

Quiz 2 (Take Home)

Solution

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Problem 1 (40 Points)

Figure 1 shows a flywheel element used in building dampers to protect buildings against earthquakes.

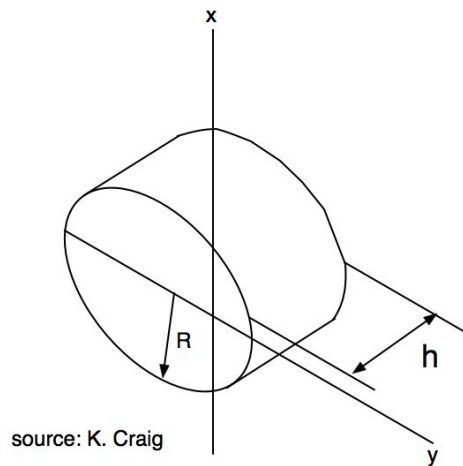


Figure 1. Flywheel Mass.

The equations to estimate the moments of inertia of a cylindrical shape flywheel are:

$$J_{xx} = m\left(\frac{h^2}{12} + \frac{R^2}{4}\right)$$

and

$$J_{yy} = \frac{m}{12}(4h^2 + 3R^2)$$

where:

m is the mass of the flywheel (in kilograms) and h and R are dimensions of the flywheel (meters).

- a) Create a Matlab function to estimate the moments of inertia J_{xx} and J_{yy} of the flywheel. The function should accept three parameters: h , R and m . The outputs of your function are the moments of inertia J_{xx} and J_{yy} .

```

1 % Function to calculate the moments of inertia of a flywheel
2
3 function [Jxx, Jyy] = flywheel_function(mass_kg, h_Flywheel_thickness_m, R_Flywheel_r
4
5 % Equations to estimate inertias
6
7 Jxx = mass_kg .* (h_Flywheel_thickness_m.^2/12 + R_Flywheel_radius_m.^2/4);
8 Jyy = mass_kg/12 .* (4* h_Flywheel_thickness_m.^2 + 3* R_Flywheel_radius_m.^2);
9
10 end

```

Figure 2. Function to Estimate the Moments of Inertia Jxx and Jyy of the Flywheel.

b) The mass of the flywheel is related to flywheel width h. Data provided in a separate Excel file shows information of flywheel mass for various dimensions h from previous lab tests. Use the data provided in the Excel file and create another Matlab function to estimate the mass of the flywheel (m) as a function of flywheel width (h).

Use Matlab Basic curve fitting or polynomial regression function to estimate the coefficients of the best equation to fit the data.

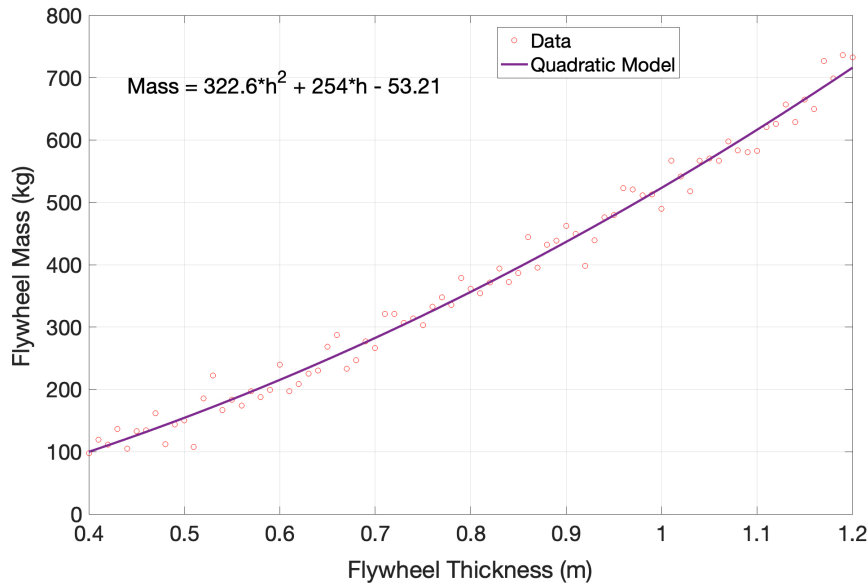


Figure 3. Flywheel Mass versus Flywheel Thickness (h).

```

function [flywheel_mass_kg] = flywheel_mass_function(h_Flywheel_thickness_m)
% Regression equation to estimate the flywheel mass as a function of h (flywheel
% thickness)
% Output:
% flywheel_mass_kg = C1 * h^2 + C2 * h + C3
%
% Input:
% h_Flywheel_thickness_m = flywheel thickness (meters)
% C1, C2, and C3 are regression coefficients - units are consistent

C1 = 322.6;
C2 = 254;
C3 = -53.21;

flywheel_mass_kg = C1 * h_Flywheel_thickness_m.^2 + C2 * h_Flywheel_thicker

```

Figure 3. Function to Estimate the Mass of the Flywheel as a Function of the Thickness.

c) Create a Matlab script and test the Matlab function created in parts (a and b) and estimate the numerical values of Jxx and Jyy using values of ranging from h = 0.4 to 1.2 meters at steps of 0.005 meters. For this solution use a constant value of R at 1.1 meters.

```

% Script to test the flywheel functions created in various tasks

% Define the values of mass, radius and thickness for a flywheel

% mass = 400;          % flywheel mass (kilograms)
flywheel_radius_m = 1.2; % radius of flywheel (meters)
flywheel_thickness_m = 0.4:0.005:1.2; % flywheel height (meters)

% Calculate the mass of the flywheel

[flywheel_mass_kg] = flywheel_mass_function(flywheel_thickness_m);

% Call the flywheel function to calculate Jxx and Jyy

[Jxx, Jyy] = flywheel_function(flywheel_mass_kg, flywheel_thickness_m, flywheel_rad

% disp(['Jxx inertia is ', num2str(Jxx), ' kg-cu.m' ])
% disp(' ')

```

Figure 4. Matlab Script to Estimate Jxx and Jyy for Multiple Thicknesses.

d) Plot two graphs with various solutions for Jxx and Jyy for various values of h (part c). One graph plots Jxx as a function of h and the second one Jyy as a function of h.

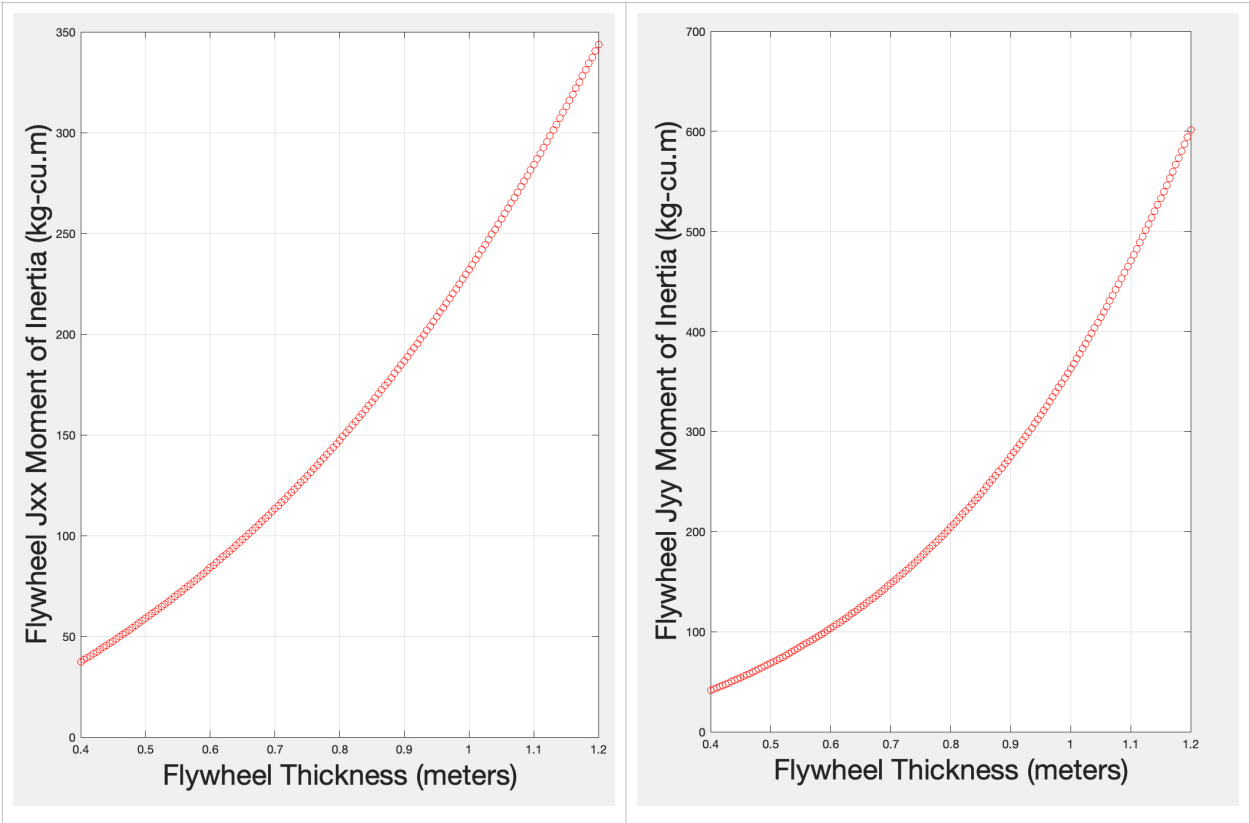


Figure 5. Plots of Jxx and Jyy for Multiple Thicknesses.

Problem 2 (40 points)

Airport ID	Name	State	Air Carrier Passengers	Commuter Passengers	Latitude (seconds)	Longitude (seconds)
00V	MEADOW LAKE	CO	0	0	140204.6960N	376451.6160W
01G	PERRY-WARSAW	NY	0	0	153868.8480N	280987.4900W
02A	GRAGG-WADE FIELD	AL	0	0	118261.7400N	311801.1700W
02C	CAPITOL	WI	0	0	155115.0360N	317440.3290W
02G	COLUMBIANA COUNTY	OH	0	0	146423.9260N	290309.0630W
04Y	HAWLEY MUNI	MN	0	0	168781.7550N	346860.9350W
05C	GRIFFITH-MERRILLVILLE	IN	0	0	149471.4276N	314638.2287W
05U	EUREKA	NV	0	0	142575.0000N	417618.2150W
06A	MOTON FIELD MUNI	AL	0	0	116857.6980N	308448.1300W
06C	SCHALMBURG REGIONAL	IL	0	0	151161.6270N	317164.4740W

Data collected by the Federal Aviation Administration is presented in the hyperlink named **Airports_data** (file name is TAF_airports_final2017.xls) available on week 2 of the syllabus page. A small portion of the file is shown below.

The following information is provided:

Column A = Airport ID (a three alphanumeric number used by FAA)

Column B = Airport name

Column C = State where airport is located

Column D = Number of annual passengers boarding aircraft owned by large air carriers (like United, Delta, Southwest, etc.)

Column E = Number of annual passengers boarding aircraft owned by commuter air carriers (like United Express, Mesaba, ASA, etc.)

Column F = Latitude (seconds). Note "N" in the latitude value stands for North of the Equator

Column G = Longitude (seconds). Note "W" in the latitude value stands for West of the Greenwich meridian

a) Import the data using the method of your choice. Tell me how you imported the data and show me the script used.

```

% Specify variable properties
opts = setvaropts(opts, ["AirportID", "Name", "State", "L
opts = setvaropts(opts, ["AirportID", "Name", "State", "L

% Import the data
tbl = readtable("/Users/atrani/Courses/CEE 3804/CEE

%% Convert to output type
AirportID = tbl.AirportID;
Name = tbl.Name;
State = tbl.State;
AirCarrierPassengers = tbl.AirCarrierPassengers;
CommuterPassengers = tbl.CommuterPassengers;
Latitudeseconds = tbl.Latitudeseconds;
Longitudeseconds = tbl.Longitudeseconds;

%% Clear temporary variables
clear opts tbl

```

Figure 6. Script Generated by Matlab to Import the Airport Data.

- b) Add code to the script in part (a) to find the number of airports in the U.S. that carry more than three million passenger boardings per year (including air carriers and commuter passengers combined). **There are 55 airports with more than 3 million total passengers.**

```
%% Code to detect airports with more than 3 million passengers
% Add carrier and commuter passengers
TotalPassengers = AirCarrierPassengers + CommuterPassengers;
% Find the airports with more than 3 million total passengers
indicesGT3Million = find(TotalPassengers>3e6);
% Find the number of airports with more than 3 million total passengers
AirportsGT3Million = length(indicesGT3Million);
% Print the number of airports found to the Command Window
clc
disp(['There are ', num2str(AirportsGT3Million), ' airports with more than 3
```

- c) Add more code to part (b) to find the number and names of the airports in the State of California with more than 65,000 passenger boardings (including air carriers and commuter passengers combined).

There are 17 airports in California with more than 65,000 total passengers.

```
%% Code to detect airports with more than 65000 passengers in California
matchCalifornia = strcmp('CA',State); % Finds airports in California (b
indicesCalifornia = find(matchCalifornia);
indicesGT65000 = find(TotalPassengers>65000); % Finds airport with more than
% Find the intersection of two vectors - elements that are the same in both
% vectors. Matlab has a command called "intersect"
indicesOfCA_GT65K = intersect(indicesGT65000,indicesCalifornia);
% Find the names of the airports found
namesCA_GT65K = Name(indicesOfCA_GT65K);
% Find the number of airports in California with more than 65,000
% passengers
numAirportsCA_GT65K = length(namesCA_GT65K);
```

- d) Create more code to find the number of airports by each state. First, identify the unique states in the nation and then count the number of airports by state.

```
% Find a vector of unique states
uniqueStates = unique(State);

% Find the number of unique states found
noUniqueStates = length(uniqueStates);

% Start a loop to count the number of airports by state
for i=1:noUniqueStates

    % Each time the loop runs find matches for each state detected
    % Finds the indices in array matchesByState
    % Counter for each state found
    matchesbyState = strcmp(uniqueStates(i),State);
    indicesbyState = find(matchesbyState);
    counterByState(i) = length(indicesbyState);

end
```

There are 57 distinct “states” found. There is a strange character “??” found. Data is always imperfect. Note that Guam (GU), Puerto Rico (PR), Mariana Islands (CQ), and the Virgin Islands (VI) are listed in the set among others.

- e) For part (d), output the solution found in a comma delimited file with two columns: 1) state (string), 2) number of airports (numeric).

```
%% Code to export the airport set and number of airports
% I reused the code demonstrated in class using the Fprintf command

% Create a text file (called airportOutput.txt) and write two output
% variables (uniqueStates, counterByState)

for i=1:noUniqueStates
    fid = fopen ('airportOutput.txt','a');
    fprintf(fid, '%s %f \n',uniqueStates(i,:), counterByState(i));
    status = fclose(fid);
end
```

The partial output file looks like this one:

```
?? 1.000000
AK 187.000000
AL 54.000000
AR 55.000000
AS 1.000000
AZ 46.000000
CA 167.000000
CO 44.000000
CQ 3.000000
CT 13.000000
DC 2.000000
DE 3.000000
FL 91.000000
GA 64.000000
```

