AMERICAN UNIVERSITY OF BEIRUT

Suliman S. Olayan School of Business

DCSN 205 – Managerial Decision Making

Fall 2010–2011 Final Exam

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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, mobile 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. Please, sign the following pledge.

"I fully understand and strongly adhere to the School of Business Honor Code. 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."

Your Signature: _____

Your Name and ID: _____

Select Your Section [1 mark]:

Instructor	Section	Days and Times	Selection
Dr. Neil Yorke-Smith	2	MWF 10:00am–10:50am	☐
	3	MWF 1:00pm–1:50pm	☐
Dr. Walid Nasr	4	TR 9:30am–10:45am	☐
	5	TR 11:00am–12:15pm	☐
Dr. Krzysztof Fleszar	6	TR 2:00pm–3:15pm	☐
	7	TR 3:30pm–4:45pm	☐

- This exam has 5 exercises, for a total of 100 points. You have 2 hours to complete it.
- Write your answers in the spaces provided. Be *concise* and follow the instructions closely. If you run out of room for an answer, continue on the back of the page.
- 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.
- Do not start the exam (do not turn to the next page) until instructed to do so.
- Once you begin, it is your responsibility to check that your paper contains 12 pages.

Formulas for M/M/1	$U = \lambda/\mu$	$P_0 = 1 - U$	$W = 1/(\mu - \lambda)$	$L = \lambda W$
	$P_w = U$	$P_n = UP_{n-1}$	$W_q = W - 1/\mu$	$L_q = \lambda W_q$

Exercise 1

A bank manager is considering hiring either Teller A or Teller B. Teller A can service a customer with an average of 6 minutes and a standard deviation of 4 minutes. Teller B can service each customer in exactly 6.5 minutes. The manager knows that the arrival rate of customers follows a Poisson process with an average inter-arrival time of 8 minutes. The manager wants to minimize the average time a customer has to wait in queue to see the teller.

1. Using the Kendall notation, write the symbols of the two queuing systems, one if Teller A is hired and the other if Teller B is hired. [2]

2. With the information given, can you recommend hiring Teller A or Teller B? Clearly justify your answer. [4]

3. If you hire Teller B and the time between inter-arrivals is now exactly 8 minutes, what is the average waiting time of customers? Explain. [4]

Exercise 2

Your company has successfully developed a new product and is considering its introduction into the market. However, a rival company has just announced that it will have a similar product available in one year that will directly compete with your newly developed product.

You estimate that if the new product is introduced, there is a 60% probability that it will be superior to your competitor's product. If your company's product is superior, then your company will earn a profit of 10 million USD; otherwise your company will lose 6 million USD.

Your company is also considering an option of waiting one year before introducing the new product in order to learn more about the competitor's product. If your company waits one year and then discovers that your product is in fact superior, then your profit is 4 million USD. If it turns out that your product is not superior, then your company can update its product and make a profit of 1 million USD.

1. Which decision alternative maximizes expected profit? Justify. 4

2. Which decision alternative minimizes maximum regret? Justify. 4

3. If you were able to hire a consultant who could tell you today with 100% certainty whether your product is superior, how much would you be willing to pay the consultant if you are looking to maximize expected profit? [4]

Exercise 3

A clinical assistant to the doctor's office wants to study the amount of time a patient spends waiting for a doctor. She decides to use simulation to estimate this waiting time. The doctor's office has two doctors working during the day, Doctor A and Doctor B. Patients wait for doctors in a single FIFO queue. Each patient is served by the first doctor that becomes available and then leaves the office. If a patient finds both doctors available, then the patient is served by Doctor A.

From empirical study, the following probability distributions on the time between arrivals of patients and on the doctors' service time (the same for both doctors) are available:

Patient inter-arrival time (in minutes)	Probability
1	0.5
2	0.3
3	0.2

Doctor service time (in minutes)	Probability
2	0.6
3	0.2
4	0.2

1. Sketch the whole process at the doctor's office. Label the components of your diagram. [4]

2. What are the expected inter-arrival time and expected service time (without simulation)? [4]

3. What are the arrival rate and service rate (without simulation)? If the doctor's office had only one doctor, what could you say about the expected waiting time of patients (using your knowledge of queuing theory). [4]

4. Using the following random numbers from uniform distribution between 0 and 99, simulate the arrival and service of 8 customers. [8]

For inter-arrival times	37	57	12	17	40	95	65	93
For service times	86	32	96	77	02	99	58	83

Show your work and reasoning.

5. From the simulation, what is your best estimate of the average patient waiting time? [2]

6. What is your best estimate of the average number of patients waiting? Explain. [4]

Exercise 4

MobileHit SAL is planning to produce two models of mobile phones. It believes that the phones will be so popular that the only limiting factors will be the common resources used by both phones. The following table summarizes the resource requirements and profits.

	Model 1	Model 2	Available units
Buttons (per unit)	1	3	180
Rear camera (per unit)	1	1	70
Speakers (per unit)	2	1	120
Profit ($ per unit)	$100	$200	

MobileHit would like to determine the product mix that would maximize the total profit.

1. Define decision variables and create an LP model that could be used to solve the problem (assume fractional values are allowed). [6]

2. Using the graphical method (or otherwise), determine the product mix that maximizes the total profit. (Remember you can use the back of the page if you need to.) [7]

3. MobileHit is also concerned with how environment-friendly their phones are, which can be measured on a 50-point scale (higher means better). Model 1, which is a newer and more environment-friendly design, scores 20 points, while older Model 2 scores only 3 points. Determine the product mix that maximizes the total number of points from all units produced. 4

4. If MobileHit would like to achieve a balance between the two objectives, profit maximization and environment-friendliness, what is the range of solutions that they should choose from? Define the range of solutions and provide one example solution that achieves some balance between the two objectives. [6]

5. Assume that MobileHit would like to solve the problem using goal programming, with target values of $15,000 for total profit and 2,000 points for environment-friendliness. Write all necessary modifications that have to be added to the model formulated in part 1. [6]

Exercise 5

ConfOrg Inc. would like to renovate a conference center that it uses to organize conferences and workshops. ConfOrg Inc. asked QuickFix Inc. to plan and perform the renovation. QuickFix used the Critical Path Method and determined that the renovation could be completed in 49 days, but after hearing from ConfOrg that it is too long, the project was crashed to 40 days.

QuickFix was kind enough to show us the model and its Excel implementation that was used to crash the project. The LP model is:

T_i = variable denoting the start time of activity i

C_i = variable denoting the number of days by which activity i is crashed

$$\begin{aligned}
&\min \sum_i c_i C_i && \text{(minimize the total cost of crashing)}\\
&\text{s.t. } T_M + t_M - C_M \le 40 && \text{(finish the last activity, } M\text{, not later than in 40 days)}\\
&\quad T_j - T_i \ge t_i - C_i && \text{(time between starts of } i \text{ and } j \text{ when } i \text{ is a predecessor of } j\text{)}\\
&\quad C_i \le C_i^{\max} && \text{(maximum crash days for activity } i\text{)}\\
&\quad T_i, C_i \ge 0 && \text{(nonnegativity)}
\end{aligned}$$

where i and j are activities ($i, j = A, B, \ldots, M$), t_i is the normal processing time of activity i, $C_i^{\max}$ is the maximum number of days by which activity i can be crashed, and c_i is the cost per day of crashing activity i.

The Excel Sensitivity Report is:

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
D5	A Start Time	0	1000	0	1E+30	1000
D6	B Start Time	3	0	0	0	1000
D7	C Start Time	20	0	0	0	340
D8	D Start Time	7	0	0	0	1000
D9	E Start Time	17	0	0	0	660
D10	F Start Time	17	0	0	0	0
D11	G Start Time	17	0	0	0	340
D12	H Start Time	23	0	0	0	340
D13	I Start Time	28	0	0	0	340
D14	J Start Time	28	0	0	0	250
D15	K Start Time	33	0	0	0	340
D16	L Start Time	33	0	0	0	250
D17	M Start Time	35	0	0	0	250
E5	A Days Crashed	0	0	1000	1E+30	0
E6	B Days Crashed	0	2000	3000	1E+30	2000
E7	C Days Crashed	0	500	500	1E+30	500
E8	D Days Crashed	0	250	1250	1E+30	250
E9	E Days Crashed	2	0	660	340	160
E10	F Days Crashed	0	1000	1000	1E+30	1000
E11	G Days Crashed	0	160	500	1E+30	160
E12	H Days Crashed	3	-500	500	500	1E+30
E13	I Days Crashed	0	0	750	1E+30	0
E14	J Days Crashed	0	250	500	1E+30	250
E15	K Days Crashed	2	0	750	0	250
E16	L Days Crashed	0	250	500	1E+30	250
E17	M Days Crashed	2	0	1000	0	250

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
E20	Actual Project Finish Time	40	-1000	40	2	3
L5	A−>B Time Between Starts	3	1000	0	3	2
L6	B−>C Time Between Starts	17	0	0	13	1E+30
L7	B−>D Time Between Starts	4	1000	0	3	2
L8	C−>H Time Between Starts	3	0	0	13	1E+30
L9	D−>E Time Between Starts	10	660	0	1	2
L10	D−>F Time Between Starts	10	0	0	2	17
L11	D−>G Time Between Starts	10	340	0	2	1
L12	E−>H Time Between Starts	6	660	0	1	2
L13	F−>H Time Between Starts	6	0	0	2	1E+30
L14	G−>H Time Between Starts	6	340	0	2	1
L15	H−>I Time Between Starts	5	750	0	0	2
L16	H−>J Time Between Starts	5	250	0	2	0
L17	I−>K Time Between Starts	5	750	0	0	2
L18	J−>L Time Between Starts	5	250	0	2	0
L19	K−>M Time Between Starts	2	750	0	0	2
L20	L−>M Time Between Starts	2	250	0	2	0

Based on the provided information, answer the following questions:

1. Which activities were crashed, by how many days, and what is the total cost of crashing? 6

2. If ConfOrg offered QuickFix an extra $1500 for each day by which the project is crashed below 40 days, what would you recommend QuickFix to do? 6

3. Assuming again that the project must finish in 40 days, would the solution be different if the cost per day of crashing activity E were higher by $200 than it currently is? Would this affect the total cost? [4]

4. QuickFix discovered that one necessary precedence relationship was missing in the model: activity C must be finished before starting activity G. Write a constraint that should be added to the model to add this precedence relationship. Would the optimal solution change if the model with this new constraint were resolved? [4]

5. If QuickFix was worried that some activities may take longer than assumed, what two methods would you recommend that they try to use (based on your knowledge from the course)? [2]