AMERICAN UNIVERSITY OF BEIRUT

SULIMAN OLAYAN SCHOOL OF BUSINESS

DCSN 200: OPERATIONS MANAGEMENT

MIDTERM EXAM SAMPLE

NAME _____

STUDENT ID _____

SECTION _____

INSTRUCTOR _____

This exam is administered in full observance of the Olayan School of Business Honor Code and the penalties it sets for violations of the standard of academic conduct. You are required to fully understand the code and to strongly adhere to it. In particular, cellular telephones, and computers of any shape or size are not allowed. No questions, no comments, no borrowing and no disturbance of the peace of any kind will be permitted or tolerated. You are required to stop working on the exam and hand it immediately when a proctor instructs you to do so. Any cheating or attempted cheating will subject the offender to a zero on the exam and a referral to the Student Affairs Committee for further penalties.

- Do not start the exam (do not turn to the next page) until instructed to do so
- You have 2 hours to complete the exam. You can answer questions in any order
- Your understanding of the questions is part of the exam. No questions will be answered by instructors. If in doubt, write your assumptions and continue solving
- When you start the exam, make sure that your exam paper has 12 pages
- You must hand in every page of the exam when you finish, including the formula sheet. If any page has become detached, your name must be written on it

  - "I vow to complete the exam on my own without giving or receiving help from anyone and to adhere to the academic integrity standards reflected in the AUB student code of conduct"

SIGNATURE _____

Write your answers in the space provided. Be concise and follow the instructions closely. If you run out of space, continue on the back of the previous page, but indicate this fact clearly.

PART I.

SHORT ANSWERS for SHORT QUESTIONS

1. **(2 points)** List two reasons why a company may wish to move all or part of its operations overseas

   1 point for each reason

2. **(3 points) Bangalore (**also known as Bengaluru) is the capital of the state of Karnataka in India. Today as a large city and growing metropolis, Bangalore is home to many of the most well-recognized colleges and research institutions worldwide. Moreover, Bangalore is known as the *Silicon Valley of India* because of its position as the nation's leading IT exporter. Give two reasons why (to your opinion) Bangalore - despite more expensive rent and higher standard of living - keeps attracting small and large IT companies.

   1 reason for each answer and 1 for the short explanation

3. **(3 points)** A service blueprint partitions the customer's interaction with the process into three segments, name them and explain in FEW words each segment

   Correct it in two stages. Stage 1: Give 1 point for each level. Second stage you check the explanation of the three levels. If it is not convincing you take one point on the total.
   (example three good answers no explanation: 3 -1 =2

4. **(1 point)** Describe the difference between production and productivity

5. **(1 point)** Name one tool that can be used to translate customer wants into a viable product design

6. **(2 points)** Explain briefly what mass customization means
   One point for each

7. **(2 points)** Mobile phone company Nikoa produces the model T1000 phone and the new model T2000. Sales for the T1000 have fallen in North America, due to competition and Nikoa's own newer model. The company sees an opportunity to continue to sell the T1000 in central and southern Africa, in countries such as Mozambique. What potential *disadvantages* of this strategy should Nikoa's senior management keep in mind?

   Sol. brand dilution, accusations of bias, complexity of maintaining manufacturing for older product, difficulty of forecasting demand. Any two sensible points (1 mark each)

SHORT ANSWERS for SHORT PROBLEMS

1. **(3 points).** AUB Olayan School of Business (OSB) has the facilities and faculty to handle an enrollment of 1800 new students per semester. However, in an effort to limit class size to a

"reasonable" level (25, generally) Dean Najjar, placed a ceiling on enrollment of 1500 new students. Although there was ample demand for business courses last semester, conflicting schedules allowed only 1200 new students to take business courses

The OSB utilization rate is **67**% and efficiency rate is **80**%;
1point for each and **1 point** for stating at least the ratios Uti=1200/1800 and Eff=1200/1500

2. **(3 points).** The weekly output of a production process is shown below, together with data for labor and material input. The standard value of the output is $125 per unit. Labor costs are $16 per hour per employee; a work week is 40-hours. In addition to labor costs, overhead is charged weekly at the rate of $1500 plus .5 times the labor cost. Material cost is $10 per running meter (M). Calculate the weekly multifactor productivity.

Output/ units	Number of Worker	Material (M)
412	6	2840

I point for writing that multifactor productivity is output divided by input.
Output: 412*125 (0.5 point)
Input:
Labor: 40*16*6 (0.5 point)
Overhead: 1500+0.5*labor (0.5point)
Material: 2840*10 (0.5 point)

Productivity=Output/input=1.44

PART II.
Question 1 (12points)
Faraya Village Club, a ski-resort in Lebanon, is planning the ski lift operation for 2011/2012. Management is trying to determine whether one or two lifts will be necessary. Each lift can

accommodate a maximum of 250 people per day. Skiing occurs in the 14-week period from December to April, during which the lift will operate 7 days per week.

During bad economic conditions, it is expected that the first lift will operate at 90% capacity and a second lift, if built, would remain idle; the probability of bad economic conditions is believed to be 30%.

During normal economic conditions the first lift will operate at 100% capacity, and if there is a second lift it will realize 50% utilization. The probability of normal economic conditions is 50%.

Finally, if economic conditions are really good, the probability of which is 20%, the utilization of the second lift can increase to 90%.

The annual cost of installing one new lift is $50,000. The annual cost of installing two lifts is only $90,000. If used at all, each lift costs $200,000 to operate, no matter how low or high its utilization rate. Lift tickets are priced at $20 per customer per day.

As Operation Manager of Faraya Village Club would you purchase one lift or two? Carefully explain your answer.

Solution.

We need to make the decision of whether to purchase one or two lifts (we could also eventually decide not to purchase anything if total profit is negative). For each decision there are possible outcomes of the economy bad normal and good
The maximum revenues per lift is **(250*7*14)*20=490000**

If one purchases one lift: we have two options either full capacity or 90% capacity
Revenues if Economy low: 0.9 *490000=441000
Reveues if economy is moderate or high=490000
Total cost=250000
Expected Profit=441000*0.3+490000*0.7 –250000=225300

If one purchases two lifts
Profit if economy is low: 441000-(200000-90000)=151000
Profit if economy is moderate: 1.5*490000- (2*200000-90000)=245000
Profit if economy is high: 1.9*490000- (2*200000-90000)=441000
Expected profit = 0.3*151+0.5*245+0.2*441=256000

Hence you should buy two lifts if you are risk neutral decision maker

Question 2 (16points)
You are the operations manager at Zara, Lebanon. The Managing Director is about to introduce the 2011 summer collection for the three categories: Women, Kids and Men. She wants to be sure that these various categories are profitable (i.e. they reach breakeven point during the

season). At a recent meeting, she asked you to develop a break-even analysis. Each category will be considered as one product. The estimated variable costs for each category are as follows: $150 for Women, $75 for Kids and $50 for Men. The expected marginal revenues as set by sales are: $350 for Women, $200 for Kids, and $150 for Men. Additional costs include the salaries for designers $40,000 for each category; rental space: 5,000 square meters manufacturing space per category at $6 per square meter. Based on a marketing study, the sales of Women, Kids and Men should account for 45%, 35% and 20% of total sales respectively.

a. **(6 points)** What is your break-even point in dollars for all categories combined?

Fixed costs: (40+30)*3=210K. 2 points. Any small mistake one point off.

	V	P	weights	1-V/P	w*(1-V/P)
W	150	350	45	0.571429	25.71428571
K	75	200	35	0.625	21.875
M	50	150	20	0.666667	13.33333333
					60.92261905

BEP$=F/0.61=$344700 of sales needed to reach breakeven
Every mistake in going through these is one point off.

b. **(4 points)** At breakeven what are the sales AND quantity sold for the women category?

BEP$(W)=BEP$*w(women)=344700*0.45=$155100
BEPX(W)= BEP$(W)/P(W)= $155100/350=443

2 points for each. Each mistake take one point

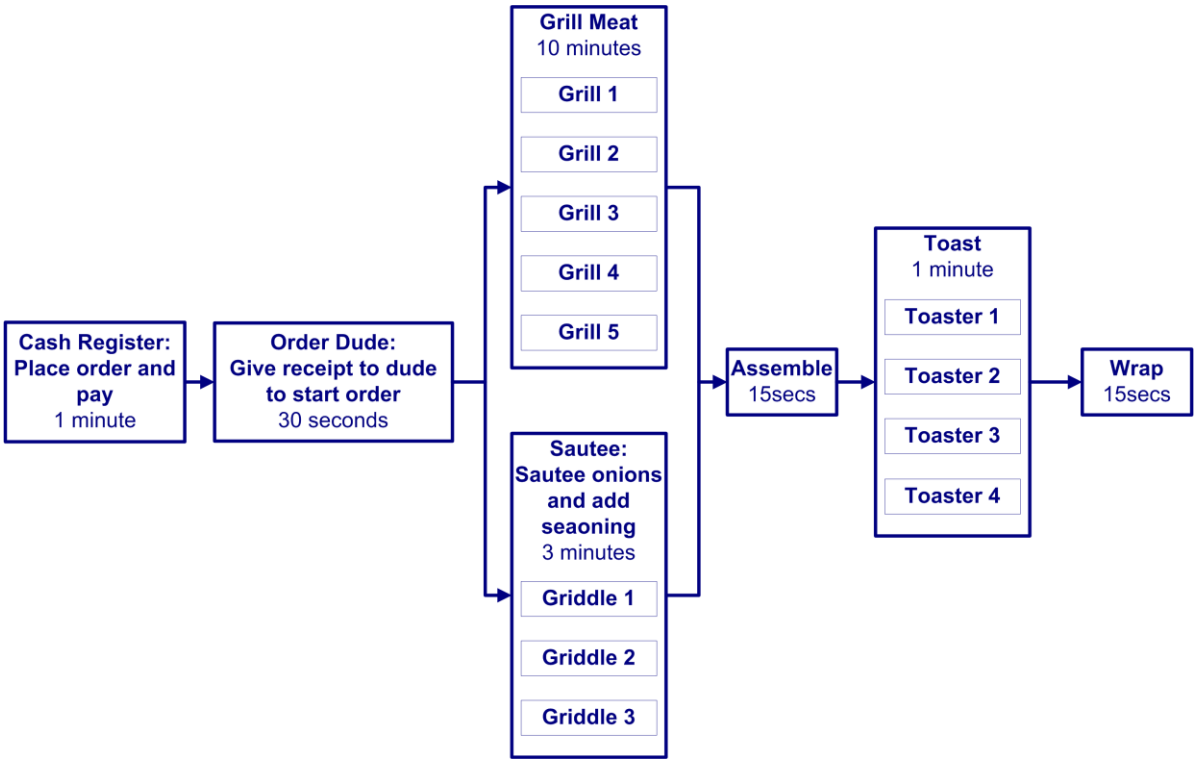
c. **(6 points)** Suppose you expect 90000 customers to visit your store in the coming season. What if each customer spends (on average) $100. How much (positive or negative) profit you will incur at the end of the season? Would you breakeven?

Each 100$ represents 45$ on women stuff 35$ on Kids and 20$ on men.
The total contribution per customer is 45*0.57 + 35*0.625 +20*0.67=$60.92 (no calculations already done!)
Hence total profit from 90K customers
Is 90K * 60.92-210000=$5273035

Any interesting (even wrong approach is 2 points)
Otherwise one point off for each mistake if the logic is there…

Question 3 (21points)

Those of you who have eaten at Bliss House know that they have a very efficient production process. But is it as efficient as possible? Sandwich preparation at Bliss is as follows: customers place and pay for their order, they give the receipt to the bald dude who shouts their order, the meat is then grilled while, simultaneously, the onions/mushrooms/peppers are sautéed with seasonings, the meat and sautéed items are then assembled in a sandwich, which is toasted, and wrapped. This process is depicted below: each box represents a step in the process and specifies the time required by the person/machine used for that step. Note there are five grilling machines, three griddles for sautéeing, and four toasters.



1. (3 points) What is the process cycle time of this process?

   Sol. 60+30+600+15+60+15=13minutes

   Summing griddle +grill =13 is one point off
   Using 2 minutes instead of 10 is 1 point off and so on for each mistake

2. (4 points) Where is the bottleneck? Explain. Would the bottleneck be affected if one griddle is out of order?
   Bottleneck is smallest capacity which could also be identified as the longest processing time/unit and that is clearly the grill with 10/5=2min/order
   If the griddle is affected the capacity of the griddle goes down and that will make the processing time of the griddle =1.5minutes still faster than the grill. ANSWER is the no!

3. (3 points) What is the process time of the system?
   The process time is 2min/order

4. (5 points) It is forecasted that in one day (1day = 20 hours), Bliss House experiences demand for 750 sandwiches. Does the current production process have the capacity to accommodate this demand? Explain.

and the capacity is 30orders/hour (2 points even if the capacity was obtained at an earlier stage)
Total capacity per day is 20*30=600orders/day (2 points)
And so no you cannot meet that demand. There is space for improvement (1 point for conclusion)

5. (6 points) Assume that the marginal profit from one sandwich is $2. Bliss house has capital of up to $250000 that can be invested to improve the business and increase capacity. The cost of a new toaster is $50000; the cost of a new grill is $125000; and that of a new griddle is $75000. We assume that Bliss House will undertake an investment if that investment generates, in the next two years, additional profits that cover the initial capital; (1 year = 350 days). Having in mind your previous analysis (1-4), what do you recommend Bliss House does?

Clearly from the previous question there is space for improvement and that can only happen by investing in the bottleneck.

By buying one new grill the capacity increases from 30orders/hour to 6/10*60=36orders/hour=36*20=720orders/day.

Additional Profit=2*(120*350*2)=$168000 which covers for the cost of the grill

Net profit=168-125=$43K

But you could eventually buy another grill but that will only improve your revenue by another 2*((750-720) *350*2)=$42000 which is much smaller than the griddle cost.

Do not invest in the second grill!!!

Be lenient on this one: two stages

Stage 1: as long as they go through some calculations that show they are moving in the right directions 3 points.

Stage 2: 3 additional points if they get to the end of the logic. Take off one (out of 3 points) for each mistake at this stage.

Question 4 (12 points)

A farmer has a peanut crop of 1,000 kg; 40% of which of top quality, the rest of standard quality. The peanuts can be sold as seed (S), for processing (P) and whole for roasting (R). The contribution margins per kg are $0.7, $0.65 and $0.9 for S, P and R respectively. At these prices, 300kg, 400kg and 500kg of S, P and R respectively can be sold. Peanuts destined for roasting (R) must contain at least 75% top quality nuts; and seed peanut (S) must contain at least 50% top quality nuts; while process peanuts (P) can all be standard quality, if necessary. [70 Marks] a. Write down a linear program to determine the sale plan (define objective and variables clearly)

Solution:

Let S,P,R= Quantity produced for Seed, Processing and Roasting, respectively.

Max 0.7 S + 0.65 P+ 0.9 R
s.t.
$S \leq 300$
$P \leq 400$
$R \leq 500$
$0.5\,S + 0.25\,R \leq 600$
$0.5\,S + 0.75\,R \leq 400$
$S + P + R \leq 1000$
$S, P, R \geq 0$

Question 5 (20 points)

Odeh Nuts produces 5 different types of nut mixes (Mix 1, Mix 2, Mix 3, Mix 4, Mix 5) by combining in precise proportions five types of raw nuts. The data table below specifies the exact number of ounces of each type of raw nuts that must be in each pound of each mix (**Note: a pound = 16 ounces**).
Nuts must be processed prior to use and there are limits on how many ounces of each type of raw nuts can be processed per day. These limits are shown in the 'Capacity' column of the table.
Mixes 1, 3 and 4 are 'fancy' mixes, of which no more than 1100 pounds in total may be sold in a day.
The 'Orders on hand' row in the table indicates orders that must be filled by the production plan. The objective is to maximize total profit.
The tables below provide the Model, the Solution, the Answer Report, and the Sensitivity Analysis.

Odeh Nuts Company Data

	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Capacity	cost/oz
Almonds	4	1	4		1	5000	$0.14
Brazils	8	1		2	2	4800	$0.17
Cashews	3	1		8	5	7000	$0.23
Filberts		1	5	6	3	8000	$0.18
Peanuts	1	12	7		7	9000	$0.10
Rev/lb	$4.00	$3.00	$3.30	$4.50	$3.00		
Orders on hand (lbs)	400.00	500.00	100.00	200.00	0.00		
Profit/lb	$1.29	$1.08	$1.14	$1.24	$0.13		

Odeh Nuts Company Answer Report

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$G$10	profit per unit Total Profit	$2,012.00	$2,012.00

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$7	pounds M1	400	400	Contin
$C$7	pounds M2	600	600	Contin
$D$7	pounds M3	200	200	Contin
$E$7	pounds M4	500	500	Contin
$F$7	pounds M5	0	0	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$G$13	Almonds Lhs	3000	$G$13<=$I$13	Not Binding	2000
$G$14	Brazils Lhs	4800	$G$14<=$I$14	Binding	0
$G$15	Cashews Lhs	5800	$G$15<=$I$15	Not Binding	1200
$G$16	Filberts Lhs	4600	$G$16<=$I$16	Not Binding	3400
$G$17	Peanuts Lhs	9000	$G$17<=$I$17	Binding	0
$G$18	Fancy mix Lhs	1100	$G$18<=$I$18	Binding	0
$G$19	Mix 1 Order Lhs	400	$G$19>=$I$19	Binding	0
$G$20	Mix 2 Order Lhs	600	$G$20>=$I$20	Not Binding	100
$G$21	Mix 3 Order Lhs	200	$G$21>=$I$21	Not Binding	100
$G$22	Mix 4 Order Lhs	500	$G$22>=$I$22	Not Binding	300

Odeh Nuts Company Sensitivity Report

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$7	pounds M1	400	0	1.29	1.711935484	1E+30
$C$7	pounds M2	600	0	1.08	1.494285714	0.996785714
$D$7	pounds M3	200	0	1.14	0.73	0.871666667
$E$7	pounds M4	500	0	1.24	2.06	0.520294118
$F$7	pounds M5	0	-0.900322581	0.13	0.900322581	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$G$13	Almonds Lhs	3000	0	5000	1E+30	2000
$G$14	Brazils Lhs	4800	0.282580645	4800	258.3333333	442.8571429
$G$15	Cashews Lhs	5800	0	7000	1E+30	1200
$G$16	Filberts Lhs	4600	0	8000	1E+30	3400
$G$17	Peanuts Lhs	9000	0.066451613	9000	9300	1550
$G$18	Fancy mix Lhs	1100	0.67483871	1100	221.4285714	129.1666667
$G$19	Mix 1 Order Lhs	400	-1.711935484	400	70.45454545	43.66197183
$G$20	Mix 2 Order Lhs	600	0	500	100	1E+30

$G$21	Mix 3 Order Lhs	200	0	100	100	1E+30
$G$22	Mix 4 Order Lhs	500	0	200	300	1E+30

Based on the provided material only, i.e., without resolving, address the following issues, each of which is independent of the others.

1. The shadow price associated with the constraint on capacity for Brazil nuts has a value of 0.28258 in the Sensitivity Report. What is the unit of measure of this number? Explain.

   $/ounce. (The objective function is measured in $. The constraint in Row 14 is measured in ounces [of Brazil nuts].)

2. Marketing proposes increasing the selling price of Mix 1 by $1.50 per pound. Based upon the Sensitivity Report, explain what impacts this price increase will have on the optimal production plan and on the optimal profit. If the optimal profit does change, compute the new optimal profit.

   The profit coefficient of M1 increases by $1.50, which is smaller than the Allowable Increase of 1.71. Therefore, the optimal solution does not change and it is still optimal to make 400 pounds of Mix 1. The new level of optimal profit is: $2,012 + 1.50(400) = $2,612.

3. Production proposes acquiring new equipment for processing Brazil nuts. The impact of this new equipment is a 10 pound (i.e., 160 ounces) increase in the amount of Brazil nuts that can be processed per day. The prorated cost of this new equipment is estimated at $30 per day. Do you recommend that the new equipment be acquired? What is the impact of the new equipment on the optimal profit?

   A 10 pound increase in the processing capacity of Brazil nuts implies that the RHS of the capacity constraint in Row 14 increases by 160 ounces. Since this increase is less than the Allowable Increase of 258.33 ounces, the shadow price of $0.28258 per ounce holds for all 160 ounces. Optimal profit will increase by 160 × 0.28258 = $45.21.
   Since this daily benefit exceeds the $30 daily cost, it should be purchased.

4. Assume that the new equipment (that increases processing capacity for Brazil nuts by 160 ounces per day) is indeed bought. Will you still produce Mixes 1 to 4 to the exclusion of Mix 5, or will the Mixes participating in the production plan change? Explain.

Since the shadow prices will still hold, the production plan will still be the same.

5. Order processing indicates that the standing orders for Mix 1 could be increased to 450 pounds. What will be the net impact on optimal profit if this increase is approved?

The RHS of the constraint in Row 19 increases by 50 pounds. Since the Allowable Increase is 70.45 pounds, the shadow price of $-1.71 per pound holds for all 50 pounds. Optimal profits will **decline** by $1.71 × 50 = $85.50.

6. By how much should the revenue/pound (selling price) of Mix 5 increase before it can become a candidate for production?

The reduced cost of Mix 5 = -0.9. Hence, it should increase by $0.9.

7. The new product development team proposes introducing a new "fancy" mix, Mix 6. (If Mix 6 is introduced, there will now be four fancy mixes: Mixes 1, 3, 4, and 6.) Each pound of Mix 6 will contain exactly 1 ounce of almonds, 3 ounces of Brazils, 5 ounces of cashews, and 2 ounces of peanuts. What is the minimum selling price per pound that is needed in order to make the production of Mix 6 profitable?

The total cost per ounce of this new mix is the sum of direct costs + opportunity costs, the shadow prices of the constraints involved:

	proportion	Cost ($/oz)	Shadow Cost	Total Cost	
Almonds	1.00	$0.14	0	$0.1400	
Brazils	3.00	$0.17	0.282581	$0.4526	
Cashews	5.00	$0.23	0	$0.2300	
Peanuts	2.00	$0.10	0.066452	$0.1665	
Fancy	1.00	$0.00	0.674839	$0.6748	
					3.655484

3.655484 = sumproduct(column 2, column 5).

The selling price of Mix 5 must be at least $3.66 per pound.

8. Advertising proposes that a $100 promotion be undertaken to increase the demand for fancy mixes (Mixes 1, 3, and 4). It is estimated that as a result of this promotion, the demand for these mixes will increase from its current level of 1,100 pounds to 1,500 pounds. Do you recommend spending the $100 on this promotion?

Increase the RHS of the constraint in Row 18 by 500. The Allowable Increase is only 221.4. The benefit generated by an increase of this quantity = 222.4* shadow price of Row 18: 221.4*0.6748) = 149.40.
Since the constraint in Row 18 is a "≥" constraint, optimal profits will increase by at least $149.40, which exceeds the cost of the promotion. Do it!