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I confirm that I understand my coursework needs to be submitted online via Google classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submission will be treated as non-submission and a marks of zero will be awarded.

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## Problem 1 solutions: (Tax Calculations)

### Introduction

A tax is a compulsory expense or monetary charge required by an administration on an individual or an association to gather income for public works giving the best offices and framework. The gathered fund is then used to finance diverse public consumption programs. In this project, excel tool was utilized to do the tax calculation process since we can utilize excel features like turn table and formulas to rapidly investigate the date and interpret the numbers quickly and efficiently. Similarly, ms excel accompanies a lot of plenty of built-in-function to work with information gave.

So, for the tax calculation in excel we are required to give the details of income, expenses, tax rate, tax amount and taxable amount left respectively. Applying the formula to an example, let us consider an individual with an income £ 55,000 and deduction was made with an average federal tax rate. Taxable income would come after subtracting annual income and total deduction for example (=E3-E9). Likewise, tax slab and income range are also used for the tax calculation.

Terms used in the tax calculation are given below:

#### Annual Income

Annual income is the amount of all pay apparent by a person in that year time span. Moreover, it is an aggregate sum of money earned in a calender year before taxes. Annual income is the income where deduction such as PF CIT and life insurance (E3,E6,E8) are deducted from the total income of the person.

#### Taxable Income

Taxable income is the sum used to compute how much tax an individual or an organization owes to the public authority in a given tax year. It is a distinction of annual income and total deduction for instance (E3-E9).

## Tax Slab

The act, in this manner isolates income ranges and collects tax at various rate according to the isolation. These groups are consequently known as tax slab. The tax slab likewise differ dependent on age if the taxpayer is an individual and according to the order of entities. For example it is calculate by subtracting income range from higher limit to the lower limit.

## Tax Rate

A tax rate is a rate at which an individual or corporation is taxed. It is the level of a people available pay or a organizing's acquiring that is owed to state, federal, and at time, civil governments.

## Taxable Amount

Taxable amount is the piece of a person's or an organization's pay used to ascertain how much tax they owe the public authority in a given assessment year.

## Screen shots for tax template

**Annual Income (In ₹)**

**Deductions:**  
PF  
CIT  
Life Insurance

**Total Deductions** 0

**Taxable Income (In ₹)** 0

Income Range (In ₹)	Tax Slab	Tax Rate	Tax Amount (In ₹)	Taxable Income Left (In ₹)
0	11850	11850	0.00%	0
11850	46350	34500	20%	0
46350	150000	103650	40%	0
150000 Over			45%	0
			Total Tax (Yearly)	0
			Total Tax (Monthly)	0

## Screen shots for Formula

The screenshot shows a Microsoft Excel spreadsheet titled "Problem 1 - Excel". The formula bar at the top displays the formula `=SUM(E6:E8)`. Cell E6 contains the value 12000. Cell E8 contains the formula `=E17-D17`, which evaluates to 11850. A tooltip box is overlaid on cell E8, stating "Whole number Please enter a valid number." The formula audit ribbon tab is selected, showing the "Trace Precedents" path from cell E8 back to cell E17.

	Income Range(in £)	Tax Slab	Tax Rate	Tax Amount(in £)	Taxable Income Left(in £)
0	11850	=E17-D17	0	=IF(E12<F17,E12*G17,F17*G17)	=IF(E12>F17,0,E12-F17)
11850	46350	=E18-D18	0.2	=IF(F17<F18,117*G18,F18*G18)	=IF(F17>F18,0,F17-F18)
46350	150000	=E19-D19	0.4	=IF(F18<F19,118*G19,F19*G19)	=IF(F18>F19,0,F18-F19)
150000	Over		0.45	=I19*G20	
			Total Tax (Yearly)	=SUM(H17:H20)	
			Total Tax(Monthly)	=H22/12	

## Screen shot of tax calculation for £55,000

## Screen shots of tax calculation for £100, 250

The screenshot shows an Excel spreadsheet titled "Problem 1 - Excel". The formula bar indicates the formula being used is `=E4`. The spreadsheet contains the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2															
3					Annual Income(In £)	1,00,250									
4					Deductions:										
5					PF										
6					CIT										
7					Life Insurance										
8					Total Deductions	0									
9															
10															
11															
12					Taxable Income(In £)	100250									
13															
14															
15															
16					Income Range(In £)	Tax Slab	Tax Rate	Tax Amount(In £)	Taxable Income Left(In £)						
17					0	11850	11850	0.00%	0	88400					
18					11850	46350	34500	20%	6900	53900					
19					46350	150000	103650	40%	21560	0					
20					150000 Over			45%	0						
21															
22								Total Tax (Yearly)	28460						
23								Total Tax(Monthly)	2371.666667						
24															
25															

The validation error message "whole number Please enter valid whole number." is displayed in a yellow box over the cell E4.

## Screen shots of tax calculation for £ 270, 755

The screenshot shows an Excel spreadsheet titled "Problem 1 - Excel". The formula bar indicates the formula being used is `=E4`. The spreadsheet contains the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2															
3					Annual Income(In £)	2,70,755									
4					Deductions:										
5					PF										
6					CIT										
7					Life Insurance										
8					Total Deductions	0									
9															
10															
11															
12					Taxable Income(In £)	270755									
13															
14															
15															
16					Income Range(In £)	Tax Slab	Tax Rate	Tax Amount(In £)	Taxable Income Left(In £)						
17					0	11850	11850	0.00%	0	258905					
18					11850	46350	34500	20%	6900	224405					
19					46350	150000	103650	40%	41460	120755					
20					150000 Over			45%	54339.75						
21															
22								Total Tax (Yearly)	102699.75						
23								Total Tax(Monthly)	8558.3125						
24															
25															

The validation error message "whole number Please enter valid whole number." is displayed in a yellow box over the cell E4.

## Screen shots of tax calculation for £ 99,500

The screenshot shows a Microsoft Excel spreadsheet titled "Problem 1 - Excel". The formula bar at the top has "E4" selected. The main area contains the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2															
3					Annual Income(In £)	99,500									
4					Deductions:										
5					PF		whole number Please enter valid whole number.								
6					CIT										
7					Life Insurance										
8					Total Deductions	0									
9					Taxable Income(In £)	99500									
10															
11															
12															
13															
14															
15															
16					Income Range(In £)	Tax Slab	Tax Rate	Tax Amount(In £)	Taxable Income Left(In £)						
17					0	11850	11850	0.00%	0	87650					
18					11850	46350	34500	20%	6900	53150					
19					46350	150000	103650	40%	21260	0					
20					150000 Over			45%	0						
21															
22									Total Tax (Yearly)	28160					
23									Total Tax(Monthly)	2346.666667					
24															
25															

At the bottom left, it says "Sheet1" and there are standard Excel navigation buttons.

## Screen shots of tax calculation for £ 237,570

The screenshot shows a Microsoft Excel spreadsheet titled "Problem 1 - Excel". The formula bar at the top has "E4" selected. The main area contains the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2															
3					Annual Income(In £)	2,37,570									
4					Deductions:										
5					PF		whole number Please enter valid whole number.								
6					CIT										
7					Life Insurance										
8					Total Deductions	0									
9					Taxable Income(In £)	237570									
10															
11															
12															
13															
14															
15															
16					Income Range(In £)	Tax Slab	Tax Rate	Tax Amount(In £)	Taxable Income Left(In £)						
17					0	11850	11850	0.00%	0	225720					
18					11850	46350	34500	20%	6900	191220					
19					46350	150000	103650	40%	41460	87570					
20					150000 Over			45%	39406.5						
21									Total Tax (Yearly)	87766.5					
22									Total Tax(Monthly)	7313.875					
23															
24															
25															

At the bottom left, it says "Sheet1" and there are standard Excel navigation buttons.

## Screen shot of tax calculation for £ -40,000

The screenshot shows a Microsoft Excel spreadsheet titled "Problem 1 - Excel". The formula bar at the top has "-40000" entered into cell E3. The spreadsheet contains several rows of data related to tax calculations, including columns for Annual Income, Deductions, and Taxable Income. A tooltip "Whole number Please enter a valid number." appears over cell E3. A modal dialog box titled "Invalid input" displays the message "Oops! something went wrong,Please try again." with options "Yes", "No", "Cancel", and "Help". The formula auditing ribbon tab is selected.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2															
3					Annual Income(In £)	-40000									
4					Deductions:										
5					PF										
6					CIT										
7					Life Insurance										
8					Total Deductions	0									
9					Taxable Income(In £)	-40000									
10															
11															
12															
13															
14															
15															
16					Income Range(In £)		Tax Slab	Tax Rate	Tax Amount(In £)	Taxable Income Left(In £)					
17					0	11850	11850	0.00%	0	0					
18					11850	46350	34500	20%	0	0					
19					46350	150000	103650	40%	0	0					
20					150000 Over			45%	0						
21															
22									Total Tax (Yearly)	0					
23									Total Tax(Monthly)	0					
24															
25															

To sum up, the taxable income were calculated using different terms like tax slab, tax rate and tax amount. Similarly, while giving negative income for example (-4000) we get the message saying please try again appears thus it means negative value for the annual income is not acceptable.

## Problem 2: Part A solutions

Solution;

Problem Analysis,

	Olive oil(A)	Vegetable peanut (B)	Olive vegetable peanut (C)	Production
olive vegetable oil	6 oz	0 oz	3 oz	15000
vegetable peanut oil	6 oz	10 oz	7 oz	23000
olive vegetable peanut	0 oz	6 oz	2 oz	4000
Profit	\$1.10	\$0.70	\$0.60	

Mathematical Formulation:

### For Decision variable

Let X, Y, Z be the number of jars for olive vegetable oil, vegetable peanut oil and olive vegetable peanut respectively.

### For Objective Function:

$$\text{Total profit} = 1.10X + 0.70Y + 0.60Z$$

$$\text{Let } C = 1.10X + 0.70Y + 0.60Z$$

$$\text{Maximize } C = 1.10X + 0.70Y + 0.60Z$$

### For Constraints:

$$6X + 3Z \leq 15000 \text{ (Olive oil constraints)}$$

$$6X + 10Y + 7Z \leq 23000 \text{ (Vegetable oil constraints)}$$

$$6Y + 2Z \leq 4000 \text{ (Peanut oil constraints)}$$

$$X, Y, Z \geq 0 \text{ (Non Negatively constraints)}$$

Let  $S_1$ ,  $S_2$  and  $S_3$  be the slack variables.

Now;

$$6X + 3Z + S_1 = 15000$$

$$6X + 10Y + 7Z + S_2 = 23000$$

$$6Y + 2Z + S_3 = 4000$$

$$X, Y, Z, S_1, S_2, S_3 \geq 0$$

Standard equation for simplex table:

$$1Z - 1.0X - 0.70Y - 0.60Z + 0S_1 + 0S_2 + 0S_3 = 0$$

$$0Z + 6X + 0Y + 3Z + 1S_1 + 0S_2 + 0S_3 = 15000$$

$$0Z + 6X + 10Y + 7Z + 0S_1 + 1S_2 + 0S_3 = 23000$$

$$0Z + 0X + 6Y + 2Z + 0S_1 + 0S_2 + 1S_3 = 4000$$

$$X, Y, Z, S_1 + 0S_2 + 1S_3 \geq 0$$

Simplex Table 1:

The diagram illustrates the steps to identify the key column and key row for the Simplex Table 1. An arrow points from a box labeled "Highest Negative (Key column)" to the column containing the coefficients for variable Z (-0.60, 3, 7, 2). Another arrow points from a box labeled "Key element" to the value 2 in the R3 row under the Z column. A third arrow points from a box labeled "Maximum Positive ratio (key Row)" to the R3 row itself.

Row	C	X	Y	Z	$S_1$	$S_2$	$S_3$	Constant	Ratio
$R_0$	1	-1.10	-0.70	-0.60	0	0	0	0	—
$R_1$	0	6	0	3	1	0	0	15000	$15000/6 = 2500$
$R_2$	0	6	10	7	0	1	0	23000	$23000/6 = 3833.33$
$R_3$	0	0	6	2	0	0	1	4000	$4000/0 = \infty$

Here X is the key column, R<sub>1</sub> is the key row and 6 is the key element.

Now, we must update key row (R<sub>1</sub>), first using the formula,

$$\text{Now; } R_1 = \frac{\text{old } R_1}{\text{key element}}$$

$$= \frac{\text{old } R_1}{6}$$

0, 1, 0, 0.5, 0.167, 0, 0, 2500

We need to update rows until all the elements of R<sub>0</sub> are  $\geq 0$  for the maximization problem.

Similarly, we should update R<sub>0</sub>, R<sub>2</sub> and R<sub>3</sub> using the formula,

$$\text{New } R_0 = \text{old } R_0 - (-1.10) \times \text{New } R_1$$

$$= \text{old } R_0 + 1.10 \times \text{New } R_1$$

$$\text{New } R_2 = \text{old } R_2 - 6 \times \text{New } R_1$$

$$\text{New } R_3 = \text{old } R_3 - 0 \times \text{New } R_1$$

old R <sub>0</sub> (+)	1.10 × New R <sub>1</sub>	New R <sub>0</sub>
1	0	1
-1.1	1.1	0
-0.7	0	-0.7
-0.6	0.55	-0.05
0	0.183	0.183
0	0	0
0	0	0
0	2750	2750

<b>old R<sub>2</sub> (-)</b>	<b>6 × New R<sub>1</sub></b>	<b>New R<sub>2</sub></b>
0	0	0
6	6	0
10	0	10
7	3	4
0	1	-1
1	0	1
0	0	0
23000	15000	8000

<b>old R<sub>3</sub> (-)</b>	<b>0 × New R<sub>1</sub></b>	<b>New R<sub>3</sub></b>
0	0	0
0	0	0
6	0	6
2	0	2
0	0	0
0	0	0
1	0	1
4000	0	4000

Simplex Table 2:

Highest Negative (Key Column)

Row	C	X	Y	Z	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Constant	Ratio
R <sub>0</sub>	1	0	-0.7	-0.05	0.183	0	0	2750	-
R <sub>1</sub>	0	1	0	0.5	0.167	0	0	2500	2500/0 = $\infty$
R <sub>2</sub>	0	0	10	4	-1	1	0	8000	8000/10 = 800
R <sub>3</sub>	0	0	6	2	0	0	1	4000	4000/6 = 666.67

Key element

Minimum positive (Key Row)

Here, Y is the key column, R<sub>3</sub> is the key row and 6 is the key element.

Now, R<sub>3</sub> is the key row and should be updated first using formula;

$$\text{New } R_3 = \frac{\text{old } R_3}{\text{key element}}$$

$$= \frac{\text{old } R_3}{6}$$

$$0, 0, 1, 0.33, 0, 0, 0.167, 666.67$$

Similarly, we should update R<sub>0</sub>, R<sub>1</sub> and R<sub>2</sub> using the formula,

$$\begin{aligned} \text{New } R_0 &= \text{old } R_0 - (-0.7) \times \text{New } R_3 \\ &= \text{old } R_0 + 0.7 \times \text{New } R_3 \end{aligned}$$

$$\text{New } R_1 = \text{old } R_1 - 0 \times \text{New } R_3$$

$$\text{New } R_2 = \text{old } R_2 - 10 \times \text{New } R_3$$

<b>old R<sub>0</sub> (+)</b>	<b>0.7 × New R<sub>3</sub></b>	<b>New R<sub>0</sub></b>
1	0	1
0	0.112	0
-0.7	0.7	0
-0.05	0.23	0.18
0.183	0	0.183
0	0	0
0	0	0
2750	466.67	3216.67

<b>old R<sub>1</sub> (-)</b>	<b>0 × New R<sub>3</sub></b>	<b>New R<sub>1</sub></b>
0	0	0
1	0	1
0	0	0
0.5	0	0.5
0.167	0	0.167
0	0	1
0	0	0
2500	0	2500

old R <sub>2</sub> (-)	10 × New R <sub>3</sub>	New R <sub>2</sub>
0	0	0
0	0	0
10	10	0
4	3.3	0.7
-1	0	-1
1	0	1
0	1.67	-1.67
8000	6666.7	7333.3

Simplex Table 3:

Row	C	X	Y	Z	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Constant
R <sub>0</sub>	1	0	0	0.18	0.183	0	0	3216.67
R <sub>1</sub>	0	1	0	0.5	0.167	1	0	2500
R <sub>2</sub>	0	0	0	0.7	-1	1	-1.67	7333.3
R <sub>3</sub>	0	0	1	0.33	0	0	0.167	666.67

Here all the coefficient of variables in R<sub>0</sub> row are all  $\geq 0$  so we reached the optimum solution.

Here, Maximum ( C ) = 3216.67

X = 2500,

Y = 666.67,

Z = 0

Hence, the company should produce 2500 jars of olive vegetables, 666.67 jars of vegetable peanut oil and zero jars of olive-vegetable peanut in-order to make the maximize profit of \$ 3216.67.

## Excel solver solutions

### Screen shots of showing template

	A	B	C	D	E	F	G	H	I	J	K
2											
3				Decision variables	X	Y	Z				
4					2500	666.6666667	0				
5											
6											
7				Objective Funcions							
8				Maximize ( C )		3216.666667					
9											
10											
11				Constraints							
12				LHS	Inequalities		LHS				
13				15000 <=			15000				
14				21666.66667 <=			23000				
15				4000 <=			4000				
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											

## Screen shots of showing formula

	A	B	C	D	E	F	G	H
1								
2								
3				Decision variables	X	Y	Z	
4					2500	666.666666666667	0	
5								
6								
7				Objective Funcns				
8				Maximize ( C )	=1.1*E4+0.7*F4+0.6*G4			
9								
10				Constraints				
11				LHS	Inequalities	LHS		
12				=6*E4+0*F4+3*G4	<=	15000		
13				=6*E4+10*F4+7*G4	<=	23000		
14				=0*E4+6*F4+2*G4	<=	4000		
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								

## Screen shots of Answer Report

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Microsoft Excel 16.0 Answer Report																		
2	Worksheet: [Book1]Sheet1																		
3	Report Created: 14-09-2021 23:49:43																		
4	Result: Solver found a solution. All Constraints and optimality conditions are satisfied.																		
5	Solver Engine																		
6	Engine: Simplex LP																		
7	Solution Time: 0.047 Seconds.																		
8	Iterations: 2 Subproblems: 0																		
9	Solver Options																		
10	Max Time Unlimited, Iterations Unlimited, Precision 0.000001, Use Automatic Scaling																		
11	Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative																		
12																			
13																			
14	Objective Cell (Max)																		
15	Cell	Name	Original Value	Final Value															
16	\$E\$8	Maximize ( C ) X	0	3216.666667															
17																			
18																			
19	Variable Cells																		
20	Cell	Name	Original Value	Final Value	Integer														
21	\$E\$4	X	0	2500	Contin														
22	\$F\$4	Y	0	666.666666666667	Contin														
23	\$G\$4	Z	0	0	Contin														
24																			
25																			
26	Constraints																		
27	Cell	Name	Cell Value	Formula	Status	Slack													
28	\$D\$13	LHS	15000	\$D\$13<=\$F\$13	Binding	0													
29	\$D\$14	LHS	21666.66667	\$D\$14<=\$F\$14	Not Binding	1333.333333													
30	\$D\$15	LHS	4000	\$D\$15<=\$F\$15	Binding	0													
31																			
32																			
33																			
34																			

## Screen shot of Sensitivity Report

Microsoft Excel 16.0 Sensitivity Report							
1	Microsoft Excel 16.0 Sensitivity Report						
2	Worksheet: [Book1]Sheet1						
3	Report Created: 14-09-2021 23:49:43						
4							
5							
6	Variable Cells						
7	Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
8	\$E\$4	X	2500	0	1.1	1E+30	0.366666667
9	\$F\$4	Y	666.6666667	0	0.7	1E+30	0.55
10	\$G\$4	Z	0	-0.183333333	0.6	0.183333333	1E+30
11							
12	Constraints						
13	Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
14	\$D\$13	LHS	15000	0.183333333	15000	1333.333333	15000
15	\$D\$14	LHS	21666.66667	0	23000	1E+30	1333.333333
16	\$D\$15	LHS	4000	0.116666667	4000	800	4000
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

## Screen shots of Limit Report

Microsoft Excel 16.0 Limits Report						
1	Microsoft Excel 16.0 Limits Report					
2	Worksheet: [Book1]Sheet1					
3	Report Created: 14-09-2021 23:49:43					
4						
5						
6	Objective					
7	Cell	Name	Value			
8	\$E\$8	Maximize ( C ) X	3216.666667			
9						
10						
11	Variable					
12	Cell	Name	Value	Lower Limit	Objective Result	Upper Limit
13	\$E\$4	X	2500	0	466.666667	2500
14	\$F\$4	Y	666.6666667	0	.2750	666.666667
15	\$G\$4	Z	0	0	3216.666667	0
16						
17						
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27						

To conclude, the company should produce 2500 jars of olive vegetables, 666.67 jars of vegetable peanut oil and zero jars of olive-vegetable peanut in-order to make the maximize profit of \$ 3216.67

## Memorandum

To: Oil Company

From: Punam Thapa Magar

Date: 15-09-2021

Sub: To maximize the profit and increase the quantity of oil containers.

In the meantime, Oil organization is the most prestigious organization in all nations. Olive vegetable oil, vegetable peanut oil and olive vegetable peanut oils are viewed as the most famous when contrasted with other oil like sunflower oil, mustard oil and so on and are generally liked by individuals. Interest for these oil are expanding hugely so with the expanding of demand, creation ought to likewise increment. Likewise we need to boost the benefit and it should create 2500 containers of olive vegetable, 666.62 containers of vegetable peanut oil and no containers of olive vegetable peanut to make the most extreme benefit to 3216.67.

Besides, while discussing the details of the oils, olive vegetable oil are the combination of two fundamental oil for example olive oil and vegetable oil. This give twofold advantage to the consumer when they use it and in like manner buyer can get fundamental supplements. Anyway so individuals may be sensitive to olive oil that is the reason, oil organization has the alternative of vegetable and peanut oil also, so the purchaser would be happy with their organization and their creation too. On top of that, oil company has its own imagination to make olive vegetable and peanut oil joining together. Alongside this, expansion of benefit likewise assumes an irreplaceable part in the company. In this way, benefit can be expand by creating certain quantities of oil containers. Nonetheless, for consumer wellbeing lapsed oil ought to be discarded so that individuals don't abuse about the company.

To wrap up, to acquire more we need to create more containers with quality oil so we can draw in our shopper to burn-through oil from our company 'The oil company'.

Thanks and Regards

Punam Thapa Magar

## Problem 2: Part B Solutions

Given;

Maximize,  $Z = 60X + 50Y$

$$2X + 4Y = 80 \rightarrow \text{equation (i)}$$

$$3X + 2Y \rightarrow \text{equation (ii)}$$

Now;

From equation (i)

When,  $X = 0$

$$2X + 4Y = 80$$

$$\text{or, } 2 \times 0 + 4Y = 80$$

$$\text{or, } 4Y = 80$$

$$\text{or, } Y = 20$$

And,

When,  $Y = 0$

$$2X + 4Y = 80$$

$$\text{or, } 2X + 4 \times 0 = 80$$

$$\text{or, } 2X = 80$$

$$\text{or, } X = 40$$

Therefore, the passing points are  $(0, 20)$  and  $(40, 0)$  respectively.

Again,

Take  $(0, 0)$  as a testing point.

$$2X + 4Y \leq 80$$

or,  $2 \times 0 + 4 \times 0 \leq 80$

or,  $0 \leq 80$  (TRUE)

Next,

From equation (ii)

When,  $X = 0$

$$3X + 2Y = 60$$

or,  $3 \times 0 + 2Y = 60$

or,  $2Y = 60$

or,  $Y = 30$

And,

When,  $Y = 0$

$$3X + 2Y = 60$$

or,  $3X + 2 \times 0 = 60$

or,  $3X = 60$

or,  $X = 20$

Therefore, the passing points are  $(0, 30)$  and  $(20, 0)$  respectively.

Again,

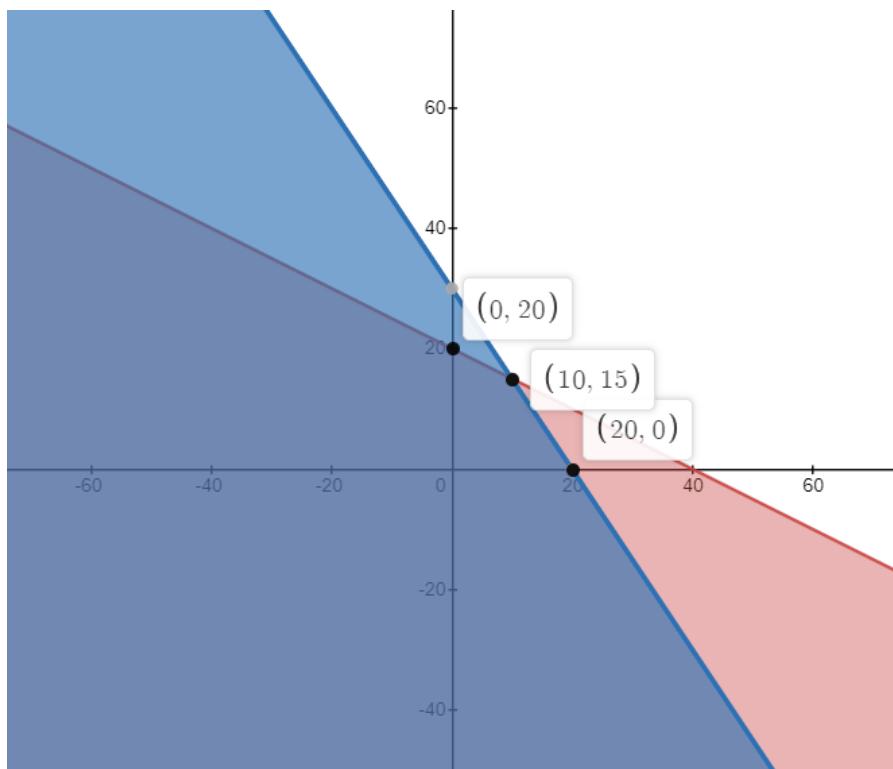
Take  $(0, 0)$  as a testing point

$$3X + 2Y \leq 60$$

or,  $3 \times 0 + 2 \times 0 \leq 60$

or,  $0 \leq 60$  (TRUE)

### Graphical Solution



(Anon., n.d.)

Hence, the feasible region is OABC

Points	X	Y	$Z = 60X + 50Y$
O(0, 0)	0	0	0
A(0, 20)	0	20	1000
B(10, 15)	10	15	1350 (MAX)
C(20, 0)	20	0	1200

Therefore, the maximum value is 1350 at point B (10, 15).

## Excel solver solutions

### Screen shots of showing template

The screenshot shows the Microsoft Excel interface with the 'DATA' tab selected. The 'Solver' button is visible in the ribbon under the 'DATA' tab. The spreadsheet contains the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1																	
2																	
3																	
4																	
5					<b>Decision variables</b>	X		Y									
6						10		15									
7																	
8					<b>Objective Functions</b>												
9					Maximize(Z)			1350									
10																	
11																	
12					<b>Constraints</b>												
13					LHS	Inequalities	RHS										
14						80 <=		80									
15						60 <=		60									
16																	

The formula bar shows the current cell is E16. The status bar at the bottom indicates 'Sheet1'.

### Screen shots of showing formula

The screenshot shows the Microsoft Excel interface with the 'FORMULAS' tab selected. The 'Function Library' group is open, showing various function categories like AutoSum, Recently Used, Financial, Logical, Text, Date & Time, Lookup & Reference, Math & Trig, and More. The 'Show Formulas' button is highlighted in green. The spreadsheet contains the same data as the previous screenshot, with the formula  $=60*D6+50*E6$  displayed in the formula bar for cell D9.

	A	B	C	D	E	F										
1																
2																
3																
4																
5					<b>Decision variables</b>	X		Y								
6						10		15								
7																
8					<b>Objective Functions</b>											
9					Maximize(Z)			$=60*D6+50*E6$								
10																
11					<b>Constraints</b>											
12					LHS	Inequalities	RHS									
13						$=2*D6+4*E6$	$\leq$	80								
14						$=3*D6+2*E6$	$\leq$	60								
15																
16																

The formula bar shows the current cell is E16. The status bar at the bottom indicates 'Sheet1'.

## Screen shots of Answer Report

**Microsoft Excel 15.0 Answer Report**

Report Created: 13-09-2021 14:20:26

Solver Engine

- Engine: Simplex LP
- Solution Time: 0 Seconds.
- Iterations: 2 Subproblems: 0

Solver Options

- Max Time Unlimited, Iterations Unlimited, Precision 0.000001, Use Automatic Scaling
- Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative

**Objective Cell (Max)**

Cell	Name	Original Value	Final Value	
\$D\$9	Maximize(Z)	X	0	1350

**Variable Cells**

Cell	Name	Original Value	Final Value	Integer
\$D\$6	X	0	10	Contin
\$E\$6	Y	0	15	Contin

## Screen shots of Sensitivity Report

**Microsoft Excel 15.0 Sensitivity Report**

Report Created: 13-09-2021 14:20:26

**Variable Cells**

Cell	Name	Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$D\$6	X	10	0	60	15	35
\$E\$6	Y	15	0	50	70	10

**Constraints**

Cell	Name	Value	Final Price	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$C\$14	LHS	80	3.75	80	40	40	
\$C\$15	LHS	60	17.5	60	60	20	

## Screen shots of Limit Report

Microsoft Excel 15.0 Limits Report

Report Created: 13-09-2021 14:20:26

Objective		
Cell	Name	Value
\$D\$9	Maximize(Z)	X 1350

Variable		Lower Objective		Upper Objective		
Cell	Name	Value	Limit	Result	Limit	Result
\$D\$6	X	10	0	750	10	1350
\$E\$6	Y	15	0	600	15	1350

## Problem 3 solutions

Solution;

Given;

$$\text{Fixed cost} = \text{£}150$$

$$\text{Variable cost per unit} = \text{£}2x \quad [\text{since } x \text{ is the number of items manufactured}]$$

So;

$$\text{Total cost} = \text{Fixed cost} + \text{Variable cost}$$

$$= 150 + 2x$$

It is also given;

$$\text{Price function } P(x) = 30 - 0.2x$$

So;

Revenue function  $R(x) = \text{Price} \times \text{No of units}$

$$= (30 - 0.2x) \times x$$

$$= 30x - 0.2x^2$$

At break-even point;

Revenue = Cost

$$30x - 0.2x^2 = 150 + 2x$$

$$0.2x^2 - 30x + 2x + 150 = 0$$

$$0.2x^2 - 28x + 150 = 0$$

Comparing;

$$0.2x^2 - 28x + 150 = 0 \text{ with } ax^2 + bx + c = 0$$

We get;

$$a = 0.2, b = -28, c = 150$$

Using quadratic equation formula,

$$\begin{aligned} x_1 &= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \\ &= \frac{-(-28) \pm \sqrt{(-28)^2 - 4 * 0.2 * 150}}{2 * 0.2} \\ &= \frac{28 \pm \sqrt{784 - 120}}{0.4} \\ &= \frac{28 + \sqrt{664}}{0.4} \\ &= \frac{28 + 25.76}{0.4} \\ &= 134.42 \end{aligned}$$

And;

$$x_2 = \frac{-(-28) \pm \sqrt{(-28)^2 - 4*0.2*150}}{2 * 0.2}$$

$$= \frac{28 \pm \sqrt{784 - 120}}{0.4}$$

$$= \frac{28 - \sqrt{664}}{0.4}$$

$$= \frac{28 - 25.76}{0.4}$$

$$= 5.58$$

For the corresponding values of x,

When,

$$x_1 = 134.42,$$

$$y_1 = 150 + 2x$$

$$= 150 + 2 \times 134.4$$

$$= 418.841$$

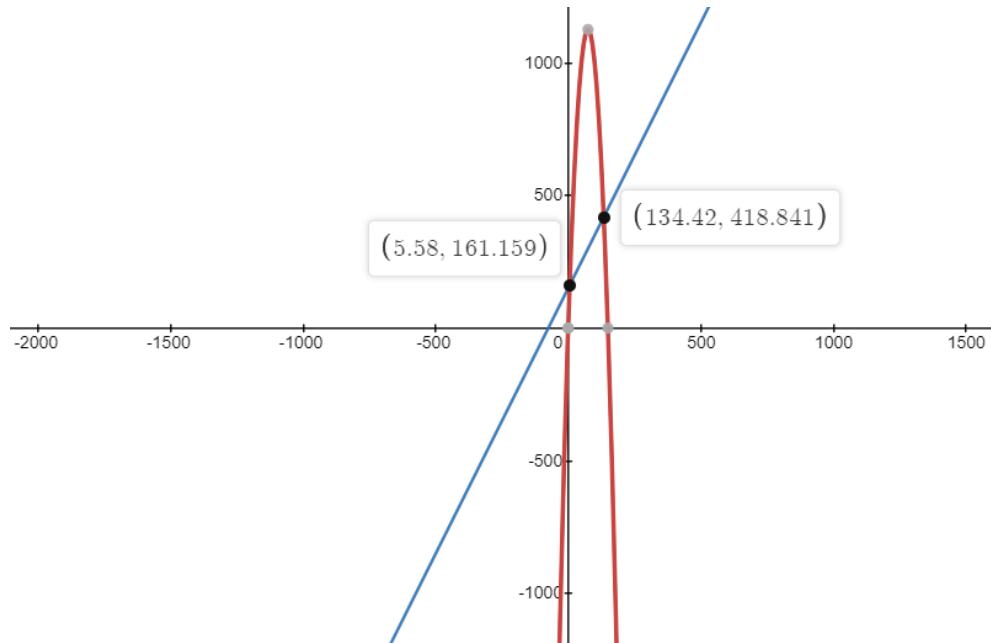
$$x_2 = 5.58,$$

$$y_2 = 150 + 2x$$

$$= 150 + 2 \times 5.6$$

$$= 161.159$$

By plotting the revenue and cost functions, obtain the break-even output level and corresponding price.



(Anon., n.d.)

The break-even points are (5.58, 168.159) and (134.42, 418.841)

Again;

The profit function is given by;

$$P(x) = R(x) - C(x) \text{ [Profit = Revenue - Cost]}$$

$$P(x) = (30x - 0.2x^2) - (150 + 2x)$$

$$P(x) = 30x - 0.2x^2 - 150 - 2x$$

$$P(x) = -0.2x^2 + 28x - 150$$

Therefore, Profit function  $P(x) = -0.2x^2 + 28x - 150$

- i. To find the level production that maximize the profit.

Level of Production;

$$x = \frac{-b}{2a}$$

Where;

$$a = -0.2, b = 28$$

$$x = \frac{-28}{2 * (-0.2)}$$

$$x = 70$$

- ii. The maximum profit is given by profit function when  $x = 70$ ,

$$= P(70)$$

$$= -0.2 \times (70)^2 + 28 \times (70) - 150$$

$$= -0.2 \times 4900 + 1960 - 150$$

$$= -980 + 1960 - 150$$

$$= £830$$

Hence, the maximum profit is £830.

## Conclusion

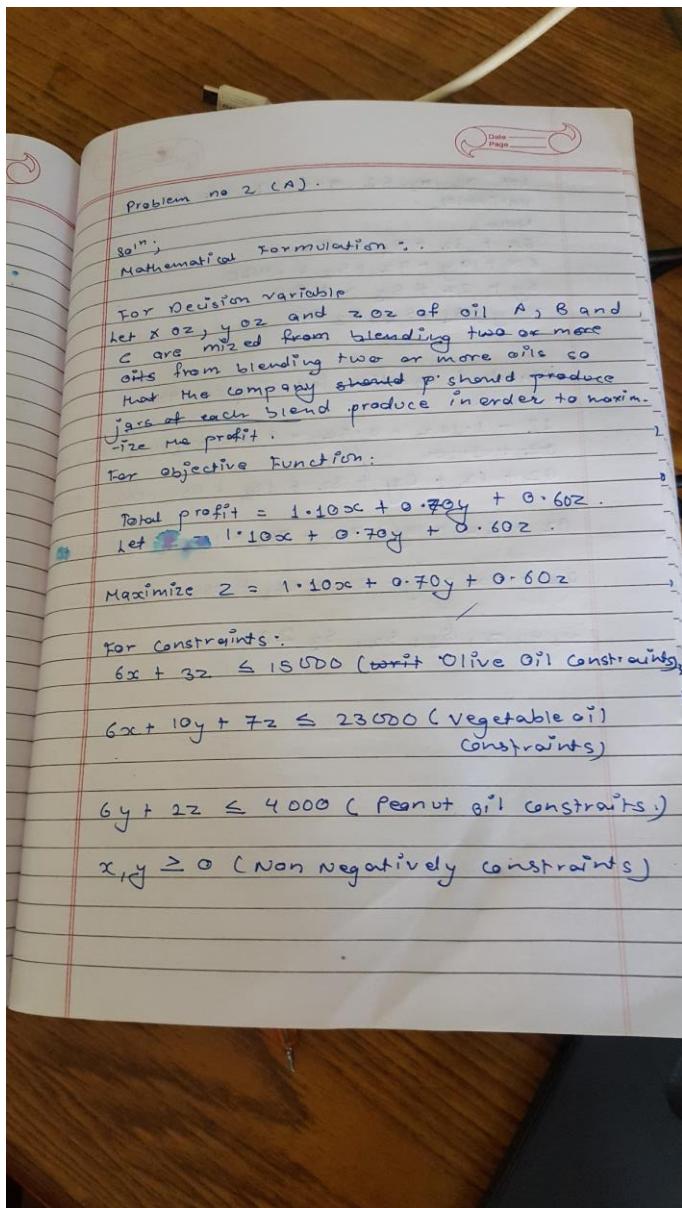
To whole up, this coursework was relegated to us for doing tax calculation and linear programming where two different tools were utilized namely excel for tax calculation and desmos for graphical method. While doing this coursework I needed to confront the challenged particularly in the simplex method as numerous mistakes occurred and I was new to the theme too I was exceptionally confounded. I was likewise somewhat confused in regards to the formulas used in the tax calculation process in excel . Yet in order to conquer the confusion and trouble, a lot pf explores were finished with respect to the applicable problems. Cent percent exertion was given to finish the undertaking allocated in this problem. Regular interaction with instructors, and going through the lecture slides and with acquiring sound information about different given problems. I likewise, became more acquainted with about the various terms and methods utilized in the problem, I knew about various terms alongside their capabilities.

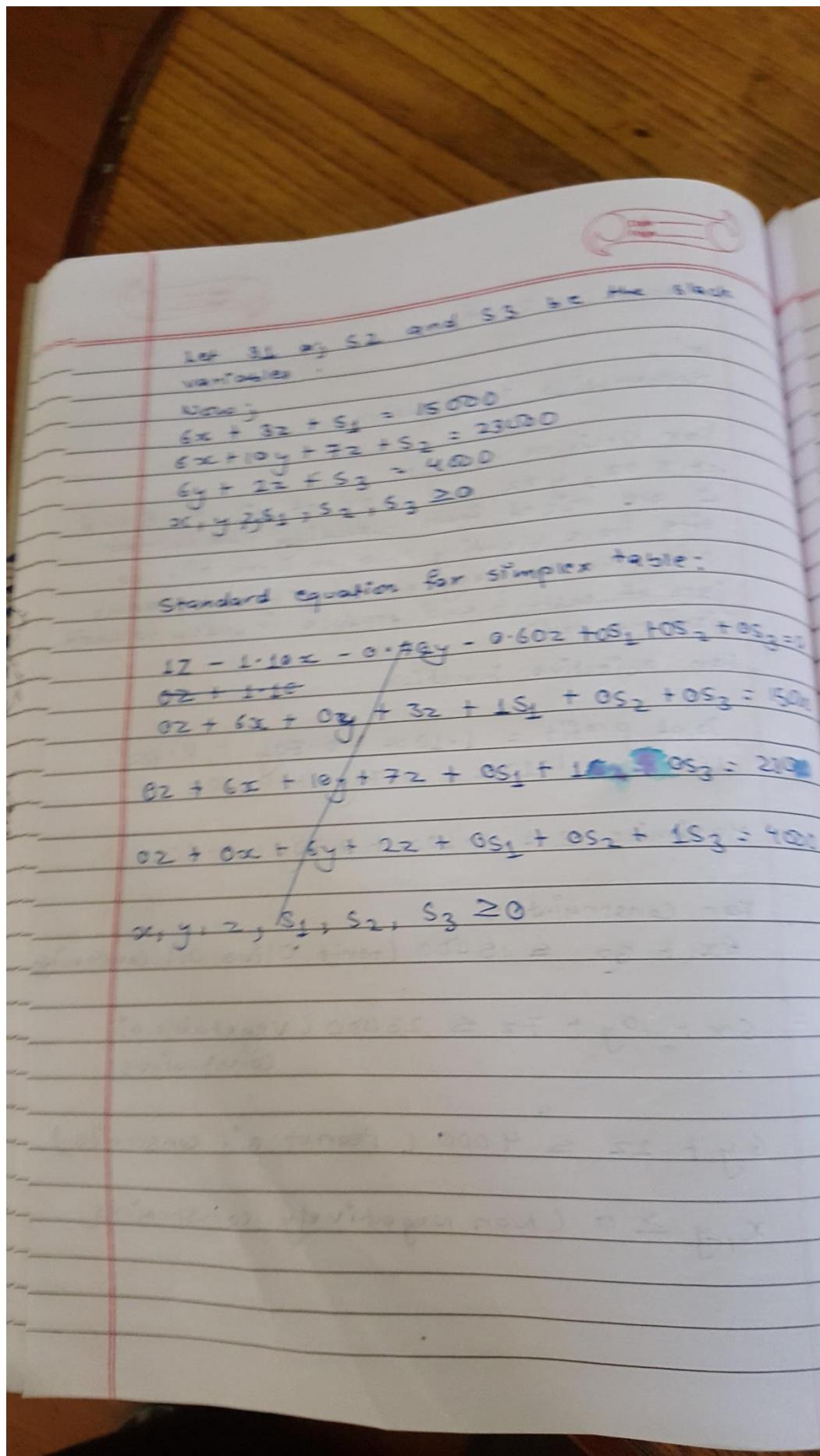
Despite the fact that it was challenging and troublesome from the outset, the coursework was finished on schedule and submitted on time as well. I had the chance to learn numerous new things and themes which I knew about. It was decent encounter to foster a program utilizing excel and desmos and it was enjoyable to chip away at this project as well.

## References

- Anon., n.d. *desmos*. [Online]  
Available at: <https://www.desmos.com/>  
[Accessed 15 09 2021].

## Evidence





Date \_\_\_\_\_  
Page \_\_\_\_\_

$$\begin{aligned}
 1z - 1 \cdot 10x - 0.70y - 0.60z + 0s_1 + 0s_2 + 0s_3 &= 0 \\
 0z + 6x + 0y + 3z + 1s_1 + 0s_2 + 0s_3 &= 15000 \\
 0z + 6x + 10y + 7z + 0s_1 + 1s_2 + 0s_3 &= 23000 \\
 0z + 0x + 6y + 2z + 0s_1 + 0s_2 + 1s_3 &= 4000 \\
 x, y, z, s_1, s_2, s_3 &\geq 0
 \end{aligned}$$

Simplex table 1:

	$Z$	$x$	$y$	$z$	$s_1$	$s_2$	$s_3$	Constant	Ratio
$R_0$	1	-1.10	-0.70	-0.60	0	0	0	-	
$R_1$	0	6	0	3	1	0	0	15000	$\frac{15000}{6} = 2500$
$R_2$	0	6	10	7	0	1	0	23000	$\frac{23000}{6} = 3833$
$R_3$	0	0	6	2	0	0	1	4000	$= 4000$

Highest negative (key column)  $\downarrow$   
Minimum positive ratio (key ratio · row)  
key element.

$\therefore$  Here  $x$  is the key column,  $R_1$  is the key row and 6 is the key element.

Date \_\_\_\_\_  
Page \_\_\_\_\_

Simplex Table 1: Highest Negative entry column

Row	C	X	Y	Z	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Constant	Ratio
R <sub>0</sub>	1	-1.10	-0.20	0.60	0	0	0	-	-
(R <sub>1</sub> )	0	0	3	1	0	0	0	15000	250
R <sub>2</sub>	0	6	10	7	0	1	0	23000	383.33
R <sub>3</sub>	0	0	6	2	0	0	1	4000	∞

key element.

Maximum Positive ratio (key row)

Here X is the key column, R<sub>1</sub> is the key row and G is the element.

Now we must update key row (R<sub>1</sub>) first using the formula.

Now;

$R_1 = \text{old } R_1 + \text{key element}$ .

$0, 1, 0, 0-5, 0-167, 0, 0, 2500$

Similarly, we should update R<sub>0</sub>, R<sub>2</sub> and R<sub>3</sub> using the formula.

New R<sub>0</sub> = old R<sub>0</sub> - (-1.10) × New R<sub>1</sub>  
 $\therefore$  old R<sub>0</sub> + 1.10 × New R<sub>1</sub>

New R<sub>2</sub> = old R<sub>2</sub> - 6 × New R<sub>1</sub>,  
New R<sub>3</sub> = old R<sub>3</sub> - 0 × New R<sub>1</sub>,

The image shows handwritten calculations in a notebook. At the top right, there is a logo with the text "Date \_\_\_\_\_" and "Page \_\_\_\_\_". Below this, there are three sets of calculations for different rows:

- Row R<sub>1</sub>:** Old R<sub>1</sub>(+) 1.10 × New R<sub>1</sub>, New R<sub>1</sub>. The calculations show a decrease from old values to new values.
- Row R<sub>2</sub>:** Old R<sub>2</sub>(-) 6 × New R<sub>2</sub>, New R<sub>2</sub>. The calculations show an increase from old values to new values.
- Row R<sub>3</sub>:** Old R<sub>3</sub>(-) 6 × New R<sub>3</sub>, New R<sub>3</sub>. The calculations show an increase from old values to new values.

The notebook is bound in a dark cover, and the pages are lined with red horizontal lines.

Row	Old Value	Calculation	New Value
R <sub>1</sub>	1.10 × New R <sub>1</sub>	New R <sub>1</sub>	
R <sub>1</sub>	1	1	
R <sub>1</sub>	-0.1	-0.1	-0.7
R <sub>1</sub>	-0.7	0	-0.09
R <sub>1</sub>	-0.6	0.55	0.183
R <sub>1</sub>	0	0.183	0
R <sub>1</sub>	0	0	0
R <sub>1</sub>	0	0.5	0
R <sub>1</sub>	0	2750	2750
R <sub>2</sub>	6 × New R <sub>2</sub>	New R <sub>2</sub>	
R <sub>2</sub>	0	0	0
R <sub>2</sub>	6	6	0
R <sub>2</sub>	0	0	10
R <sub>2</sub>	10	3	4
R <sub>2</sub>	7	1	-1
R <sub>2</sub>	0	0	1
R <sub>2</sub>	1	0	0
R <sub>2</sub>	0	0	8000
R <sub>2</sub>	23500	15000	8000
R <sub>3</sub>	6 × New R <sub>3</sub>	New R <sub>3</sub>	
R <sub>3</sub>	0	0	0
R <sub>3</sub>	0	0	6
R <sub>3</sub>	6	0	3
R <sub>3</sub>	0	0	0
R <sub>3</sub>	2	0	0
R <sub>3</sub>	0	0	0
R <sub>3</sub>	0	0	1
R <sub>3</sub>	1	0	4000
R <sub>3</sub>	4000	4000	4000

Simple Table 2:

Row	C	X	Y	Z	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	On
R <sub>0</sub>	1	0	-0.2	-0.05	0.163	0	0	2750
R <sub>1</sub>	0	1	0	0.5	0.167	0	0	2500
R <sub>2</sub>	0	0	10	4	-1	1	0	8000
R <sub>3</sub>	0	0	(6)	2	0	0	1	4000

↓ Minimum positive (key row).

Here, Y is the key column, R<sub>3</sub> is the key row and 6 is the key element.

Now;

R<sub>3</sub> is the key row and should be updated first using formula;

New R<sub>3</sub> = old R<sub>3</sub> / key element.

= old R<sub>3</sub> / 6

0, 0, 1, 0.33, 0, 0, -167, 666.67,

similarly, we should update R<sub>0</sub>, R<sub>1</sub>, and R<sub>2</sub> using the formula.

$\Delta \text{New } R_0 = \text{Old } R_0 + 0.7 \times \text{New } R_3$	$\Delta \text{New } R_1 = \text{Old } R_1 - 0 \times \text{New } R_3$	$\Delta \text{New } R_2 = \text{Old } R_2 - 10 \times \text{New } R_3$
$\text{Old } R_0 (+)$	$0.7 \times \text{New } R_3$	$\text{New } R_0$
1	0	1
0	0.112	0
-0.2	0.7	0
-0.05	0.23	0.18
0.183	0	0.183
0	0	0
0	0	0
2750	466.67	3216.67
$\text{Old } R_1 (-)$	$0 \times \text{New } R_3$	$\text{New } R_1$
0	0	0
1	0	1
0	0	0
0.5	0	0.5
0.167	0	0.167
0	0	1
0	0	0
0	0	2502
$\text{Old } R_2 (-)$	$10 \times \text{New } R_3$	$\text{New } R_2$
0	0	0
0	0	0
10	10	0.7
4	3.3	-1
-1	0	1
0	1.67	-1.67
8000	6666.7	7333.3

