Assignment 3: Excel Pivot Tables and Excel Functions

Solution Key Instructor: Trani

Show all your work including screen captures of Excel pivot tables, VBA code, etc. Create a single PDF file for the complete homework and submit a single file.

Problem 1

ID	StateNumber	RestStopName	Highway	MilePost	Municipality	County	State	Latitude_deg	Longitude_deg	Spots
1	1	Grand Bay Welcome Center	I-10 EB	0.485	Grand Bay	Mobile	AL	30.477238	-88.393032	90
2	1	Baldwin County Welcome Center	I-10 WB	65.8	Seminole	Baldwin	AL	30.575718	-87.418285	27
3	1	Houston County Welcome Center	US-231 NB / SB	0.706	Cottonwood	Houston	AL	31.006808	-85.407686	8
4	1	Covington County Rest Area	US-331 NB / SB	8.002	Florala	Covington	AL	31.090454	-86.296196	5
5	1	Conecuh County Rest Area (NB)	I-65 NB	84.208	Evergreen	Conecuh	AL	31.336613	-87.114501	22

Truck Rest Stop Data.

Use the truck rest stop data provided to answer the following questions.

a) Use a Pivot Table to summarize the number of truck stops by state. Show a screen capture of the Pivot Table.

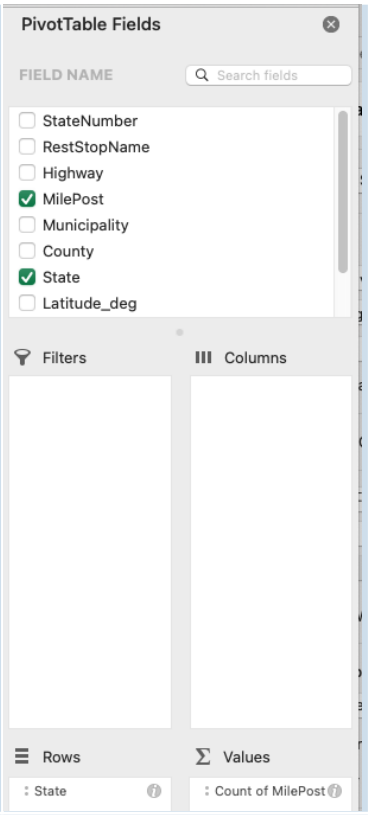
The Pivot Table is shown below. The table is ordered alphabetically by default.

Row Labels	Count of MilePost
AL	28
AR	21
AZ	25
CA	83
CO	24
CT	20
DE	2
FL	87
GA	45
IA	35
ID	12
IL	81
IN	41
KS	41
KY	36
LA	21

Pivot Table with Summary of Truck Stops by State.

b) Use another Pivot Table to summarize the total number of truck stops by state. Show a screen capture of the Pivot Table.

Row Labels	Count of MilePost
AL	28
AR	21
AZ	25
CA	83
CO	24
CT	20
DE	2
FL	87
GA	45
IA	35
ID	12
IL	81
IN	41
KS	41
KY	36
LA	21



Pivot Table with Summary of Truck Stops by State.

c) List the five states with the highest total number of truck stops.

The five states with more stops are shown below.

Row Labels	Number of Truck Stops
OH	95
FL	87
CA	83
IL	81
NY	78

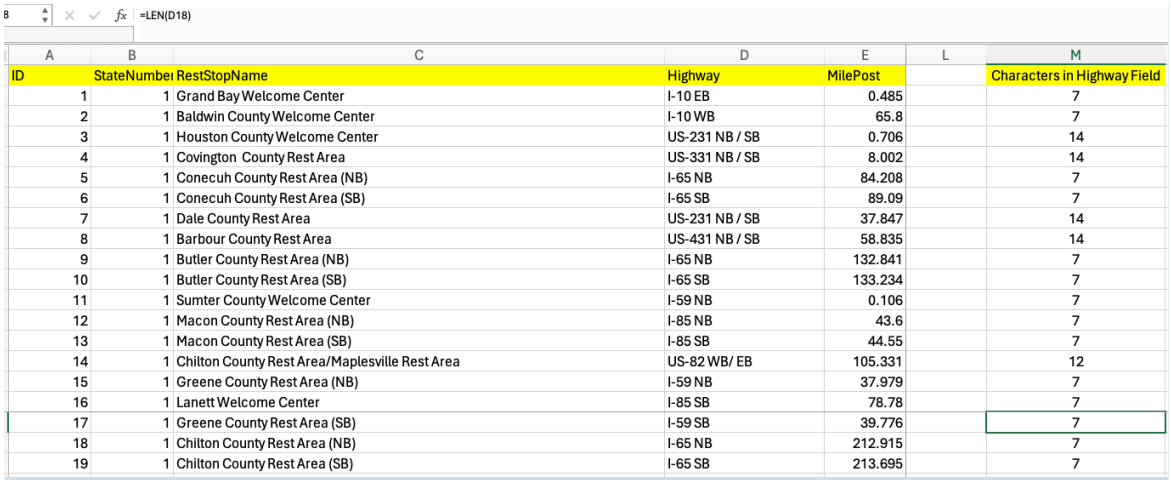
States with higher number of truck stops.

d) Use the LEN command in Excel to find the number of characters contained in the Highway field. Just show me a sample of the first 20 entries (rows).

Example of LEN command:

=LEN(D18)

Retrieves the number of characters in cell D18.



8 =LEN(D18)

	A	B	C	D	E	L	M
	ID	StateNumbe	RestStopName	Highway	MilePost		Characters in Highway Field
	1	1	Grand Bay Welcome Center	I-10 EB	0.485		7
	2	1	Baldwin County Welcome Center	I-10 WB	65.8		7
	3	1	Houston County Welcome Center	US-231 NB / SB	0.706		14
	4	1	Covington County Rest Area	US-331 NB / SB	8.002		14
	5	1	Conecuh County Rest Area (NB)	I-65 NB	84.208		7
	6	1	Conecuh County Rest Area (SB)	I-65 SB	89.09		7
	7	1	Dale County Rest Area	US-231 NB / SB	37.847		14
	8	1	Barbour County Rest Area	US-431 NB / SB	58.835		14
	9	1	Butler County Rest Area (NB)	I-65 NB	132.841		7
	10	1	Butler County Rest Area (SB)	I-65 SB	133.234		7
	11	1	Sumter County Welcome Center	I-59 NB	0.106		7
	12	1	Macon County Rest Area (NB)	I-85 NB	43.6		7
	13	1	Macon County Rest Area (SB)	I-85 SB	44.55		7
	14	1	Chilton County Rest Area/Maplesville Rest Area	US-82 WB/ EB	105.331		12
	15	1	Greene County Rest Area (NB)	I-59 NB	37.979		7
	16	1	Lanett Welcome Center	I-85 SB	78.78		7
	17	1	Greene County Rest Area (SB)	I-59 SB	39.776		7
	18	1	Chilton County Rest Area (NB)	I-65 NB	212.915		7
	19	1	Chilton County Rest Area (SB)	I-65 SB	213.695		7

States with higher number of truck stops.

e) Find the longest Highway name using the information on part (d).

The highway with largest name is: I-70 & I-76 W - PTC Mainline (20 characters)

Problem 2

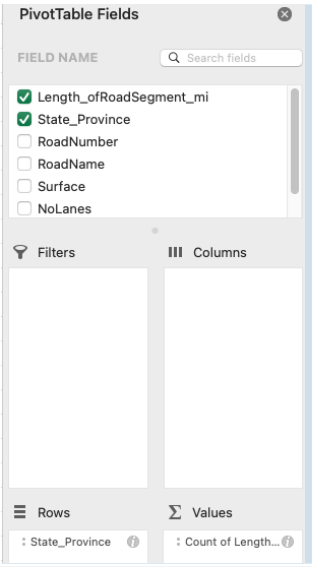
	A	B	C	D	E	F	G
1	Length_ofRoadSegment_mi	State_Province	RoadNumbe	RoadName	Surface	NoLanes	SpeedLimit_kmhr
2	1.57	Alaska		AHMOAGAK AVE	Paved	2	88
3	1.41	Alaska		AHMOAGAK AVE	Paved	2	88
4	30.48	Alaska	S11	JAMES DALTON HWY	Unpaved	2	80
5	0.13	Alaska	S11	JAMES DALTON HWY	Unpaved	2	80
6	21.61	Alaska	S11	JAMES DALTON HWY	Unpaved	2	80
7	13.91	Alaska	S11	JAMES DALTON HWY	Unpaved	2	80
8	20.51	Alaska	S11	JAMES DALTON HWY	Unpaved	2	80
9	38.64	Alaska	S11	JAMES DALTON HWY	Unpaved	2	80
10	1.82	Alaska	S11	JAMES DALTON HWY	Unpaved	2	80
11	25.94	Alaska	S11	JAMES DALTON HWY	Unpaved	2	80

Use the highway segment file provided to answer the following questions. This problem requires that you use Excel Pivot Tables.

a) Summarize the number of road/highway segments by state. Show a screen capture of the Pivot Table.

The Pivot Table is shown below. Notice that states are ordered alphabetically by default.

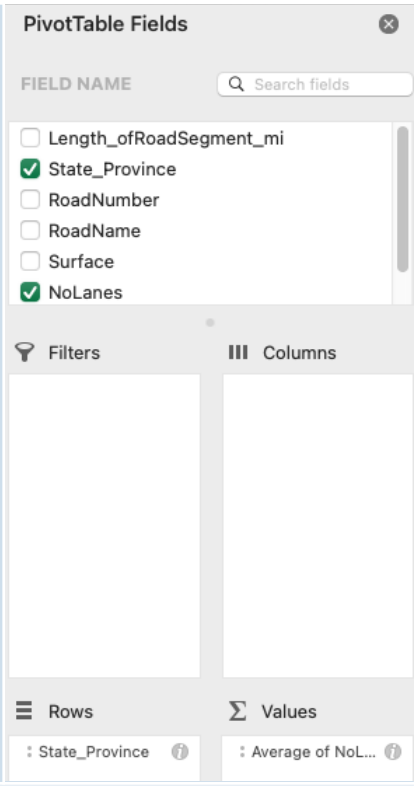
Row Labels	Count of Length_ofRoadSegment_mi
Alabama	10006
Alaska	2661
Arizona	7429
Arkansas	13512
California	63677
Colorado	7500
Connecticut	6511
Delaware	1199
District of Columbia	1048
Florida	19906
Georgia	16805
Hawaii	953
Idaho	5578
Illinois	17639
Indiana	24883
Iowa	9977
Kansas	8298



Pivot Table with Summary of Count of Road Segments by State.

b) Find the average number of lanes for all road segments belonging to each state. Show a screen capture of the Pivot Table.

Row Labels	Average of NoLanes
Alabama	3.4
Alaska	2.7
Arizona	3.9
Arkansas	2.8
California	4.3
Colorado	3.7
Connecticut	3.5
Delaware	3.8
District of Columbia	3.7
Florida	4.2
Georgia	3.5
Hawaii	3.6
Idaho	2.7
Illinois	3.4
Indiana	2.9
Iowa	2.9
Kansas	3.1
Kentucky	3.3
Louisiana	3.3
Maine	2.7
Maryland	3.9



Summary of Average Number of Lanes for Road Segments by State.

c) Find the top ten states with the highest average speed limit for their road/highway segments.

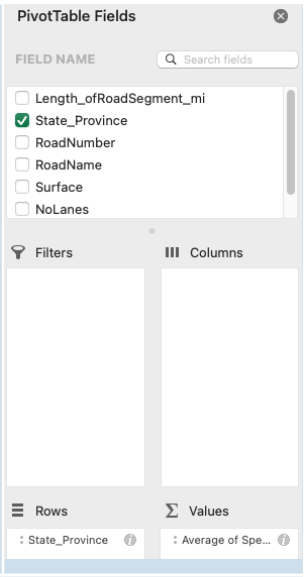
State	Ave. Speed Limit (km/hr)
Montana	95.1
Wyoming	93.1
South Dakota	91.4
New Mexico	91.0
North Dakota	88.1
California	87.3
Kansas	87.3
Alabama	87.2
Nevada	86.6
Utah	86.6

Top 10 states with highest average speed limit.

d) Find the average speed limit (km/hr) for all the road/highway segments in every state. Show a screen capture of the Pivot Table.

The table below shows the states with average speed limits in descending order. Montana has the highest average speed limit limit at 95.1 km/hr.

State	Ave. Speed Limit (km/hr)
Montana	95.1
Wyoming	93.1
South Dakota	91.4
New Mexico	91.0
North Dakota	88.1
California	87.3
Kansas	87.3
Alabama	87.2
Nevada	86.6
Utah	86.6
Nebraska	86.0
Oklahoma	85.4
Texas	84.7
Missouri	84.1

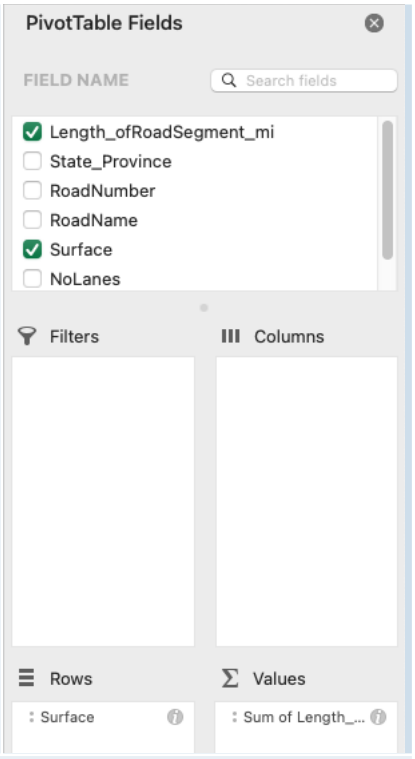


Average speed limit by state.

e) Create a Pivot Table to quickly find the total number of miles of unpaved roads and ferry segments. Show a screen capture of the Pivot Table.

The pivot table is shown below. There are 711,645 miles of roads. There are 132 miles of ferry services and 997 miles of unpaved roads in the database.

Row Labels	Sum of Length_ofRoadSegment_mi
Ferry	132
Paved	711,645
Unpaved	997
Grand Total	**712,775**



Paved versus Non-paved road segments.

Problem 3

Use the car data file provided in class (week 1) to answer the following questions. This problem requires that you use Excel database functions explained in class. **Using IF statements to classify the data is not allowed**.

Show all your work and provide screen captures of your work and **include the actual database commands** used to make each query.

a) Calculate the average gas tank size for cars produced in the US with weight > 2,500 lbs.

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Model	Country	Type	Weight_lbs	Turning Circle_ft	Displacement_cInch	Horsepower_hp	Gas Tank Size_gallons
	USA		>2500				
Average Tank Size	17.272	Gallons					

Command used to do the query:
=DAVERAGE($A$1:$H$117,8,K2:R3)

b) Calculate the average engine displacement for Japanese cars whose tank size > 14.7 gallons.

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Model	Country	Type	Weight_lbs	Turning Circle_ft	Displacement_cInch	Horsepower_hp	Gas Tank Size_gallons
	Japan						>14.7
Ave. Engine Displacement	164.316	Cubic Inches					

Command used to do the query:
=DAVERAGE($A$1:$H$117,6,K8:R9)

c) Count the number of cars produced in the US with horsepower > 135 HP and turning circle > 36 feet.

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Model	Country	Type	Weight_lbs	Turning Circle_ft	Displacement_cInch	Horsepower_hp	Gas Tank Size_gallons
	USA			>36		>135	
Count vehicles	28	Vehicles					

Command used to do the query:
=DCOUNTA($A$1:$H$117,2,K14:R15)

d) Count the number of cars produced in Japan with tank size > 14.8 gallons and weight < 3200 lbs.

d) Count the number of cars produced in Japan with tank size > 14.8 gallons and weight < 3200 lbs.

Model	Country	Type	Weight_lbs	Turning Circle_ft	Displacement_cInch	Horsepower_hp	Gas Tank Size_gallons
	Japan		>3200				>14.8
Count vehicles	9.000	Vehicles					

Command used to do the query:
=DCOUNTA($A$1:$H$117,2,K20:R21)

Problem 4

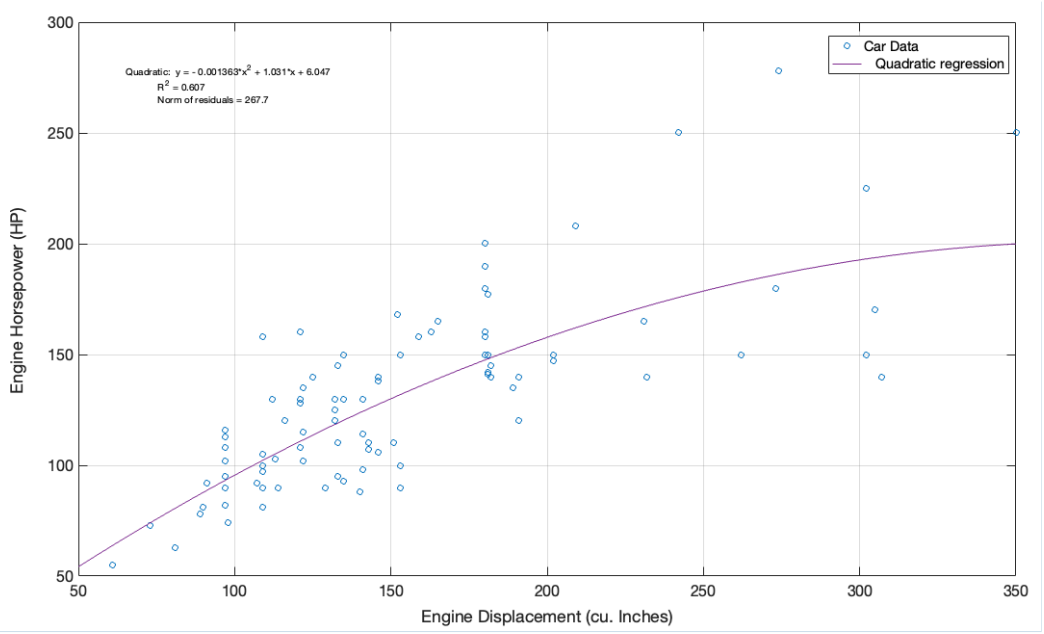
Use the car data file provided in class (week 1) to answer the following.

Model	Country	Type	Weight_lbs	Turning Circle_ft	Displacement_cInch	Horsepower_hp	Gas Tank Size_gallons
Acura Integra	Japan	Small	2700	37	112	130	13.2
Acura Legend V6	Japan	Medium	3265	42	163	160	18
Audi 100	Other	Medium	2935	39	141	130	21.1
Audi 80	Other	Compact	2670	35	121	108	15.9
Audi 90	Other	Compact	2790	35	141	130	15.9
BMW 325i	Other	Compact	2895	35	152	168	16.4
BMW 535i	Other	Medium	3640	39	209	208	21.1
Buick Century	USA	Medium	2880	41	151	110	15.7

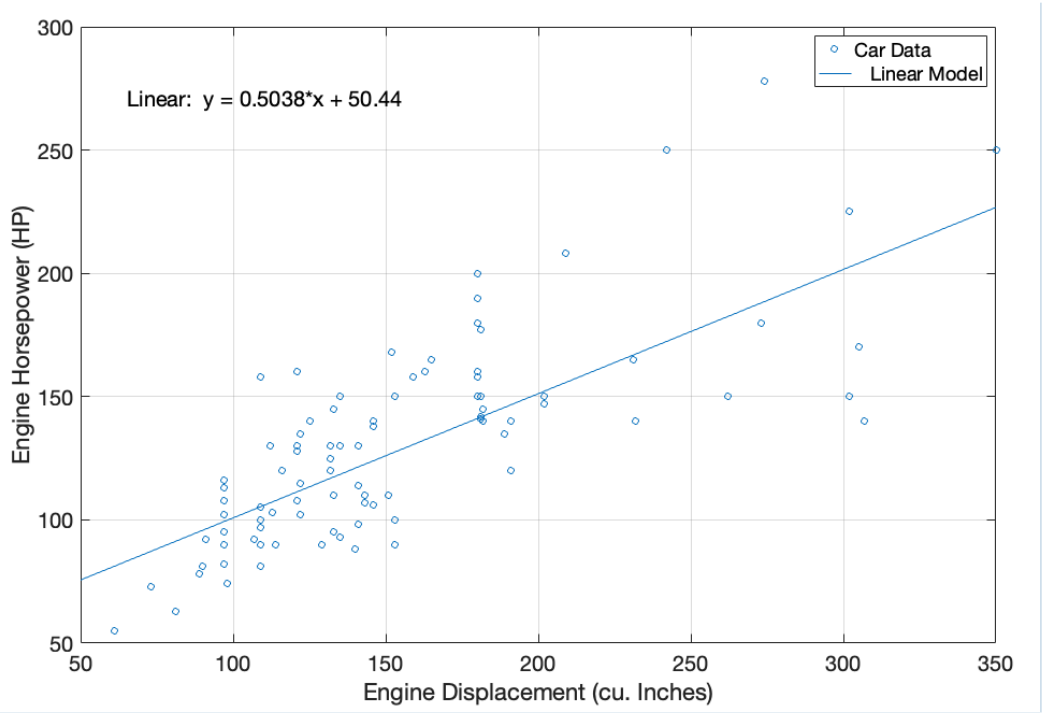
a) Perform a **linear regression** using Excel to estimate the best regression model that relates vehicle the engine displacement (in cubic inches) and plotted in the x-axis, and engine horsepower (in the y-axis). Use the **trend analysis function in Excel** to estimate the equation of the line that fits the data best.

The best fit to the data is (y= Engine power and x = engine displacement) is a second order polynomial model (i.e., quadratic or parabolic model). The value of R-square for the quadratic model (0.60) is slightly better than a linear model (0.57). Linear solutions should be acceptable in this problem.

$$y = -0.001363x^2 + 1.001x + 6.047$$



Engine Displacement and horsepower regression analysis. 2nd Order polynomial.



Engine Displacement and horsepower regression analysis. Linear Regression Model.

c) Create a function in Excel (using VBA) to calculate the vehicle horsepower (dependent variable) given the engine displacement.

```
(General)                                    horsepower
Option Explicit

Dim displacement As Single

Public Function horsepower(displacement) As Single

' Function to calculate the engine horsepower
'
'   Input: engine displacement (cu. inches)
'   Output: horsepower (HP)

    horsepower = -0.001363 * (displacement) ^ 2 + 1.001 * (displacement) + 6.047

End Function
```

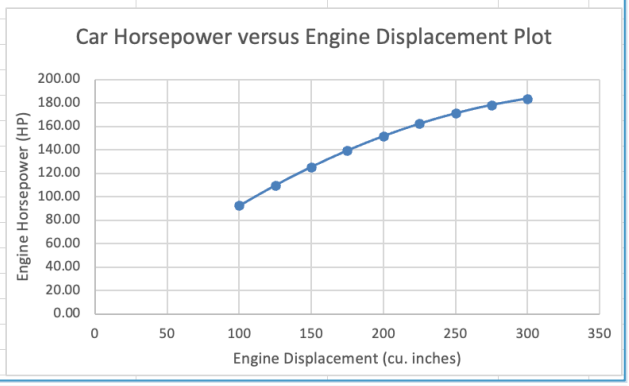
Engine Displacement and horsepower function. I used the second order model equation.

d) Test the function created in part (c) to estimate the engine horsepower expected for engine displacements ranging from 100 to 300 cubic inches. Make a plot to check your solution.

The figure below illustrates the use of the function created in part (c). You are expected to include the plot in the solution.

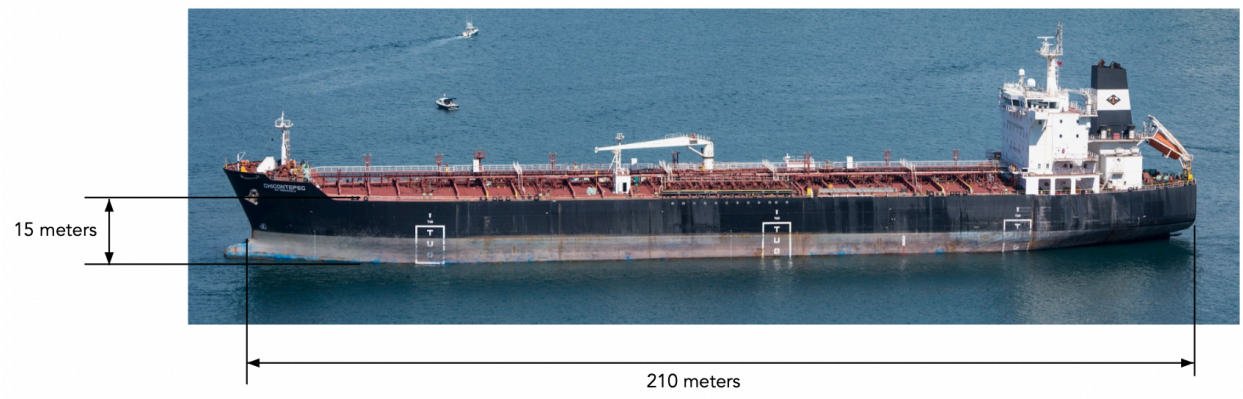
Problem		
Car data: Calculates HP given engine displacement		
Program calculates car HP given engine displacement (cubic inches)		
Programmer	Trani	
Date	2/14/24 8:07	
Formula	HP = -00.1363*(displacement)^2 + 1.001*(displacement) + 6.047	
Inputs to problem		
Car engine displacement	200 cubic inches	
Output: Car HP		
Car horsepower	151.73 horsepower	

Engine displacement (cu inches)	Car horsepower (HP)
100	92.52
125	109.88
150	125.53
175	139.48
200	151.73
225	162.27
250	171.11
275	178.25
300	183.68



Excel interface with application of the function horsepower.

Problem 5



The equations to estimate the sail drag (lateral force acting on the tanker when subjected to crosswinds) and the power required to overcome the "sail" drag force are presented below:

$$D_{sail} = \frac{1}{2}\rho V_c^2 S_a C_d$$

D_{sail} = sail drag (Newtons)

V_c = crosswind speed (m/s)

ρ = air density (kg/cu. meter)

S_a = sail area (square meters)

C_d = drag coefficient (dimensionless)

$$P_{sail} = D_{sail} V_c$$

P_{sail} = power to overcome sail drag (Watts)

The air density at sea level conditions is 1.225 kg/cu.meter. The ship's sides act as flat plates that generate resistance force with a drag coefficient (Cd) value of 0.95. The ship's sail area is the lateral area of the ship above the water line exposed to crosswinds. You can estimate the sail area using Figure 1.

a) Create an Excel function (Public Function) to calculate the ship's sail drag with a crosswind speed of 20 m/s. The function should take the ship's parameters (including the ship's dimensions) and estimate the sail drag (Newtons). Note that all units in the equations above are consistent.

(General) saildrag

```
Option Explicit

Dim area As Single
Dim density As Single
Dim dragCoefficient As Single
Dim speed As Single
Dim shipHeight As Single
Dim shipLength As Single

Public Function saildrag(density, speed, dragCoefficient, shipHeight, shipLength) As Single
' Function to calculate the sail drag
'
'   Inputs: area,speed, dragCoefficient,density
'   Output: pavement thickness (inches)
    area = shipHeight * shipLength

    saildrag = 0.5 * density * area * speed * speed * dragCoefficient

End Function
```

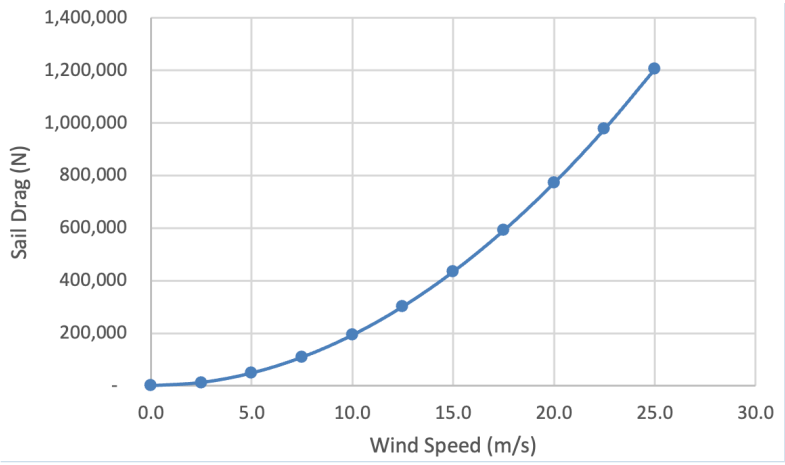
Sail drag computation function.

b) Perform a sensitivity analysis to estimate the sail drag (force) as a function of wind speed. Create a table in Excel with wind speeds ranging from 0 to 25 m/s at steps of 2.5 m/s and calculate the sail drag force.

Wind Speed (m/s)	Sail Drag (N)
0.0	-
2.5	12,059
5.0	48,234
7.5	108,527
10.0	192,938
12.5	301,465
15.0	434,109
17.5	590,871
20.0	771,750
22.5	976,746
25.0	1,205,859

Sensitivity analysis for sail drag versus wind speed.

c) Plot sail drag (y-axis) versus wind speed (m/s).



Plot of sail drag versus wind speed.