

## Assignment 6 Solution

### Problem 1

A common problem in Civil Engineering is to estimate the deflection of a double-supported beam at different stations (see Figure 1).

$$y = \frac{W}{24EI}(-x^4 + 2Lx^3 - L^3x)$$

**a) Create a Matlab script to estimate the estimate the beam deflection (y) given the parameters on the right hand side of Equation 1. Evaluate the deflection by creating 1,000 equally-spaced stations ( ) along the beam length. The values of the parameters are:**

**W = 3000 N/m.**

**L = 6 meters**

**E = 3.00e9 (N/m<sup>2</sup>) - steel beam**

**I = 0.001 (m<sup>4</sup>)**

---

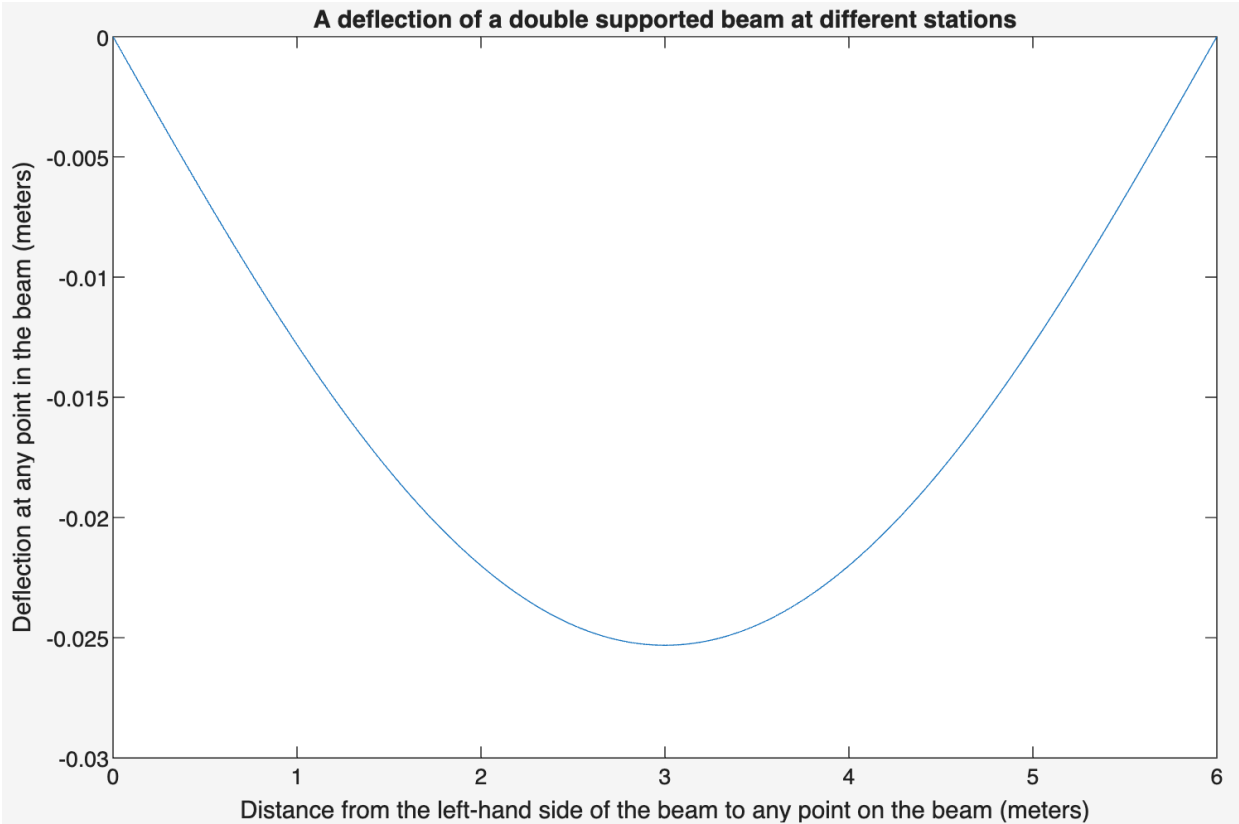
```
%% Part a
% Parameters
W = 3000; % Unit: N/m
E = 2.00e9; %Unit: N/m^2
I = 0.001; % Unit: m^4
L = 6; %Unit: meter

% 1,000 equally-spaced stations
x = linspace(0, 6, 1000); % distance from the left-hand side of the beam to any point on the beam (meters)
% Formula to calculates deflection of a double supported beam
y = (W / (24*E*I)).*(-x.^4 + 2*L*x.^3 - L^3*x); % deflection at any point in the beam (meters)
```

**b) Plot the deflection (y) as a function of the beam station (x)**

---

```
%% Part b
figure
plot(x, y);
xlabel('Distance from the left-hand side of the beam to any point on the beam (meters)')
ylabel('Deflection at any point in the beam (meters)')
title('A deflection of a double supported beam at different stations')
```



**c) Using the Matlab `max(y)` command, find the maximum deflection of the beam.**

**`max(y) = 0.025`, and its index is 501.**

---

```

%% Part C
% i return the y value where y is max
% n return the index where y is max
[i n]=max(abs(y)); % Since y are negative values, uses the 'abs' to convert into positive
% [i n] = min(y) is also works.

```

**d) Modify the script created in part (A) creating another variable z where z is defined as:**

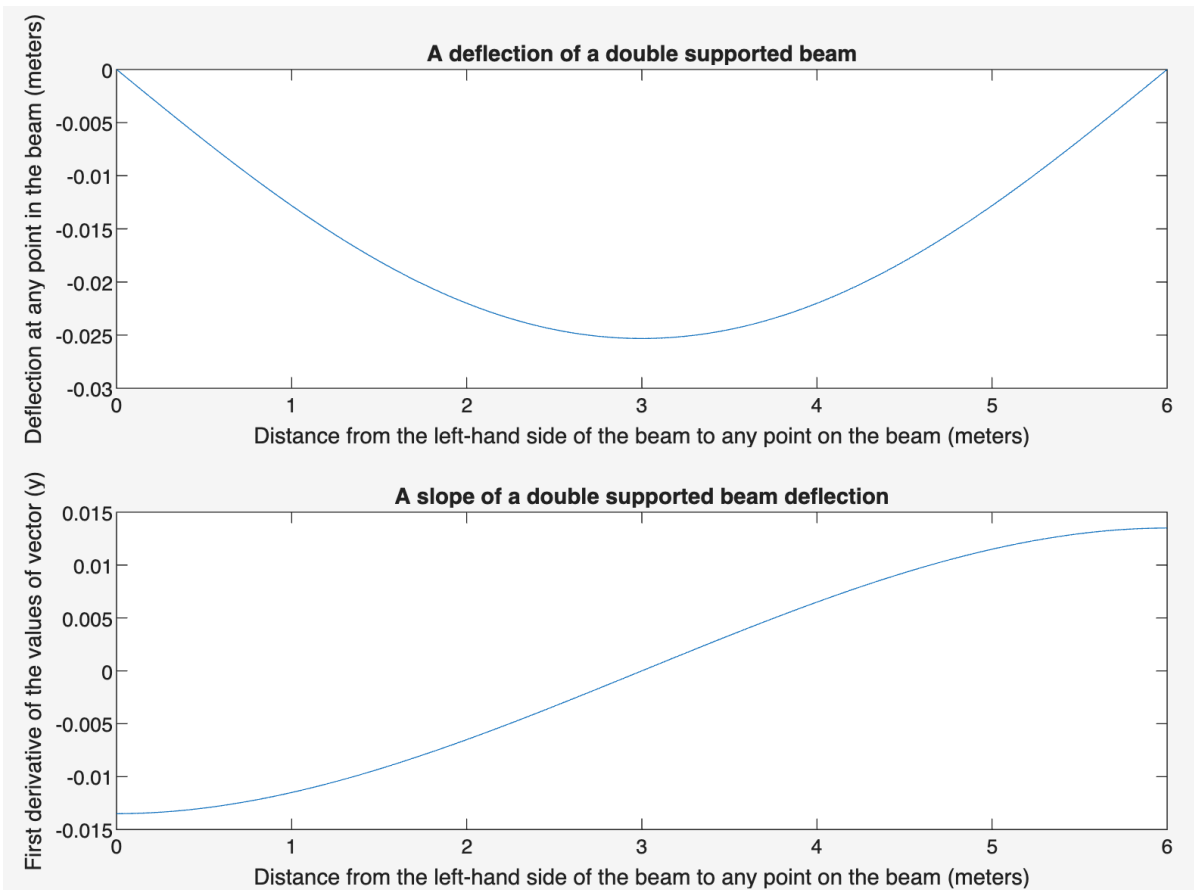
**`z = gradient(y)`**

The function `gradient` takes the first derivative of the values of vector (`y`) - the slope of the deflection. Using the “subplot” command create a new figure with two plots. Plot the values of `x` vs. `y` in the upper part of the window and `x` vs. `z` in the lower part of the same window. Change the line colors to distinguish the two views.

```
%% Part D
z = gradient(y, x); % x in the gradient function reflect actual x-spacing

figure
subplot(2, 1, 1);
plot(x, y);
xlabel('Distance from the left-hand side of the beam to any point on the beam (meters)')
ylabel('Deflection at any point in the beam (meters)')
title('A deflection of a double supported beam')

subplot(2,1,2);
plot(x, z);
xlabel('Distance from the left-hand side of the beam to any point on the beam (meters)')
ylabel('First derivative of the values of vector (y)')
title('A slope of a double supported beam deflection')
```



**e) Verify that the “gradient” function is working by inspecting the slope of the beam deflection at the maximum deflection point.**

The gradient of  $y$  is 0 at the middle point. The gradient is 0, which represents a local maximum or minimum; we can say that the 'gradient' function works well.

```
%% Part D
z = gradient(y, x); % x in the gradient function reflect actual x-spacing
z_at_max = round(z(n),2); % Gradient value of the maximum y value
disp(['Gradient where the maximum y value is ', num2str(z_at_max)])

figure
% First plot
subplot(2, 1, 1);
plot(x, y);
hold on
plot(x(n), y(n), 'ro')
text(x(n), y(n)+0.002, '\downarrow Point where y is max')

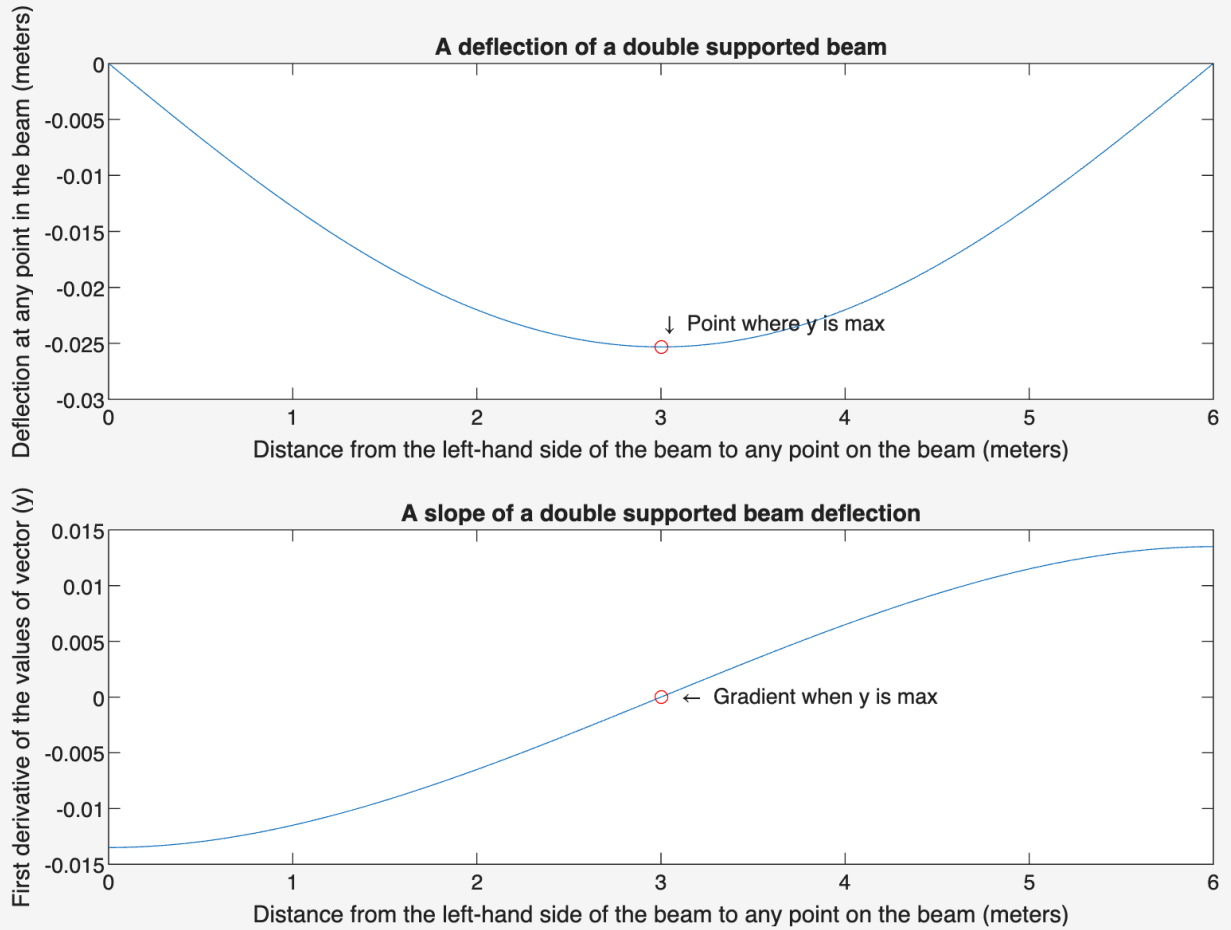
xlabel('Distance from the left-hand side of the beam to any point on the beam (meters)')
ylabel('Deflection at any point in the beam (meters)')
title('A deflection of a double supported beam')

% Second plot
subplot(2,1,2);
plot(x, z);
hold on
plot(x(n), z(n), 'ro')
text(mean(x)+0.1, 0, '\leftarrow Gradient when y is max')

xlabel('Distance from the left-hand side of the beam to any point on the beam (meters)')
ylabel('First derivative of the values of vector (y)')
title('A slope of a double supported beam deflection')
```

Command Window

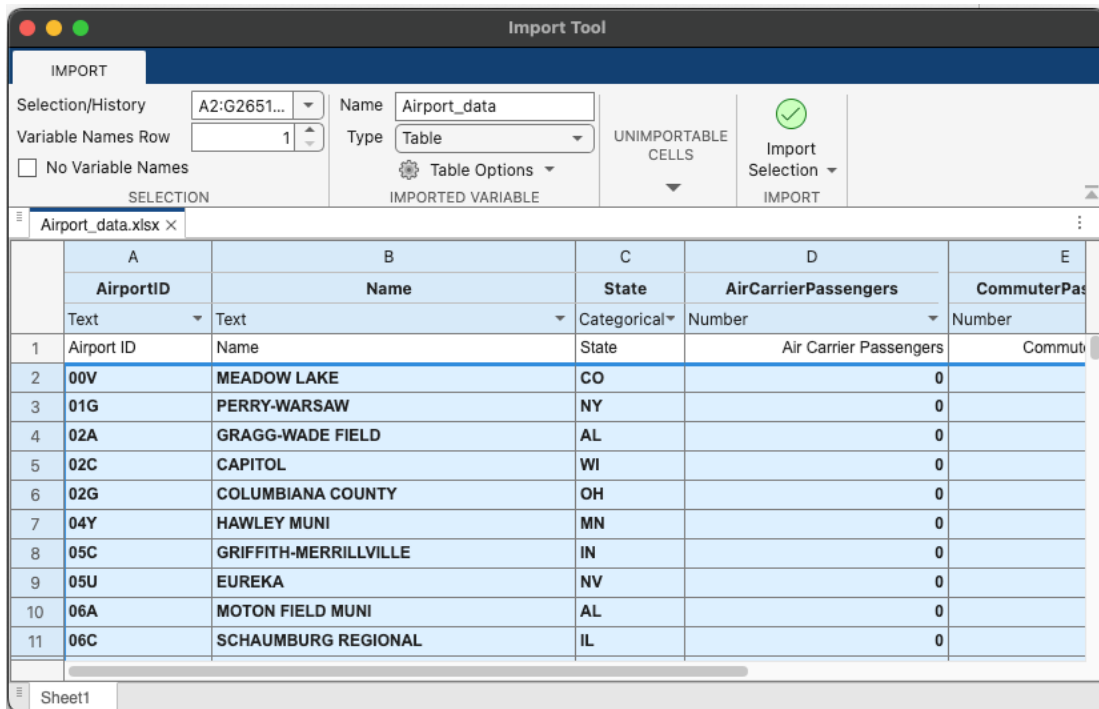
Gradient where the maximum y value is 0



## Problem2

Use the Airport\_data.xlsx file to work on the problem. For each problem show the Matlab code used to execute the task.

a) Use the Matlab import wizard to read the all data. Let Matlab create the code to read the data. Save the file and provide a screen capture of the first 15 lines of code.



```

%% Import data from spreadsheet
% Script for importing data from the following spreadsheet:
%
%   Workbook: /Users/jeongwoopark/Documents/Documents - Jeongwoo's MacBook Pro/Spring 2026/Computer_TA/A6/Airport_data.xlsx
%   Worksheet: Sheet1
%
% Auto-generated by MATLAB on 23-Mar-2026 12:44:53

%% Set up the Import Options and import the data
opts = spreadsheetImportOptions("NumVariables", 7);

% Specify sheet and range
opts.Sheet = "Sheet1";
opts.DataRange = "A2:G2651";

% Specify column names and types
opts.VariableNames = ["AirportID", "Name", "State", "AirCarrierPassengers", "CommuterPassengers", "Latitude_deg_", "Longitude"];
opts.VariableTypes = ["string", "string", "categorical", "double", "double", "double", "double"];

% Specify variable properties
opts = setvaropts(opts, ["AirportID", "Name"], "WhitespaceRule", "preserve");
opts = setvaropts(opts, ["AirportID", "Name", "State"], "EmptyFieldRule", "auto");

```

**b) Create individual variables for each column of data provided. Label the variables according to the headers in the Excel file.**

```

31 %% Part b
32 % Create individual variables for each column of data provided.
33 Airport = Airport_data.AirportID;
34 Name = Airport_data.Name;
35 State = Airport_data.State;
36 AirCarrierPassengers = Airport_data.AirCarrierPassengers;
37 CommuterPassengers = Airport_data.CommuterPassengers;
38 Latitude_deg = Airport_data.Latitude_deg_;
39 Longitude_deg = Airport_data.Longitude_deg_;
40

```

**c) Plot the longitude of the airport (x-axis) versus the latitude of the airport location (y-axis) to get an idea of the locations of the airports in the US.**

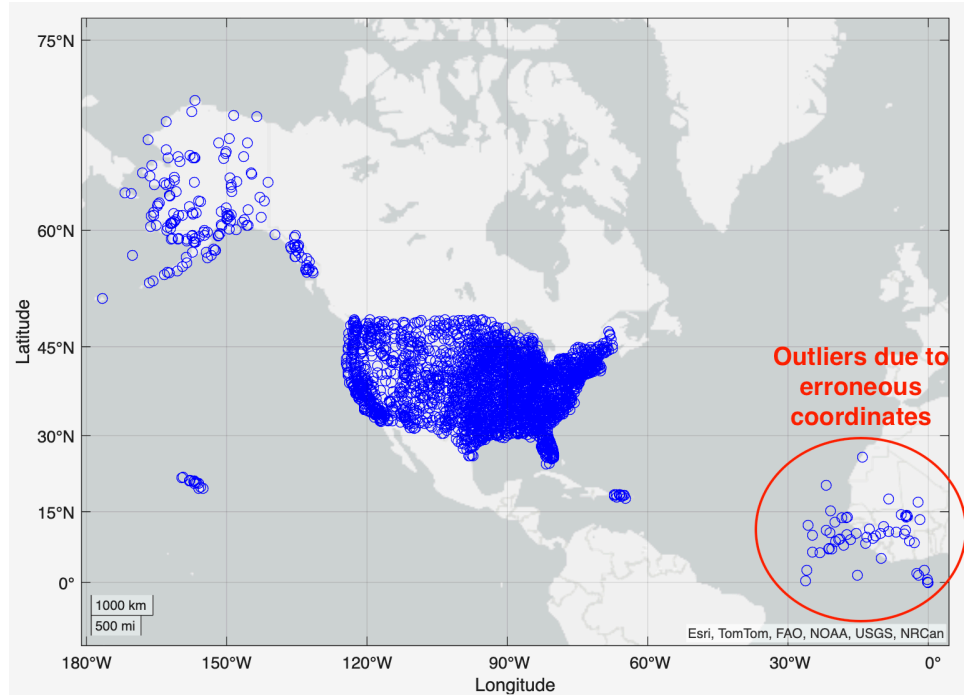
We need to flip the longitude coordinates because they are positive values in the raw data. Note that there are outliers due to erroneous coordinates in the raw data. Data is always imperfect. The file was obtained from a public source. Always check the data.

```

%% Part C
Longitude_deg = -abs(Longitude_deg); % Since every longitude values are positive value.
figure
%In order to draw coordinates on the map
gx = geoaxes;
hold on
geoplot(gx, Latitude_deg, Longitude_deg, 'ob') % Geoplot automatically added the labels

% Below code is also acceptable
% plot(Longitude_deg, Latitude_deg, 'ob')
% xlabel('Longitude (Deg)')
% ylabel('Latitude (Deg)')

```



d) Use the string comparison command (`strcmp`) to find the airports in the state of Virginia. Create a variable with the names of the airports in Virginia. Show me the name of the first 15 airports listed in your answer.

```
%% Part D
```

```
% Convert the type into a string
```

```
% because the type of the 'State' variable is a categorical variable.
```

```
State = string(Airport_data.State);
```

```
VirginiaAirport = strcmp(State, 'VA');
```

```
NameVirginiaAirport= Name(VirginiaAirport); % Name of airports in Virginia
```

NameVirginiaAirport ×	
str 37x1 string	
	1
1	MECKLENBURG-BRUNSWICK REGIONAL
2	VIRGINIA TECH/MONTGOMERY EXECUTIVE
3	CHARLOTTESVILLE-ALBEMARLE
4	CHESAPEAKE REGIONAL
5	DANVILLE REGIONAL
6	EMPORIA-GREENSVILLE REGIONAL
7	CHESTERFIELD COUNTY
8	FRANKLIN MUNI-JOHN BEVERLY ROSE
9	FRONT ROYAL-WARREN COUNTY
10	FARMVILLE REGIONAL
11	MIDDLE PENINSULA RGNL
12	GRUNDY MUNI
13	MANASSAS REGIONAL/HARRY P. DAVIS FI...
14	TWIN COUNTY
15	INGALLS FIELD

e) Add to the script in part (e) to find the number of airports in California.

There are 166 airports in California.

**%% Part E**

```
CalAirport = strcmp(State, 'CA');
NameCalAirport= Name(CalAirport); % Name of airports in California
NumberofCal = length(NameCalAirport); % Number of airports in California
disp(['There are ', num2str(NumberofCal), ' airports in California.'])
```

Command Window

```
>> Problem2
There are 166 airports in California.
```

f) Add another piece of Matlab code to create an index variable (pointer) for airports with more than 10,000 passengers (the sum of commuter and air carrier passengers). Show me the names (via a screen capture) of the first 15 airports that make your list.

**%% Part F**

```
total_passengers = CommuterPassengers + AirCarrierPassengers; % Sum of passengers
passengers_index = find(total_passengers > 10000); % Find the index where number of passengers more than 10k
NameOfTotalPassOver10k = Name(passengers_index); % Name of airports more than 10k passengers
```



NameOfTotalPassOver10k ×	
364×1 string	
1	
1	GRAND CANYON WEST
2	LEHIGH VALLEY INTERNATIO...
3	ABILENE REGIONAL
4	ALBUQUERQUE INTL SUNPO...
5	ABERDEEN REGIONAL
6	SOUTHWEST GEORGIA REGI...
7	NANTUCKET MEMORIAL
8	WACO REGIONAL
9	ARCATA
10	ATLANTIC CITY INTERNATIO...
11	KODIAK
12	ALEXANDRIA INTL
13	AUGUSTA RGNL AT BUSH FIE...
14	KING SALMON
15	ALBANY INTL

**g) Find the airports in Texas with more than 100,000 total passengers.**

There are 14 airports in Texas with more than 100k passengers. The “&” (and condition) command is used in the “find” command to find airports in Texas with more than 10k passengers.

```
%% Part G
% Find the index where number of passengers more than 100k in Texas
passengers_index_TX = find(total_passengers > 100000 & State == "TX");

% Name of airports more than 10k passengers in Texas
NameOfTotalPassOver100k_TX = Name(passengers_index_TX);

% Number of airports more than 10k passengers in Texas
NumberOfTotalPassOver100k_TX = length(passengers_index_TX);
disp(['There are ', num2str(NumberOfTotalPassOver100k_TX), ' airports in Texas with more than 10k passengers.'])
```

```
>> Problem2
There are 166 airports in California.
There are 14 airports in Texas with more than 10k passengers.
```

NameOfTotalPassOver100k_TX ×	
14x1 string	
	1
1	RICK HUSBAND AMARILLO INTL
2	AUSTIN-BERGSTROM INTL
3	CORPUS CHRISTI INTL
4	DALLAS LOVE FIELD
5	DALLAS/FORT WORTH INTERNATIONAL
6	EL PASO INTL
7	ROBERT GRAY AAF
8	WILLIAM P HOBBY
9	VALLEY INTL
10	GEORGE BUSH INTERCONTINENTAL/H...
11	LUBBOCK PRESTON SMITH INTL
12	MIDLAND INTERNATIONAL
13	MC ALLEN MILLER INTL
14	SAN ANTONIO INTL
15	



**Problem 3**

Use the GPS data collected by a car data logger to do this problem. A sample of the data is shown below.

a) Read the data using Matlab.

---

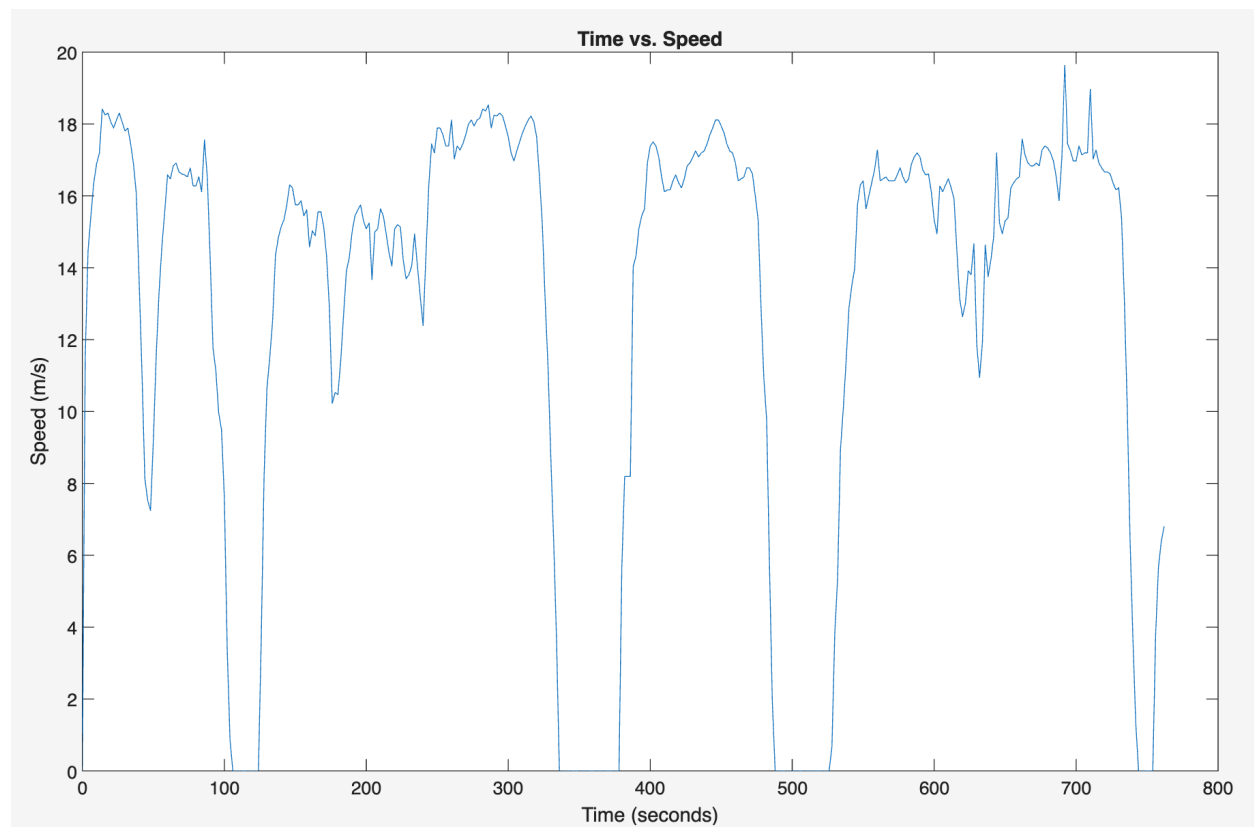
```
%% Part A
% Load the car speed data
load('CarSpeed_Data.m')
```

b) Plot the car speed in meters/second (in y-axis) vs. time (x-axis) in seconds. Observe the plot and comment on the number of stops in the profile.

---

```
%% Part B
% Plot the time versus speed in m/s
% Since the unit of time is seconds, we need to convert speed into m/s
speed_meter_second = speed .* (1000/3600); % in meters per second

figure
plot(time, speed_meter_second);
xlabel('Time (seconds)')
ylabel('Speed (m/s)')
title('Time vs. Speed')
```



c) Convert the speed data into units of miles per hour and create a new variable.

```
%% Part C
```

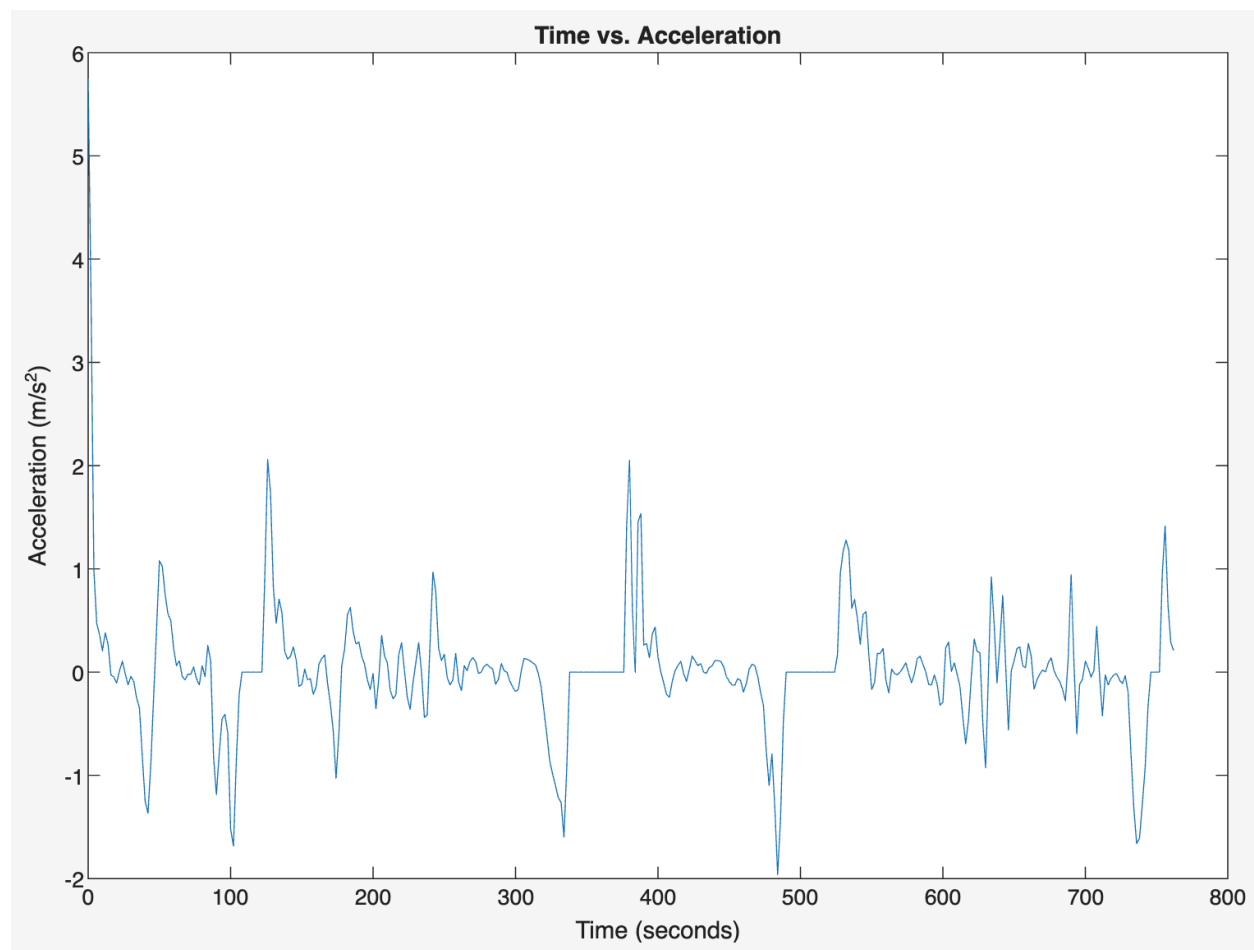
```
speedmph = speed ./ 1.609; % divide the speed value by 1.609
```

d) Estimate the acceleration of the car as a function of time using the metric data. Use the Matlab “gradient(x)” function to find the acceleration using the speed vector created in part (c). Plot the calculated acceleration vs. time recorded by the GPS data logger unit.

```
%% Part D
```

```
% Since the unit of time is seconds, we need to convert speed into m/s
speed_meter_second = speed .* (1000/3600); % in meters per second
acceleration = gradient(speed_meter_second,time); % time in the gradient function reflect actual time spacing
```

```
figure
plot(time,acceleration)
xlabel('Time (seconds)')
ylabel('Acceleration (m/s^2)')
title('Time vs. Acceleration')
```



e) Use the Max(x) command in Matlab to detect the largest speed during the journey. Find the time when the maximum speed is recorded. Display the maximum speed and the time in the Command window (use the DISP command).

The maximum speed is 70.7 km/hr at 692 seconds in the speed profile.

```
%% Part E
% Find the maximum speed
[MaxSpeed indexmaxspeed] = max(speed);
MaxTime = time(indexmaxspeed); % Time when car reached max speed
disp(['The max speed is ', num2str(MaxSpeed), ' km/hr and the time for it is ', num2str(MaxTime), ' seconds'])
```

#### Command Window


```
The max speed is 70.7 km/hr and the time of it is 692 seconds
The average speed is 12.6457 m/s
The number of seconds the car was stopped at intersections is 118 seconds
```

f) Find the average speed in meters per second of the car when the car is in motion. Use the Matlab function MEAN(x) to get the average speed for all values.

The average speed is 14.9556 m/s.

```
%% Part F
% Find the average speed in m/s
speed_in_motion = speed_meter_second(speed_meter_second > 0); % Only extracts where car in motion
meanspeed = mean(speed_in_motion); % Average speed in meter per seconds
disp(['The average speed is ', num2str(meanspeed), ' m/s'])
```

#### Command Window

```
The max speed is 70.7 km/hr and the time for it is 692 seconds
The average speed is 14.9556 m/s
The number of seconds the car was stopped at intersections is 118 seconds
>> ⚡ Press  to generate code with Copilot
```

g) Find the number of seconds the car is stopped at intersections. Use the Matlab FIND function to do this part.

The number of seconds the car was stopped at intersections is 118 seconds. Twice the number of records found since the data is logged every two seconds.

```
%% Part G
% Find the number of seconds the car is stopped at intersections.
StopIndex = find(speed == 0); % Find the index where the speed is 0
StopTime = length(StopIndex)*2; % Because the time interval is 2 seconds

disp(['The number of seconds the car was stopped at intersections is ', num2str(StopTime), ' seconds'])
```

**Command Window**

```
The max speed is 70.7 km/hr and the time of it is 692 seconds  
The average speed is 12.6457 m/s  
The number of seconds the car was stopped at intersections is 118 seconds
```