Management Science Homework #2

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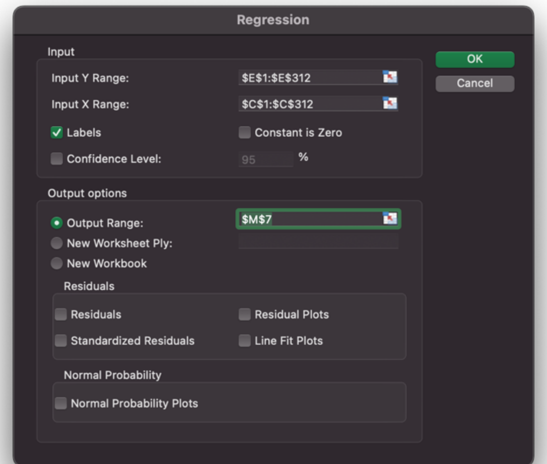
1. a

Using the regression function under Data analysis and inputting the window such as:

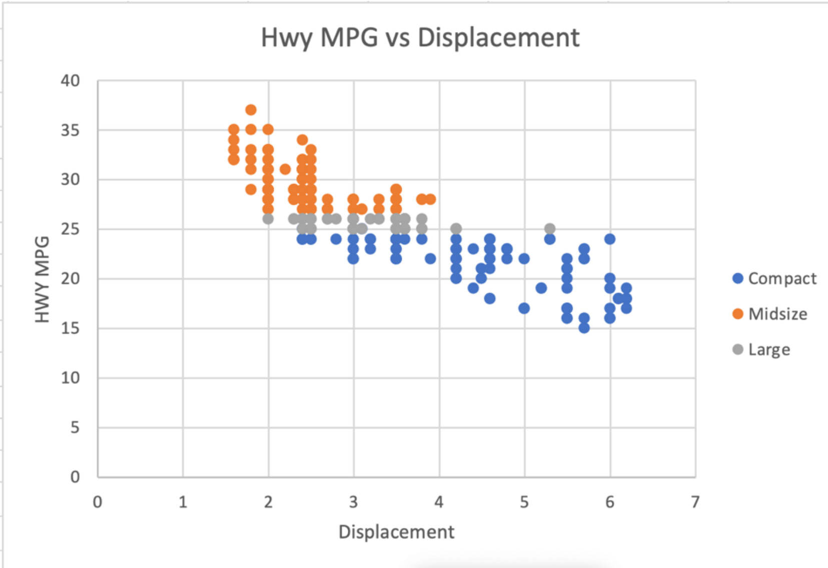


We get the following Data:

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.833339							
R Square	0.694453							
Adjusted R Square	0.693464							
Standard Error	2.221153							
Observations	311							
ANOVA								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression	1	3464.821	3464.821	702.3017	1.51E-81			
Residual	309	1524.458	4.933522					
Total	310	4989.28						
	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept=beta0	35.39504	0.381833	92.69774	1.5E-227	34.64372	36.14636	34.64372	36.14636
Displacement=beta1	-2.882089	0.108754	-26.50098	1.51E-81	-3.096081	-2.668097	-3.096081	-2.668097

From this data, we can develop a regression equation such that
Fuel_efficiency= 35.39504-2.882089* Engine_Displacement
Since P value is way less than 0.05 therefore we can claim that beta 1 is including meaningful results to the prediction.
R Square is approximately 0.6944 which means the regression equation explains about 69.44% of the variations in the values of hwyMPG.

b.



As you can see there is a certain pattern between the class of auto mobile and HWYMPG. Midsize cars seems to have the highest fuel efficiency followed by Large cars with Compact cars showing the lowest fuel efficiency.

c.

we need to do some data work before creating a regression Line. First we use the formula =IF(H2="P",1,0) to replace fuel type to a Boolean 0 1 type. 0 if regular fuel, and 1 if premium fuel. Then we represent Compact cars as 1, Medium cars as 2, and Large cars as 3 like such

Class	Class	Displacement	Fuel Type	Hwy MPG		Fuel Type
Compact	0	3.1	1	25		P
Compact	0	3.1	1	25		P
Compact	0	3	1	25		P
Compact	0	3	1	25		P
Compact	0	3	1	25		P
Compact	0	3	1	25		P
Compact	0	2.4	1	25		P
Compact	0	3.5	1	25		P
Compact	0	3	1	25		P
Compact	0	2.4	1	24		P
Compact	0	2.8	1	24		P
Compact	0	2.5	1	24		P
Compact	0	3	1	24		P
Compact	0	2.5	1	24		P
Compact	0	2.4	0	24		R
Compact	0	5.3	1	24		P
Compact	0	6	1	24		P
Compact	0	3.5	0	24		R
Compact	0	3.5	0	24		R
Compact	0	3.5	0	24		R
Compact	0	3.5	0	24		R
Compact	0	3.5	0	24		R
Compact	0	3.8	0	24		R
Compact	0	3.5	0	24		R
Compact	0	3.5	1	24		P

Then we can utilize the regression function and achieve this data

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.86729
R Square	0.752191
Adjusted R S	0.74977
Standard Err	2.006818
Observation	311

ANOVA

	df	SS	MS	F	ignificance F
Regression	3	3752.893	1250.964	310.619651	1.21E-92
Residual	307	1236.387	4.027319		
Total	310	4989.28			

	Coefficients	tandard Erro	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	34.08656	0.609805	55.89748	5.7099E-163	32.88663	35.28648	32.88663	35.28648
Class	0.469245	0.175752	2.669931	0.007990577	0.123415	0.815076	0.123415	0.815076
Displacemer	-2.457933	0.116679	-21.06575	1.43555E-61	-2.687524	-2.228341	-2.687524	-2.228341
Fueltype	-1.914446	0.242304	-7.901005	4.98584E-14	-2.391233	-1.437659	-2.391233	-1.437659

This can be used to develop a regression equation

HwyMPG= 34.0856+ 0.469245*(Class)-2.457933(Displacement)-1.914446*(FuelType)

Checking R^2, 75% of variation in the sample values are explained by this equation.

D.
Since the car is a compact model, Class is represented as 1, Displacment is 2.9 and Fueltype is unknown and HwyMPG= 25

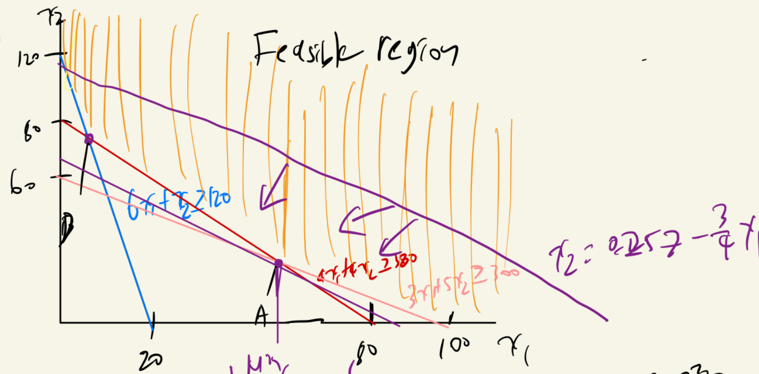
This would give us

25=34.0856+0.469245*(1)-2.457933(2.9)-1.914446*(FuelType)

Which would equal to
0.5123=1.914446*Fuel Type. If you chose a premium fuel type then fuel type would be 1, crossing the 25 MPG limit. Therefore the car ca not be designed to used premium fuel.

2.

a)



b) Objective function

Min (50, 30)

min z

$3x_1+4x_2=z$

$4x_2 = z-3x_1$

$x_2 = 0.25z - \frac{3}{4}x_1$

A = $4x_1+4x_2=320$

$x_1+x_2 \ge 80$

$x_1 = 80 - x_2$

$3(80-x_2)+5x_2=300$

$240+2x_2=300$

A = (50, 30)

B = $6x_1+x_2=120$

$-x_1+x_2=80$

$5x_1=40$

$x_1=8$

72

B = (8, 72)

For A

z=270

B

z= 312

Thus optimal/minimum sol is

$x_1 = 50$

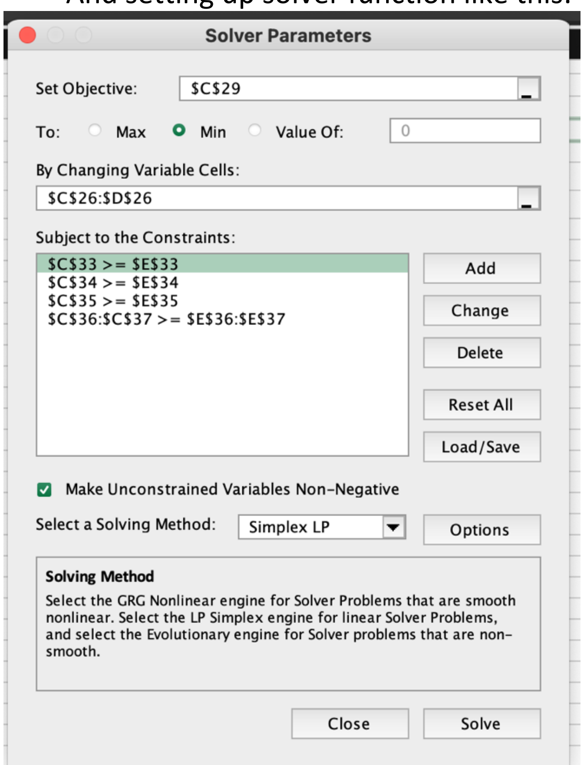
$x_2 = 30$

z=270

c. Setting up the Excel sheet as so

	Minimization Problem			
Input (Data)				
	x1	**x2**		
Minimize	3	4		**Min**
Constrains1	6	1		120
Constrains2	4	4		320
Constrains3	3	5		300
Decision Variables				
	x1	**x2**		
Number	50	30		
Objective Function				
Mininimize	270			
Constraints				
	Used		**Available**	
1	330	>=	120	
2	320	>=	320	
3	300	>=	300	
	50	>=	0	
	30	>=	0	

And setting up solver function like this:



Will give you 270 as the optimal solution at x1=50, x2=30

D. Surplus for each constraint

6 x1 + x2 ≥ 120 = 210 Surplus
4 x1 + 4 x2 ≥ 320 = 0 Surplus
3 x1 + 5 x2 ≥ 300 = 0 Surplus
x1, x2 ≥ 0= x1 surplus is 50, x2 surplus is 30

4 x1 + 4 x2 ≥ 320 = 0 Surplus
3 x1 + 5 x2 ≥ 300 = 0 Surplus
These two equations are the binding constraints

3.a.

Decision variables — KRW of Loan/Security

x_1	x_2	x_3	x_4	x_5	x_6
Home mort type1	Home mort type2	CL	AL	HIL	RFS

Objective function - Max

(0.06x1+ 0.08x2+ 0.11x3+ 0.09x4+ 0.1x5+ 0.04x6)/(x1+x2+x3+x4+x5+x6)

Constraints

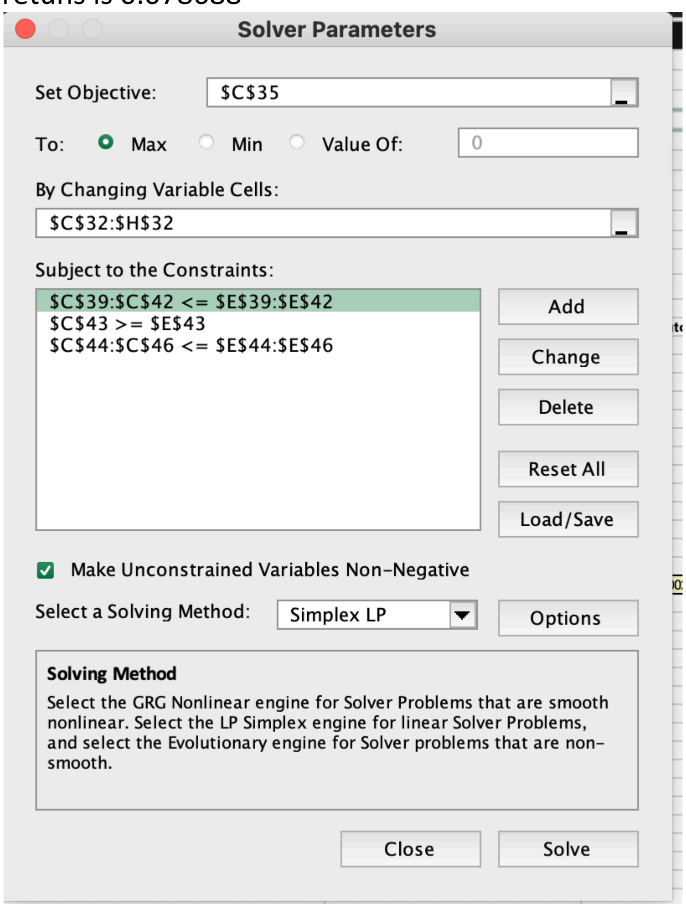
$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 \le 9{,}000{,}000{,}000$$
$$0.1x_1 + 0.1x_2 + 0.1x_3 + 0.1x_4 + 0.1x_5 - 0.9x_6 \le 0$$
$$x_5 \le 809{,}000{,}000$$
$$-0.4x_1 - 0.4x_2 + 0.6x_3 + 0.6x_4 + 0.6x_5 \le 0$$
$$x_1 - 2x_2 \ge 0$$
$$-0.4x_1 + x_5 \le$$
$$-x_3 + x_4 + x_5 \le 0$$
$$-0.5x_1 - 0.5x_2 + x_3 \le 0$$

x1,x2,x3,x4,x5,x6>= 0 but we don't need to put this constraint in excel as we can use "Make unconstrained variables non-negative"

b.

	SNU Bank MAX Problem						
Input (Data)							
	Homemort Type 1	**Homemort Type 2**	**Commercial Loan**	**Automobile Loan**	**Home improvemement**	**Risk-Free**	**Limit**
Annual Rate of Return	0.06	0.08	0.11	**0.09**	0.1	0.04	
Constraints Inputted							
Constraint 1	1	1	1	1	1	1	9,000,000,000
Constraint 2	0.1	0.1	0.1	0.1	0.1	-0.9	0
Constraint 3					1		800,000,000
Constraint 4	-0.4	-0.4	0.6	0.6	0.6		0
Constraint 5	1	-2					0
Constraint 6	-0.4				1		0
Constraint 7			-1	1	1		0
Constraint 8	-0.5	-0.5	1				0
Decision Variables							
	x1	**x2**	**x3**	**x4**	**x5**	**x6**	
Number	3240000000	1620000000	2430000000	10000000	800000000	900000000	
Objective Function							
Maximize average annual rate of returns	0.078688889						
Constraints Formulated							
1	9000000000	<=	9,000,000,000				
2	0	<=	0				
3	800000000	<=	800,000,000				
4	1.19209E-07	<=	0				
5	0	>=	0				
6	-496000000	<=	0				
7	-1620000000	<=	0				
8	0	<=	0				

Setting the Input data, constraints, decision variables, and objective variables as we have set it up on a, We get the following. We try to use formulas in places where we can easily calculate things like using SUMPRODUCT formula. Then we use the solver function to find the max of the objective function and input all the constraints and variable cells. The maximum average annual rate of retuns is 0.078688



4.a

decision variable:

x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
Ham	Mclean	Bigmac	FF	C Mcnug	Hon	Chef salad	Garden Salad	Egg Mc	Wheaties	VY	Milk	OJ	GJ	AJ

objective function

Minimize

$0.59x_1 + 1.79x_2 + 1.65x_3 + 0.68x_4 + 1.56x_5 + 0x_6 + 2.69x_7 + 1.96x_8 + 1.36x_9 + 1.09x_{10} + 0.63x_{11} +$
$0.56x_{12} + 0.81x_{13} + 0.68x_{14} + 0.68x_{15}$

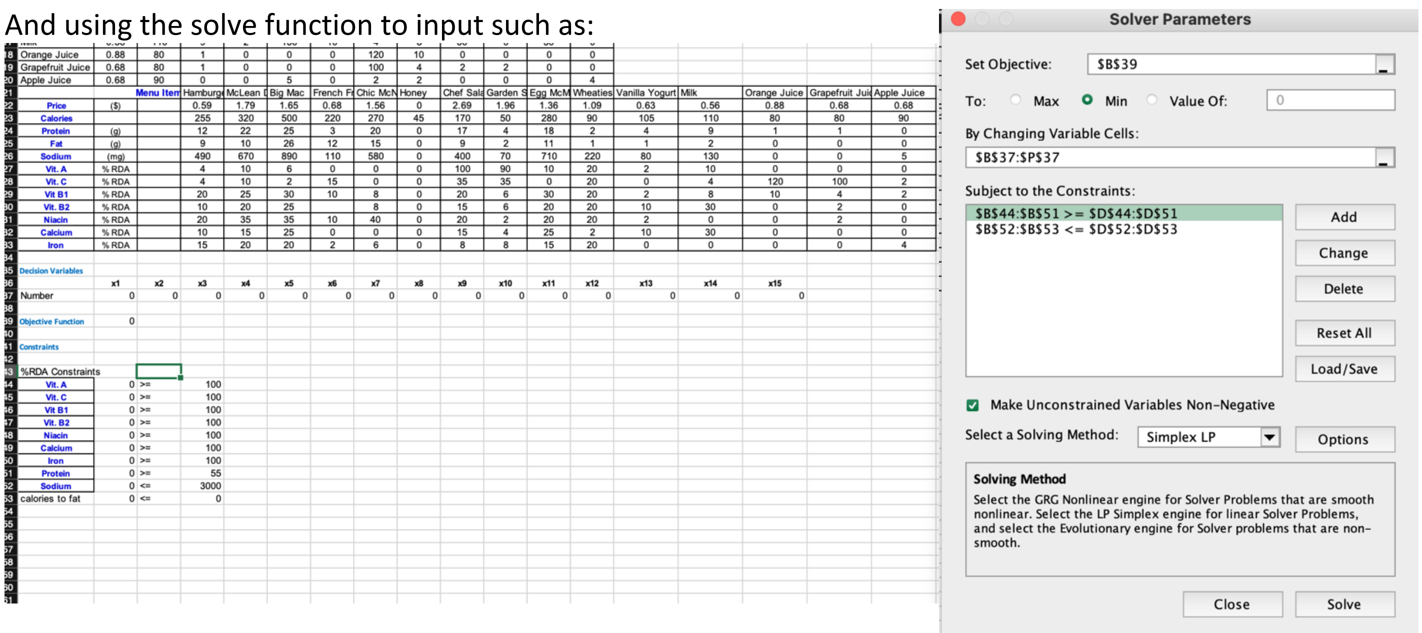
Constraints

Vit. A	Sum product of ($x_1 \ldots x_{15}$, their respective nutrient values arrays) ≥ 100
Vit. C	
Vit B1	
Vit. B2	
Niacin	
Calcium	
Iron	
Protein	Sum product of ($x_1 \ldots x_{15}$, their protein values) ≥ 55
Sodium	Sum product of ($x_1 \ldots x_{15}$, their sodium value) ≤ 3000
calories to fat	$9 \times$ Sumproduct ($x_1 \ldots x_{15}$, fat values) $-$ ($0.3 \times$ Sum product ($x_1 \ldots x_{15}$, calory values)) ≤ 0

x1,x2,…x15>= 0 but we don't need to put this constraint in excel as we can use "Make unconstrained variables non-negative" b.First I transposed the data so that I can use sumproduct more efficiently. Then I set up the data as so:

		Menu Item	Hamburger	McLean Deluxe	Big Mac	French Fries	Chic McNuggets	Honey	Chef Salad
Price	($)		0.59	1.79	1.65	0.68	1.56	0	2.69
Calories			255	320	500	220	270	45	170
Protein	(g)		12	22	25	3	20	0	17
Fat	(g)		9	10	26	12	15	0	9
Sodium	(mg)		490	670	890	110	580	0	400
Vit. A	% RDA		4	10	6	0	0	0	100
Vit. C	% RDA		4	10	2	15	0	0	35
Vit B1	% RDA		20	25	30	10	8	0	20
Vit. B2	% RDA		10	20	25		8	0	15
Niacin	% RDA		20	35	35	10	40	0	20
Calcium	% RDA		10	15	25	0	0	0	15
Iron	% RDA		15	20	20	2	6	0	8
Decision Variables									
	x1	x2	x3	x4	x5	x6	x7	x8	x9
Number	5.29919410760382	0	0	0	0	0	0	0.53507642284002	0
Objective Function	=SUMPRODUCT(B37:P37,D22:R22)								
Constraints									
%RDA Constraints									
Vit. A	=SUMPRODUCT($B$37:$P$37,D27:R27)	>=	100						
Vit. C	=SUMPRODUCT($B$37:$P$37,D28:R28)	>=	100						
Vit B1	=SUMPRODUCT($B$37:$P$37,D29:R29)	>=	100						
Vit. B2	=SUMPRODUCT($B$37:$P$37,D30:R30)	>=	100						
Niacin	=SUMPRODUCT($B$37:$P$37,D31:R31)	>=	100						
Calcium	=SUMPRODUCT($B$37:$P$37,D32:R32)	>=	100						
Iron	=SUMPRODUCT($B$37:$P$37,D33:R33)	>=	100						
Protein	=SUMPRODUCT($B$37:$P$37,D24:R24)	>=	55						
Sodium	=SUMPRODUCT($B$37:$P$37,D26:R26)	<=	3000						
calories to fat	=(9*SUMPRODUCT($B$37:$P$37,D25:R25))-(0.3*SU	<=	0						

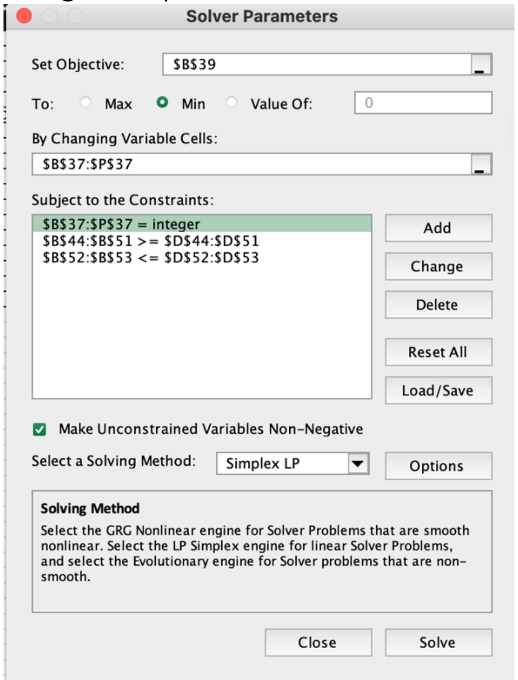
And using the solve function to input such as:



Will give us Optimal values of variables as 5.29914 Hamburgers, 0.53508 Honey, 0.81157Garden Salads, 1.44149Wheaties and 0.38078124Milk

And optimal price of $6.1260

c.
Using these parameters for solver function gives us



Optimal values variables as 2 Hamburgers, 4Garden Salad, and 3 wheaties
And optimal price of $7.22

5a.

6 A + 5 B + 3 C ≤ 300 pound can be interpreted as that Serious Toys have 300 pounds of plastic they can allocate per hour and Advanced sets, Beginner sets, and intermediate sets take 6, 5, and 3 pounds to make each toy set respectively

9A+4B+5C≤280minutes can be interpreted that the company has 280 min of labor they can use per hour and Advanced sets, Beginner sets, and intermediate sets take 9, 4, and 5 minutes of labor to produce respectively

2A+8B+4C≤320minutes can be interpreted that the company has 320 min of machine time they can use per hour and Advanced sets, Beginner sets, and intermediates take 2, 8 and 4 minutes of machine time to produce respectively

B ≥ 18 sets means the company must produce atleast 18 sets of Beginner sets

A, B, C ≥ 0 means each number of sets cant be negative

b.

	advanced set	beginer	intermediate	
price	1.2	1.6	1.4	
Constraints				
	6	5	3	300
	9	4	5	280
	2	8	4	320
	0	1	0	18
Decision Variables				
	a	b	c	
Number	0	20	40	
Objective Function				
Maximize Hourly Profit	88			
Constraints Formulated				
1	220	<=	300	
2	280	<=	280	
3	320	<=	320	
4	20	>=	18	

Optimal variables, Advanced set=0, Beginner set= 20, Intermediate sets= 40

And maximum hourly profit is $88/hr

Sensitivity Report

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$C$68	a	220	$C$68<=$E$68	Not Binding	80
$C$69	a	280	$C$69<=$E$69	Binding	0
$C$70	a	320	$C$70<=$E$70	Binding	0
$C$71	a	20	$C$71>=$E$71	Not Binding	2

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$C$61	Number a	0	-0.8	1.2	0.8	1E+30
$D$61	Number b	20	0	1.6	0.738461538	0.48
$E$61	Number c	40	0	1.4	0.6	0.3

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$C$68	Plastic (pounds)	220	0	300	1E+30	80
$C$69	Labor (min)	280	0.2	280	12	120
$C$70	Machine (min)	320	0.1	320	147.6923077	9.6
$C$71	Const 1	20	0	18	2	1E+30

C.

0.2 shadow price means every increase of min of labor per hour, it increases profit by $0.2

D. Range of feasibility for labor constraint is [160,292]

E. Yes it would change the optimal quantity of the decision variable and optimal price because labor constraint is binding and increasing it by 60 will also surpass the range of feasibility.

F. If machine time increased by 50, it will still be inside the range of feasibility which is [310.4,467.69] so it will increase by 50* 0.1 which is $5

G. if the machine increased by 100, it will still be within the range of feasibility which means 100*0.1 so $10 increase

H. 10 pounds of plastic/hour would not change anything because this constraint is not binding anyways

I. Advanced sets can be increased by until 0.8 still not change the optimal price. 0.8 is 66% of 1.2 which means increasing by 70% would affect the optimal price.