B.Com (Hons.) Semester IV

Subject: Business Mathematics (Practical)

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Linear Programming through Excel Solver

Before moving on to excel solver, we need to have detailed question. Therefore, we start with the following problem:

A firm makes two types of furniture's, chairs and tables. Profits are \gtrless 20 per chair and \gtrless 30 per table. Both products are processed on three machines M1, M2 and M3. The time required for each product in hours and total time available in hours per week on each machine are as follows:

Machine	Chair	Table	Available Time
M1	3	3	36
M2	5	2	50
M3	2	6	60

How should the manufacturer schedule his production in order to maximize profit?

STEP 1: Formulate the problem:

Let x and y be the number of chairs and table to be produced per week respectively

Maximize Z= 20x + 30y

Subject to constraints:

$$3x+3y \le 36$$

 $5x+2y \le 50$
 $2x+6y \le 60$

x, y ≥ 0 (Non-negativity constraint)

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5	Constraints				Maximum Capacity		
6	Machine 1	3	3		36		
7	Machine 2	5	2		50		
8	Machine 3	2	6		60		
9							
10 11	NOTE: In the sh	aded cells	we need to	apply the	formulas		
12							

STEP 2: Now enter all this information to excel spreadsheet in the below format.

STEP 3: NEXT, enter the formula in the cell D3 and D6 to D8.

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	A	В	С	D	E	F	G	н
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4				SUMPRO	DUCT(array1,	array2], [ar	ray3], [array4],	,)
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5	Constraints				Capacity			
6	Machine 1	3	3		36			
7	Machine 2	5	2		50			
8	Machine 3	2	6		60			
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10 11	NOTE: In the sh	aded cells	we need to	apply the	formulas			

Enter the formula in D3 to calculate total profit using SUMPRODUCT formula (i.e. multiplying profit per unit into quantity of specific furniture and then adding it)

Similarly enter the formula in D6 to D8 using SUMPRODUCT formula to calculate capacity utilised of each machine

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D6	· · · × ·	fx =SUN	APRODUCT	(\$B\$2:\$C\$	2,B6:C6)			
	A	B	С	D	E	F	G	н
1		Chair	Table	Profit				
2	Decision variables							
3	Contribution	20	30	0				
4								
5	Constraints				Maximum Capacity			
6	Machine 1	3	3	=SUMPRO	DUCT(\$B\$2:\$	C\$2,B6:C6)	
7	Machine 2	5	2		50			
8	Machine 3	2	6		60			
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10	NOTE: In the sh	aded cells	we need to	apply the	formulas			
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STEP 4: To load the solver add-in, execute the following steps.

- a. Go to the File tab then, under File tab click on "Options".
- b. Go to Add-ins under Excel Options.



c. Under this select "Excel Add-ins" and click on Go.

Excel Options			8 ×
Save		Analysis ToolPak	C:\32.XLL Exce
Language		Add-in:	Analysis ToolPak
Ease of Access		Publisher: Compatibility:	Microsoft Corporation
Advanced		Location:	C:\Program Files\Microsoft Office\ro
Customize Ribbon		Description:	Office16\Library\Analysis\ANALYS32. Provides data analysis tools for statist
Quick Access Toolbar			and engineering analysis
Add-ins		Manage: Excel	Add-ins 🔻 <u>G</u> o 💌
Trust Center	-		
			OK Cancel

d. Under below pop up choose "Solver Add-in" and click on "Ok" to enable it.

Add-ins		? ×
Add-ins available:		
Analysis ToolPak	~	ОК
Euro Currency Tools		Cancel
Solver Add-in		
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e. Now we can see "Solver Add-in" under the DATA tab.

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1		Chair	Table	Profit															
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					Maximum														
5	Constraints				Capacity														
6	Machine 1	3		3 (<mark>)</mark> 36														
7	Machine 2	5		2 (<mark>)</mark> 50														
8	Machine 3	2		6 (D 60														
9																			

STEP 5: Solve Linear Programming through Excel Solver

To apply solver go to the DATA tab and click on "Solver" we will see below window.

er Parameters				
Se <u>t</u> Objective:		SNS7		1
To: O Max) Mi <u>n</u>	© <u>V</u> alue Of:	0	
By Changing Varia	ble Cells:			
				1
S <u>u</u> bject to the Cor	istraints:			
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				<u>R</u> eset All
			-	Load/Save
✓ Make Unconst	rained Variables No	on-Negative		
S <u>e</u> lect a Solving Method:	GRG Nonlinear		-	O <u>p</u> tions

In the above window, our first option is "Set Objective". Our objective is to identify the "Total Profit", so our Total Profit cell is D3, so select the cell D3 for this "Set Objective" and set it to "Max".

	Get External [Data		Connections	Solver Parameters	×
D3	• : X 🗸	fx =SU	MPRODUC	T(\$B\$2:\$C\$2	2	
	A	В	С	D	Set Objective: \$D\$3	
1		Chair	Table	Profit	Toy Max Min Value Of: 0	
2	Decision variables					
3	Contribution	20	30	0 0	By Changing Variable Cells:	
4						
5	Constraints				Subject to the Constraints:	
6	Machine 1	3	3	3 0	Add	
7	Machine 2	5	5 1	2 0		
8	Machine 3	1	2 (5 0	Change	
9						
10	NOTE: In the sh	aded cells	we need t	o apply the	f Delete	-

Next option is "By changing variables", in this problem, our variables are "Chairs" and "Tables". To select a range of cell B2:C2.

	Get External D)ata		Conne	olver Para	meters				×
B2		$f_x = S$	UMPRODUC	T(\$B\$2						
	A	В	С	D	Set Ob	jective:	\$D\$3			1
1		Chair	Table	Profit	Tor		•••	0.44	0	
2	Decision variables				10.	• <u>M</u> ax		O <u>v</u> alue Of:	0	
3	Contribution		20 30		By Cha	inging Variable Ce	lls:			
4					\$B\$2:5	\$C\$2				
5	Constraints				S <u>u</u> bjec	t to the Constraint	s:			
6	Machine 1		3 3	3					~	Add
7	Machine 2		5	2						
8	Machine 3		2 6	5						Change
9										_
10	NOTE: In the sh	aded ce	lls we need t	o annh						Delete
11	NOTE. In the sh	aued ce	is we need t	o apply						
12										<u>R</u> eset All

Now, the next option "subject to the constraints", Once you click on "Add" we will see below add constraint window.

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E6	• : × 🗸	fx =SUN	//PRODUCT	(\$B\$2:\$C\$	2,B6:C6)							
	А	В	С	D	E	F	G	н	1	J	K	L
1		Chair	Table	Profit								
2	Decision variables											
3	Contribution	20	30	0								
4												
5	Constraints				Maximum Capacity	Add Co. Train	nt					×
6	Machine 1	3	3	0	36	Coll Peferenc				Constraint		
7	Machine 2	5	2	0	50		е.	P22				P. 21
8	Machine 3	2	6	0	60	\$D\$0			= <u>·</u>	- \$530		HM
9												
10	NOTE: In the ch	adad calls	wo nood to	apply the	formulas	<u>O</u> K			Add		<u>C</u> ancel	
11	NOTE. III the sh	aueu cens	we need to	apply the	Tormulas							
12												

Click on "Add" to stay back in the same window. Now in the second constraint select the value as D7 and select "<=" and under constraint select G7 cell.

Similarly, for the third constraint select the value as D8 and select "<=" and under constraint select G8 cell.

After adding all constraints, Click on "Ok" to come out of Add Constraint window. Constraints are added like below. Now our all parameters are ready.

er Parame	eters				
Se <u>t</u> Objec	ctive:	\$D\$3			
То:	● <u>M</u> ax	<u>О Міп</u>	○ <u>V</u> alue Of:	0	
By Chang	ging Variable Ce	ells:			
\$B\$2:\$C	\$2				1
S <u>u</u> bject to	o the Constraint	ts:			
\$D\$6 <=	= \$E\$6			~	Add
\$D\$7 <=	= \$E\$7				
\$D\$8 <=	= \$E\$8				Change

Now tick check box for non-negative constraints and select "Simplex LP" as solving method from the drop down. Finally, Click on Solve.

Set Objective:	\$D\$3				
To: <u>Max</u>	() Mi <u>n</u>	◯ <u>V</u> alue Of:	0		
By Changing Variable Cells					
\$B\$2:\$C\$2					
Subject to the Constraints:					
\$D\$6 <= \$E\$6 \$D\$7 <= \$E\$7				Add	
\$D\$8 <= \$E\$8				Change	
				change	
				Delete	
				Reset All	
				/	
_				Load/Save	
Make Unconstrained V	ariables Non-Ne	gative			
Select a Solving Method:	Sin	nplex LP	~	Options	
Solving Method					
for linear Solver Problem	engine for Solve s, and select the	er Problems that are sm Evolutionary engine for	ooth nonlinear. Select the Solver problems that are	LP Simplex engine non-smooth.	
	,				
			¥		

Finally, the answers will appear on the screen as you can see in the shaded cells below.

	А	В	С	D	E	Solver Results	×					
1		Chair	Table	Profit								
2	Decision variables	3	9			Solver found a solution. All Constraints and						
3	Contribution	20	30	330		optimality conditions are satisfied.	Answer					
4						Keep Solver Solution Sensitivity Limits O Restore Original Values						
5	Constraints				Maximum Capacity							
6	Machine 1	3	3	36	36							
7	Machine 2	5	2	33	50	Return to Solver Parameters Dialog						
8	Machine 3	2	6	60	60							
9						OK Cancel	Save Scenario					
10	NOTE: In the ch	adad colls	we need to	annly the	formulas							
11	NOTE. III ule si	NUTE: In the shaded cells we need to apply the formulas										
12						satisfied.						
13		When the GRG engine is used, Solver has found at least a local optimal solution. When Simplex LP is used, this means Solver has found a global optimal solution.										
14												
15				/								
16				1								

Click Ok, to save the solution.

STEP 5: Write the final solution.

As per the given solution, firm can have maximum profit of \gtrless 330 by producing 3 chairs and 9 tables per week.

Question for Practice:

A diet is to contain at least 20 ounces of protein and 15 ounces of carbohydrate. There are three foods A, B, and C available in the market, costing Rs. 2, Re. 1, and Rs. 3 per unit respectively. Each unit of A contains 2 ounces of protein and 4 ounces of carbohydrate. Each unit of B contains 3 ounces of protein and 2 ounces of carbohydrate; each unit of C contains 4 ounces of protein and 2 ounces of carbohydrate. Formulate the LPP so as to minimize the cost of diet and solve using Excel Solver.