Problem Solving For Engineering Transfer

ENS 1300 - Spring 2020

Due Date		Last Modified
10 Febuary 2020	**Lab 2: Functions and Plotting**	7 February 2020

Important:
Create a new directory for this lab, `ENS1300/Labs/Lab02`. Set this as your working directory in MATLAB before beginning. Upon completion: (1) be sure that all the deliverable(s) specified at the end of each problem are contained within the `Lab02` folder, (2) zip `Lab02`, name it `Lab02_LastnameFirstname.zip`, and (3) upload `Lab02_LastnameFirstname.zip` to the dropbox.

Problem 1

In this course, your final grade will be calculated based on the following breakdown:

Labs:	40%
Quizzes:	10%
Projects:	10%
Midterm exam:	20%
Final exam:	20%

The following **script** calculates the average final score and displays a message in the command window. Open a new script try it out!

```
1 %% Initialize
2 exams = [50 75]; % Exam scores
3 labs = [90, 85, 100, 40, 50, 75, 85, 99, 88, 100]; % Lab grades
4 quizzes = [82, 91, 13, 92, 64, 10, 28, 55, 96, 97]; % Quiz grades
5 projects = [60 75 85];
6 
7 %% Execute
8 grade = mean(exams)*0.4 + mean(labs)*0.4 + ...
9     mean(quizzes)*0.1 + mean(projects)*0.1;
10 
11 %% Print
12 fprintf('Your average final score is %0.2f\n',grade)
```

Rewrite the grade calculation as a **function** called `calcGrade`. It should have four inputs and one output. The input and output variable names used in your function are entirely up to you, but the inputs should be specified in this exact order:
`exams, labs, quizzes, projects`

HINT: If line 8 of the script above were modified to use the `calcGrade()` function, it would look like this:

```
grade = calcGrade(exams, labs, quizzes, projects);
```

Don't forget to follow the ENS 1300 function template!

Deliverable(s): `calcGrade.m`

Graded Item	**Point Value**
Function file appropriatly named	5
Function header present and adequate	5
Correct input and output	5
Correct grade calculation	5
Total	20

Problem 2

Write a **function** called `quadraticSolver` that takes the three scalar coefficients of a quadratic equation as inputs and returns both roots (three inputs and two outputs). The smaller of the two roots should be the first output and the larger the second. The inputs should be in the order `a`, `b`, `c`. Use the form of the following polynomial:

$$ax^2 + bx + c = 0$$

Hint:

```
[root1, root2] = quadraticSolver(a, b, c);
```

Don't forget to follow the ENS 1300 function template!

Deliverable(s): `quadraticSolver.m`

Graded Item	**Point Value**
Function file appropriatly named	5
Function header present and adequate	5
Correct inputs	5
Correct outputs	5
Total	20

Problem 3

Write four velocity unit conversion **functions** called `fps2mph`, `mph2fps`, `fps2mps`, and `mps2fps`. Each one of the fuctions should have a single input and a single output. They should be able to accomodate vector input/output.

Function	**Purpose**
`fps2mph`	convert $\frac{\text{ft}}{\text{s}}$ to $\frac{\text{mi}}{\text{hr}}$
`mph2fps`	convert $\frac{\text{mi}}{\text{hr}}$ to $\frac{\text{ft}}{\text{s}}$
`fps2mps`	convert $\frac{\text{ft}}{\text{s}}$ to $\frac{\text{m}}{\text{s}}$
`mps2fps`	convert $\frac{\text{m}}{\text{s}}$ to $\frac{\text{ft}}{\text{s}}$

Don't forget to follow the ENS 1300 function template!

Deliverable(s): `fps2mph.m`, `mph2fps.m`, `fps2mps.m`, `mps2fps.m`

Graded Item	**Point Value**
Function files appropriatly named	5
Function header present and adequate	5
Correct inputs	5
Correct outputs	5
Total	20

Problem 4

Equations 1 and 2 give the x and y positions of an object in projectile motion assuming there are negligible drag forces. Equations 3 and 4 give the x and y positions of an object in projectile motion assuming there are significant drag forces.

$$x = x_o + v_{ox}t \tag{1}$$

$$y = y_o + v_{oy}t - \frac{1}{2}gt^2 \tag{2}$$

$$x_D = \frac{v_t^2}{g} \ln\left(\frac{v_t^2 + g v_{ox} t}{v_t^2}\right) \tag{3}$$

$$y_D = \frac{v_t^2}{2g} \ln\left(\frac{v_{oy}^2 + v_t^2}{v_{Dy}^2 + v_t^2}\right) \tag{4}$$

$$v_{Dy} = v_t \frac{v_{oy} - v_t \tan(\frac{tg}{v_t})}{v_t + v_{oy} \tan(\frac{tg}{v_t})} \tag{5}$$

$$v_t = \sqrt{\frac{2mg}{C_d \rho A}} \tag{6}$$

Reference: NASA

$x_o =$ initial x-position
$x =$ position in the x direction, neglecting drag
$x_D =$ position in the x direction, considering drag
$y_o =$ initial y-position
$y =$ position in the y direction, neglecting drag
$y_D =$ position in the y direction, considering drag
$v_o =$ initial velocity of object
$v_{ox} =$ initial velocity in the x-direction $= v_0 \cos(\theta)$
$v_{oy} =$ initial velocity in the y-direction $= v_0 \sin(\theta)$
$v_{Dy} =$ velocity in the y-direction, considering drag
$v_t =$ terminal velocity
$\theta =$ launch angle measured from the +x-axis
$\rho =$ density of fluid
$A =$ cross sectional area of object
$C_D =$ drag coefficient
$g =$ acceleration due to gravity
$m =$ mass of object
$t =$ time

Use the following constants in your code:

$x_o = 0$ m	$C_D = 0.35$	$\theta = 40°$
$y_o = 0.75$ m	$A = 0.004278$ m^2	$m = 0.145$ kg
$v_o = 49.0$ $\frac{\text{m}}{\text{s}}$	$\rho = 1.22$ $\frac{\text{kg}}{\text{m}^3}$	$g = 9.81$ $\frac{\text{m}}{\text{s}^2}$

Start a new **script**, `TrajectoryPlot.m`, and complete the following tasks:

	Task	Variable Name(s)
(a)	Fill in the header section.	-
(b)	Calculate x, y, x_D and y_D for 150 equally spaced values of time between 0 and 6.45 seconds, inclusive	`x, y, yD`
(c)	Create a plot with x-position on the horizontal axis and y-position on the vertical axis. Plot both y vs x and y_D vs x_D on the same figure window.	`fig1`
(d)	Annotate the plot from part (c) appropriately with a title, axis labels, and a legend.	-
(e)	Create two plots, x-position vs time and y-position vs time, and display them in the same figure window using using the `subplot()` function. Plot y vs x on the first plot and y_D vs x_D on the second.	`fig2`
(f)	Annotate the plot from part (e) appropriately with a title, axis labels, and legends.	-
(g)	Use the `text()` function to show maximum height on the plot from part (e).	-

Deliverable(s): `TrajectoryPlot.m`

Graded Item	**Point Value**
Complete header section	1
Adequate comments and organization	3
Correct part (c) plot	10
Approptirate part (c) title	3
Approptirate part (c) axis labels	3
Correct part (e) plots	10
Approptirate part (e) title	3
Approptirate part (e) axis labels	3
Text correctly inserted in part (e) plots	2
Adhearing to specified variable names	2
Total	40