x+y}}{(x-y)^2}+2x^2-xy^2$

**22.** You pack 4217 eggs into boxes that hold 36 eggs each. If every box that is used is full, how many eggs remain unpacked? (*Hint*: Use MATLAB's **fix** command.)

## *Chapter 2*

**7.** Create row vector **g** with first element 3, last element 27, and increment 4 between elements.

**10.** Create column vector **N** with 7 equally spaced elements starting with 44 and ending with 23.

**22.** Create row vectors **vD**=20:4:44 and **vE**=50:3:71.

- (a) Create row vector **vDE** that contains the 2nd through 5th elements of **vD** followed by the 4th through 7th elements of **vE**.
- (b) Create row vector VED that contains the 2nd through 6th elements of **vE** *in reverse order* followed by the first 4 elements of **vD** *in reverse order*. [You'll find the **fliplr** command useful.]

**32.** Define row vectors **a**=[5 8 -1 0 2], **b**=[4 1 9 -2 3], and **c**=[-3 5 0 6 1].

- (a) Create a $3\times 5$ matrix with rows **c**, **b**, **a**, respectively.
- (b) Create a $5\times 3$ matrix in which the columns are **c**, **b**, **a**, respectively.

**44.** Use the **zeros**, **ones**, and **eye** commands to create the following matrices.

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

## *Chapter 3*

**1.** Calculate $y=x^2-\frac{x}{x+3}$ for $x=0,1,2,3,4,5,6,7$, by using element-by-element operations.

**8.** The magnitude of a vector $\mathbf{u}=\begin{bmatrix} x & y & z \end{bmatrix}$ is $\|\mathbf{u}\|=\sqrt{x^2+y^2+z^2}$. For $\mathbf{u}=\begin{bmatrix} -5.6 & 11 & -14 \end{bmatrix}$, compute its magnitude using element-by-element multiplication together with **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 $\left(\mathbf{A}^{-1}\right)^t = (\mathbf{A}^t)^{-1}$? [ $^t$ signifies transpose]
- (d) Does $(\mathbf{A} + \mathbf{B})^t = \mathbf{A}^t + \mathbf{B}^t$?

**33.** Solve this system of linear equations.

$$\begin{aligned} -2x + 5y + 7z &= -17.5 \\ 3x - 6y + 2z &= 40.6 \\ 9x - 3y + 8z &= 56.2 \end{aligned}$$

## Chapter 4

**8.** The amount of medication in a body can be modeled by $A = A_0 e^{kt}$, where $A$ is the amount at time $t$, $A_0$ is the amount at time $t = 0$, and $k$ is the decay constant. The half-life of a particular medication is 3.5 h. A person takes 400 mg of the medication at time $t = 0$, then an additional 400 mg every 4 h. Determine the amount of medication in the person's body 23 h after taking the first dose.

- First determine the value of $k$ symbolically, so as to avoid round-off error.
- Then define a vector **t**=[23 19 15 11 7 3], the time since taking each dose, and calculate the corresponding values of $A$.
- Finally, use MATLAB's **sum** command to determine the total amount of medication.

**13.** The angle $\theta$ 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 **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 **t**=0:0.5:6 s, calculate $\theta$ and $r$. Make a 3-column table of these values. (Plot at end.)

**24.** Determine the cubic $f(x) = ax^3 + bx^2 + cx + d$ that passes through the four points $(-1.2, 18.8)$, $(0.2, 5)$, $(2, 16)$, and $(3.5, 15)$ by solving a linear system. Corroborate your result by graphing the cubic along with the points on the same plot.

## Chapter 5

**4.** For $f(x) = x^2 e^{-x}$, plot the function (solid line) and its derivative (dashed line) for $0 \le x \le 10$ in one figure. Add a legend and label the axes.

**13.** Use **fplot** to graph $f(x) = \frac{x^2 - 6x + 7}{x^3 - 8}$ for $0 \le x \le 4$.

**17.** Use **polarplot** to graph $r = \pm\sqrt{\theta}$ for $0 \le \theta \le 5\pi$.

**24.** Motion of a particle is defined by $x = 52t - 9t^2$ m, $y = 125 - 5t^2$ m. The speed of the particle is $v = \sqrt{v_x^2 + v_y^2}$ in m/s, where $v_x = \frac{dx}{dt}$ and $v_y = \frac{dy}{dt}$. For $0 \le t \le 5$ s (time spacing 0.1 s), graph the position of the particle ($y$ vs $x$) and in a second plot the speed ($v$ vs $t$). Use the **min** command to determine the minimum speed. Use an asterisk marker to show the corresponding position on the first plot.

**34.** Sound waves combine to produce the phenomenon of beats. Plot the beating sound for $0 \le t \le 0.3$ 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

**6.** Use loops to create a $4 \times 6$ matrix in which the value of each element is two times its row number minus three times its column number.

**11.** The Pascal triangle can be displayed as elements in a lower-triangular matrix where the element $ij$ is the binomial coefficient $\begin{pmatrix} i-1 \\ j-1 \end{pmatrix}$. Use the **nchoosek** command in this regard. Create the Pascal triangle having 7 rows.

**19.** Write a MATLAB script file that finds and displays all integers between 100 and 999 whose product of digits is 6 times the sum of the digits.

**21.** Sexy primes are two prime numbers $p$ and $q$ such that $q = p+6$. Find all sexy primes between 1 and 300. Display them as pairs in a two-column matrix.

**23.** A perfect number is a positive integer that is equal to the sum of its positive divisors excluding the number itself. Write a program that finds and prints the first three perfect numbers.

## *Chapter 7*

**1.** Write an anonymous MATLAB function for $f(x) = 0.6x^3e^{-0.47x} + 1.5x^2e^{-0.6x}$ using element-by-element operations.

- (a) Calculate $f(-2)$ and $f(4)$.
- (b) Use the function to make a plot of $y = f(x)$ for $-4 \le x \le 8$.

**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 $x_1, x_2, \ldots, x_n$ is $H = \frac{n}{\frac{1}{x_1}+\frac{1}{x_2}+\cdots+\frac{1}{x_n}}$ . 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 reistors. The resistors have resistances $250, 320, 550, 160, 1000$, which are measured in ohms.

## *Chapter 8*

**1.** Plot the polynomial $y = 0.9x^5 - 0.3x^4 - 15.5x^3 + 7x^2 + 36x - 7$ for $-4 \le x \le 4$. Use **polyval** and **plot**.

**8.** The product of four consecutive *even* integers $\{n_1, n_2, n_3, n_4\}$ is 1,488,384. Use MATLAB's polynomial functions to determine $n_1$. (There are two answers. Find both of them.)

**13.** A rectangular box *without* a top has surface area 2500 cm$^2$. The length $x$ of its base is 18 cm longer that 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 $5 \le x \le 35$ 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

**1.** Determine the two solutions of $x^3 - e^{0.8x} = 20$ between $x = 0$ and $x = 8$.

**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.

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

- (a) $\int_1^{11} \frac{x^3e^{-0.2x}}{1+x^2}\,dx$
- (b) $\int_2^7 \frac{4x+3\cos(4x)}{2+\sin x}\,dx$

**19.** The speed of a race car during the first 7 s of a race is given in the following table. Use MATLAB's **trapz** command to numerically compute the distance the car traveled during the first 7 s. (Be sure to convert the speeds into ft/s.)

| $t$ (s) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| $v$ (mi/h) | 0 | 14 | 39 | 69 | 95 | 114 | 129 | 139 |

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

## Chapter 10

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

## Chapter 11

**1.** 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 $x = 7$.

**4.** Define $x$ as symbolic.

- (a) Construct an expanded equation of the polynomial that has the roots $x = -3, -\frac{1}{2}, 1, 2, 4$.
- (b) Determine the roots of the following polynomial using the **factor** and **solve** commands.

$$f(x) = x^6 - 2x^5 - 39x^4 + 20x^3 + 404x^2 + 192x - 576$$

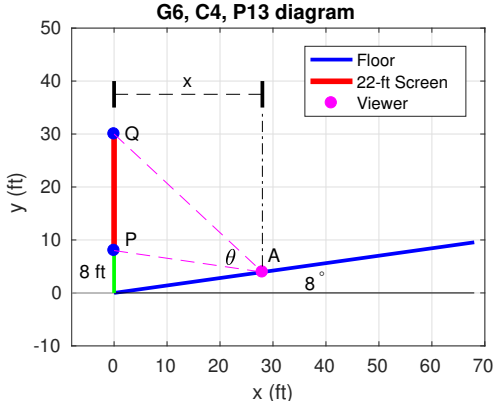
**7.** Plot the hyperbola $x^2 - y^2 = 1$ for $-3 \le x \le 3$, $-3 \le y \le 3$, using MATLAB's **fimplicit** command. Use **simplify** to show that the hyperbola may be expressed parametrically as $x = \frac{t^2+1}{t^2-1}$, $y = \frac{2t}{t^2-1}$.

**10.** Find the points of intersection of the following ellipses, then plot these points and ellipses on the same graph. (Use **fimplicit** for the latter.)

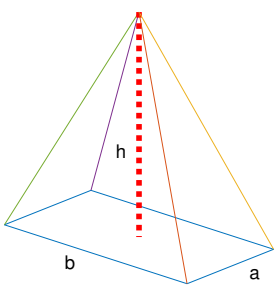
$$\frac{(x-1)^2}{6^2} + \frac{y^2}{3^2} = 1, \qquad \frac{(x+2)^2}{2^2} + \frac{(y-5)^2}{4^2} = 1$$

**28.** Solve the differential equation $\frac{dy}{dx} = e^y \cos x$.

G6, C4, P13 diagram




G6, C4, P14 diagram




G6, C4, P17 diagram