OMIS 2010 – Assignment 2 – Fall 2017
Section ___
Due Date:

Assignment Instructions (please read carefully)

1. Submit your assignment to the link posted on Moodle.
2. Make sure to upload it to the correct link by section.
3. Work can be done by group of 2-3 students. Groups can not consist of students from other sections of the course.
4. Only one person uploads the assignment, adding all names on the file.
   The files names should be of the form: "A2_LastName1_LastName2_LastName3.xlsx"
   LastName1 is the last name of student 1, LastName2 is the last name of student 2, etc.
5. You are free to discuss your approach with other individuals or pairs, but your write-up should be prepared independently by the person(s) submitting the assignment. It is a violation of the rules of academic honesty to copy someone else's assignment and present it as your own.
6. The assignment cover page is posted (see next page).
7. You should upload 3 files:
   a. A completed cover page.
   b. A Word or PDF file with the assignment answers. Each answer file should include screenshots of supporting work (Excel model & output) to accompany the relevant question.
   c. Excel file with your work [**always submit the Excel work to support your answer**]. Use different tabs to identify the answers to each individual question when needed.
8. Generally, answers should be typed on the computer (graphs can be generated manually and incorporated into the assignment document).
9. The assignments should be organized by question. That means every piece of information for that question is found in the same section of the report. Use labeling and titles to make sure all is clear. If I have to look for it, it is not organized. **Don't forget to add the Excel outputs if you used them to analyze the case.** You may use an appendix to give further details of your model or calculations if required.
10. Late work will not be accepted. (You will earn a grade of 0.)

OMIS 2010 – Assignment Cover Page
Fall 2017

Schulich School of Business

Assignment #:	2
Section:	

	Group Member 1	Group Member 2	Group Member 3
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Group can be minimum of 2 members and maximum of 3 members only from the same section.

Question 1 :

The Development Bank of Singapore Limited is a busy bank that has requirements for between 10 and 19 tellers, depending on the time of day.

The afternoon time, from noon to 3 p.m., is usually heaviest. The table below indicates the workers needed at various hours that the bank is open. The bank now employs 12 full-time tellers but also has several people available on its roster of part-time employees.

A part- time employee must put in exactly 4 hours per day but can start anytime between 9 a.m. and 1 p.m. Part-timers are a fairly inexpensive labor pool because no retirement or lunch benefits are provided for them. Full-timers, on the other hand, work from 9 a.m. to 5 p.m. but are allowed 1 hour for lunch. (Half of the full-timers eat at 11 a.m. and the other half at noon.) Each full-timer thus provides 35 hours per week of productive labor time. The bank's corporate policy limits part-time hours to a maximum of 50% of the day's total requirement. Part-timers earn $10 per hour (or $40 per day) on average, and full-timers earn $90 per day in salary and benefits, on average. The bank would like to set a schedule that would minimize its total personnel costs. It is willing to release one or more of its full-time tellers if it is cost-effective to do so.

Time	Number of workers required
9am-10am	10
10am-11am	12
11am-noon	14
Noon-1pm	16
1pm-2pm	19
2pm-3pm	17
3pm-4pm	15
4pm-5pm	10

a) Formulate this problem.

Min Z = 40P1 + 40P2 + 40P3 + 40P4 + 40P5 + 90F

Pi = Part time worker for the day; 1 = 9-1 , 2 = 10-2, 3 = 11-3, 4 = 12-4, 5 = 1-5

Fi = Full time worker for the day; 1 = break at 11, 2 = break at 12

P1+F1+F2 >= 10;	workers required for 9-10
P1+P2+F1+F2 >= 12;	workers required for 10-11
P1+P2+P3+F2 >= 14;	workers required for 11-12
P1+P2+P3+P4+F1 >= 16;	workers required for 12-1
P2+P3+P4+P5+F1+F2 >= 19;	workers required for 1-2
P3+P4+P5+F1+F2 >= 17;	workers required for 2-3
P4+P5+F1+F2 >= 15;	workers required for 3-4
P5+F1+F2 >= 10;	workers required for 4-5
4P1+4P2+4P3+4P4+4P5 <= 56.5;	corporate policy limits constraint
P1, P2, P3, P4, P5, F1, F2 >= 0;	non-negativity
P1, P2, P3, P4, P5, F1, F2 = int.;	integer constraint

b) Solve using Solver, provide the Excel output.

Q1								
	LHS coefficients							
Constraints	**P1**	**P2**	**P3**	**P4**	**P5**	**F1**	**F2**	**RHS**
#1	1					1	1	10
#2	1	1				1	1	12
#3	1	1	1				1	14
#4	1	1	1	1		1		16
#5		1	1	1	1	1	1	19
#6			1	1	1	1	1	17
#7				1	1	1	1	15
#8					1	1	1	10
#9	1	1	1	1	1	1	1	10
#10	1	1	1	1	1	1	1	19
#11	4	4	4	4	4			56.5
OBJ.FUNC.COEFF.	40	40	40	40	40	90	90	
	Decision Variables							
	1	2	2	5	1	0	9	
	Max/Min Objective Function						1250	

Contraints	**Amount Used**	**Sign**	**Amount Available**
1	10	>	10
2	12	>	12
3	14	>	14
4	19	>	16
5	19	>	19
6	17	>	17
7	15	>	15
8	10	>	10
9	20	>	10
10	20	<	19
11	53	<	56.5

Final Value: Min = 40(1) + 40(2) + 40(2) + 40(5) + 40(1) + 90(0) + 90(9) = $1250

Question 2 :

Roedel Electronics produces tablet computer accessories, including integrated keyboard tablet stands to connect a keyboard to a tablet device while optimizing the viewing angle of the screen. Roedel produces two sizes of tablet stands: large and small. Each size uses the same keyboard attachment, but the stand consists of two different pieces, a top flap and a vertical stand that differ by size. Thus, a completed integrated keyboard tablet stand consist of 3 subassemblies: a keyboard, a top flap and a vertical stand.

Roedel's sales forecast indicates that 7000 small integrated keyboard tablet stands and 5000 large integrated keyboard tablet stands will be needed to satisfy demand during the upcoming Christmas season. Because only 500 hours of in-house manufacturing time are available, Roedel is considering purchasing some, or all, of the subassemblies from outside suppliers. If Roedel manufactures a subassembly in-house, it incurs a fixed setup cost as well as a variable manufacturing cost. The following table shows the setup cost, the manufacturing time per subassembly, the manufacturing cost per subassembly and the cost to purchase each of the subassemblies from an outside supplier:

Subassembly	Setup Cost ($)	Manufacturing Time /Unit (min)	Manufacturing Cost/Unit (S)	Purchase Cost/Unit ($)
Keyboard	1000	0.9	0.40	0.65
Small top flap	1200	2.2	2.90	3.45
Large top flap	1900	3.0	3.15	3.00
Small vertical stand	1500	0.8	0.30	0.50
Large vertical stand	1500	1.0	0.55	0.70

a) Formulate a linear program to solve this problem. Clearly define all variables.

1=keyboard; 2=small top flap; 3= large top flap; 4=small vertical stand; 5=large vertical stand

x_i = manufacturing cost; i = 1, 2, 3, 4, 5

y_i = Whether the subassembly is set up or not; 1 = set up, 0 = not set up; i = 1, 2, 3, 4, 5

p_i = purchasing cost; i=1, 2, 3, 4, 5

Min Z = 1000y1 + 1200y2 + 1900y3 + 1500y4 + 1500y5 + 0.4x1 + 2.9x2 + 3.15x3 + 0.3x4 + 0.55x5 + 0.65p1 + 3.45p2 + 3p3 + 0.5p4 + 0.7p5

x1 + p1 >= 12000;	Demand Constraint
x2 + p2 >= 7000;	Demand Constraint
x4 + p4 >= 7000;	Demand Constraint
x3 + p3 >= 5000;	Demand Constraint
x5 + p5 >= 5000;	Demand Constraint
0.9x1 + 2.2x2 + 3x3 + 0.8x4 + x5 <= 30000;	Manufacturing time constraint (minutes)
x1 <= 12000y1;	Setup cost
x2 <= 7000y2;	Setup cost
x3 <= 7000y3;	Setup cost
x4 <= 5000y4;	Setup cost
x5 <= 5000y5;	Setup cost
xi, yi, pi, >= 0 for all i;	non-negativity
yi = binary for all i;	binary, use vs non use

b) Create an Excel model to solve this problem. Determine how many of each subassembly Roedel should manufacture and how many units of each subassembly Roedel should purchase. What is the total manufacturing and purchase cost associated with your recommendation?

	LHS coefficients															
Constraints	**x1**	**x2**	**x3**	**x4**	**x5**	**y1**	**y2**	**y3**	**y4**	**y5**	**p1**	**p2**	**p3**	**p4**	**p5**	**RHS**
#1	1										1					12000
#2		1										1				7000
#3				1										1		7000
#4			1										1			5000
#5					1										1	5000
#6	0.9	2.2	3	0.8	1											30000
#7	1															12000
#8		1														7000
#9			1													0
#10				1												0
#11					1											0
OBJ.FUNC.COEFF.	0.4	2.9	3.15	0.3	0.55	1000	1200	1900	1500	1500	0.65	3.45	3	0.5	0.7	
	Decision Variables															
	12000	7000	0	0	0	1	1	0	0	0	0	0	5000	7000	5000	
	Max/Min Objective Function					49300										

Contraints	**Amount Used**	**Sign**	**Amount Available**
1	12000	>	12000
2	7000	>	7000
3	7000	>	7000
4	5000	>	5000
5	5000	>	5000
6	26200	<	30000
7	12000	<	12000
8	7000	<	7000
9	0	<	0
10	0	<	0
11	0	<	0

Min Z = 1000 + 1200 + 0.4(12000) + 2.9(7000) + 3(5000) + 0.5(7000) + 0.7(5000) = 49300

c) Suppose Roedel is considering purchasing new machinery to produce large top flaps. For the new machinery, the setup cost is $3000; the manufacturing time is 2.5 minutes per unit, and the manufacturing cost is $2.60 per unit. Assuming that the new machinery is purchased, determine how many units of each subassembly Roedel should manufacture and how many units of each subassembly Roedel should purchase. What is the total manufacturing and purchase cost associated with your recommendation? Do you think the new machinery should be purchased? Explain.

The new machinery should not be purchased. Roedel will still save more money purchasing the units than producing them in-store. (2.6*5000 + 3000 = 16000) > (3*5000 = 15000)

Question 3

AppliancesЯUs (AЯU) has decided to introduce their own store-brand that they will call "PDQ". Eight product lines of appliances are being considered as shown in the table below, along with the money that would be need to stock inventory and the floor space, in square meters, required for displays. The expected contribution margin for each product line is also shown in the table. As AЯU has limited funds and floorspace, decisions must be made with respect to which product lines to carry.

Knowing that choices will have to be made, management has also decided:

- If washers are carried, dryers will also be carried, and vice versa.
- All three types of large kitchen appliances (refrigerators, dishwashers and electric ranges) will be carried or not at all.
- Gas Ranges will only be carried if Electric Ranges are carried.

Product Line	Code	Inventory$	Floor Space	Contribution
Washers	WA	180,000	12	22,500
Dryers	DR	75,000	12	6,750
Refrigerators	RE	250,000	25	31,500
Dishwashers	DW	210,000	10	31,200
Elect. Ranges	ER	240,000	15	33,000
Gas Ranges	GR	200,000	6	28,000
Freezers	FR	150,000	20	14,250
Microwaves	MW	50,000	8	4,250
Available		700,000	60	

Formulate and solve AppliancesЯUs' product line problem. Use the symbols in the "Code" column for variable names. What would be the expected contribution margin?
Should additional working capital be found to be able to carry a more lucrative combination of product lines. What would be expected contribution margin if $800,000, $900,000 or $1,000,000 for inventory investment were available?

Max Z = 22500WA + 6750DR + 31500RE + 31200DW + 33000ER + 28000GR + 14250FR + 4250MW

180000WA + 75000DR + 250000RE + 210000DW + 240000ER + 200000GR + 150000FR + 50000MW <= 700000; total investment opportunity
12WA + 12DR + 25RE + 10DW + 15ER + 6GR + 20FR + 8MW <= 60; floor space constraint

WA – DR = 0;	washer and dryer constraint
2RE – DW – ER = 0;	kitchen appliance constraint
ER – GR >= 0;	range appliance constraints
WA, DR, RE, DW, ER, GR, FR, MW = binary;	binary constraint
WA, DR, RE, DW, ER, GR, FR, MW >= 0;	non-negativity

Expected Contribution Margin, $700000 Investment, $95700 contribution margin

	LHS coefficients								
Constraints	**WA**	**DR**	**RE**	**DW**	**ER**	**GR**	**FR**	**MW**	**RHS**
#1	180000	75000	250000	210000	240000	200000	150000	50000	700000
#2	12	12	25	10	15	6	20	8	60
#3	1	-1							0
#4			2	-1	-1				0
#5					1	-1			0
#6									
#7									
#8									
#9									
#10									
#11									
OBJ.FUNC.COEFF.	22500	6750	31500	31200	33000	28000	14250	4250	
	Decision Variables								
	0	0	1	1	1	0	0	0	
	Max/Min Objective Function					95700			

Contraints	**Amount Used**	**Sign**	**Amount Available**
1	700000	<	700000
2	50	<	60
3	0	=	0
4	0	=	0
5	1	>	0

Expected Contribution Margin, $800000 investment, $99950 contribution margin

	LHS coefficients								
Constraints	**WA**	**DR**	**RE**	**DW**	**ER**	**GR**	**FR**	**MW**	**RHS**
#1	180000	75000	250000	210000	240000	200000	150000	50000	800000
#2	12	12	25	10	15	6	20	8	60
#3	1	-1							0
#4			2	-1	-1				0
#5					1	-1			0
#6									
#7									
#8									
#9									
#10									
#11									
OBJ.FUNC.COEFF.	22500	6750	31500	31200	33000	28000	14250	4250	
	Decision Variables								
	0	0	1	1	1	0	0	1	
	Max/Min Objective Function					99950			

Contraints	**Amount Used**	**Sign**	**Amount Available**
1	750000	<	800000
2	58	<	60
3	0	=	0
4	0	=	0
5	1	>	0

Expected Contribution Margin, $900000 investment, $123700 contribution margin

	LHS coefficients								
Constraints	**WA**	**DR**	**RE**	**DW**	**ER**	**GR**	**FR**	**MW**	**RHS**
#1	180000	75000	250000	210000	240000	200000	150000	50000	900000
#2	12	12	25	10	15	6	20	8	60
#3	1	-1							0
#4			2	-1	-1				0
#5					1	-1			0
#6									
#7									
#8									
#9									
#10									
#11									
OBJ.FUNC.COEFF.	22500	6750	31500	31200	33000	28000	14250	4250	

	Decision Variables							
	0	0	1	1	1	1	0	0

Max/Min Objective Function 123700

Contraints	Amount Used	Sign	Amount Available
1	900000	<	900000
2	56	<	60
3	0	=	0
4	0	=	0
5	0	>	0

Expected Contribution Margin,

	LHS coefficients								
Constraints	**WA**	**DR**	**RE**	**DW**	**ER**	**GR**	**FR**	**MW**	**RHS**
#1	180000	75000	250000	210000	240000	200000	150000	50000	1000000
#2	12	12	25	10	15	6	20	8	60
#3	1	-1							0
#4			2	-1	-1				0
#5					1	-1			0
#6									
#7									
#8									
#9									
#10									
#11									
OBJ.FUNC.COEFF.	22500	6750	31500	31200	33000	28000	14250	4250	

	Decision Variables							
	0	0	1	1	1	1	0	0

Max/Min Objective Function 123700

Contraints	Amount Used	Sign	Amount Available
1	900000	<	1000000
2	56	<	60
3	0	=	0
4	0	=	0
5	0	>	0