MGT 40750 – Quantitative Decision Modeling

Spring 2017

Midterm Exam (Type A)

Time: 02/13/2017 (Monday)

Name: _____

NetID: _____

This is an open-computer/closed-book/closed-note exam. A one-page one-sided cheat sheet is allowed.

Please show all work and submit your Excel files on Sakai in order to receive partial credit.

Good luck!

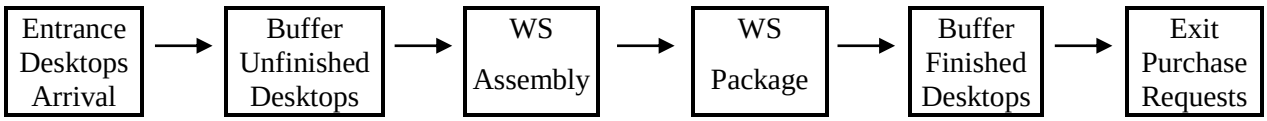
Grade:

Question 1:	_____ / 30
Question 2:	_____ / 30
Question 3:	_____ / 40
Total:	**_____ / 100**

Question 1:

Best Buy sells HP desktops and designates a receiving area enough to hold 12 HP desktops. Distributors deliver HP desktops to fill the designated receiving area (according to an order-up-to inventory policy) every 36 hours. Received unfinished desktops then wait in the receiving area for assembly. The processing time at Assembly follows a uniform distribution with a minimum of 1 hours and a maximum of 4 hours. The assembled desktops are then packaged to finished desktops. The processing time of packaging follows an exponential distribution with a mean of 30 minutes. Finished desktops are stored in a large storage space to wait for purchase. Assume that HP desktops are purchased every 3 hours, on average according to an exponential distribution, when there are desktops available. Initially all storages are empty. The process flow map for Best Buy is given below. Suppose we want to run 50 simulations. Each simulation will be run for 600 hours. Let time units represent *hours.*

Process Flow Map for Best Buy



a. (12 points) Specify your SimQuick model by filling in the following tables.

Entrances:

1	
Name →	
Time between arrivals →	
Num. objects per arrival →	
Output destination(s) ↓	

Buffers:

1			2		
Name →			**Name →**		
Capacity → Initial # objects →			Capacity → Initial # objects →		
Output destination(s) ↓	Output group size ↓		Output destination(s) ↓	Output group size ↓	

Work Stations:

	1				2		
	Name → Working time →				**Name →** Working time →		
Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓	Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓

Exits:

1	
Name →	
Time between departures →	
Num. objects per departure →	

b. (3 points) Based on your SimQuick results, what fraction of customer demand is being satisfied in these simulations?

c. (6 points) According to these simulations, what's the cycle time of process, i.e., how much time, on average, are the desktops spending in the process between the time of arrival and the time of purchase? (Show all work in order to receive partial credit.)

d. (3 points) What's the utilization rate of Assembly?

e. (3 points) Compared to the original process, if desktops are purchased every 4 hours, on average according to an exponential distribution, then the cycle time of process will

(circle one): Decrease / Increase / Remain unchanged

f. (3 points) Compared to the original process, if distributors deliver HP desktops to fill the designated receiving area every 48 hours, then the service level will

(circle one): Decrease / Increase / Remain unchanged

Question 2:

Consider the following process of visiting Alcatraz Island ("The Rock") in the San Francisco Bay during the peak demand hours of 9am-1pm. Alcatraz Cruises offers ferry transportation services. Each ferry carries exactly 40 travelers every time and depart every 30 minutes starting from 9am. Upon arrival at the island, 30% of travelers will enter a line to rent audio guides for the tour and then enter the ticket line to buy entrance tickets. The rest of travelers will directly enter the ticket line to buy entrance tickets. We assume there is enough space for all waiting lines. There are one audio rental window and two ticket windows. The amount of time for each traveler to rent an audio guide can be approximated by a normal distribution with a mean of 2 minutes and a standard deviation of 1 minute. In addition, the amount of time for each traveler to buy a ticket can be approximated by a normal distribution with a mean of 1 minutes and a standard deviation of 0.5 minute. After buying the tickets, all travelers will start their island tours. The National Park Services wants to study waiting times for the travelers.

a. (9 points) Using the elements of SimQuick, draw below a process flow map that models this process.

b. (10 points) Suppose we want to run 50 simulations and we assume there are no customers in the lines at the beginning of the simulations. Fill in the following tables accordingly (you may not need to use them all).

Entrances:

1			2	
Name →			**Name →**	
Time between arrivals →			Time between arrivals →	
Num. objects per arrival →			Num. objects per arrival →	
Output destination(s) ↓			Output destination(s) ↓	

Buffers:

1			2	
Name →			**Name →**	
Capacity →			Capacity →	
Initial # objects →			Initial # objects →	
Output destination(s) ↓	Output group size ↓		Output destination(s) ↓	Output group size ↓

3			4	
Name →			**Name →**	
Capacity →			Capacity →	
Initial # objects →			Initial # objects →	
Output destination(s) ↓	Output group size ↓		Output destination(s) ↓	Output group size ↓

Work Stations:

	1					2		
	Name →				**Name →**			
	Working time →				Working time →			
Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓		Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓

	3				4		
	Name →				**Name →**		
	Working time →				Working time →		
Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓	Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓

Decision Points:

1			2	
Name →			**Name →**	
Output destinations ↓	Percents ↓		Output destinations ↓	Percents ↓

Exits:

1			2	
Name →			**Name →**	
Time between departures →			Time between departures →	
Num. objects per departure →			Num. objects per departure →	

Simulation controls:	
Time units per simulation →	
Number of simulations →	

c. (3 points) On average, how long does a traveler need to wait in line to buy a ticket?

d. We want to conduct sensitivity analysis to test the impact of the percentage of travelers who rent audio guides (consider four scenarios 20%, 25%, 30%, and 35%) on the waiting time in line to rent audio guides.

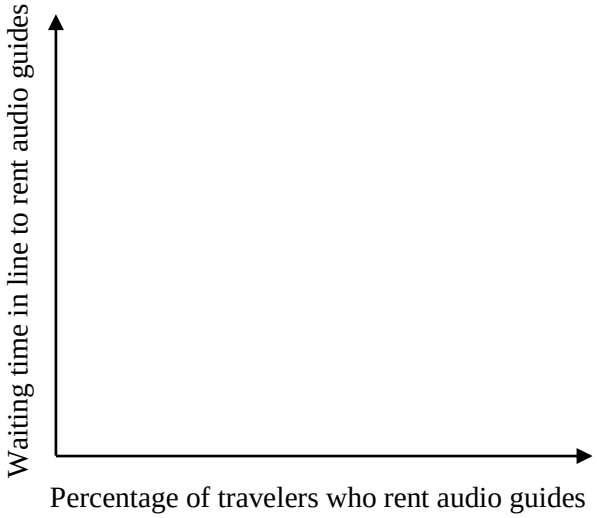
Set up the decision point using ScenVar(·) and specify Scenarios below (4 points):

1	
Name →	
Output destinations ↓	Percents ↓

Scenarios Return to Control Panel

		Scenario Variables		
		1	2	3
Scenarios	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			

Plot the waiting time in line to rent audio guides with respective to the percentage of travelers who rent audio guides below (4 points).



Question 3:

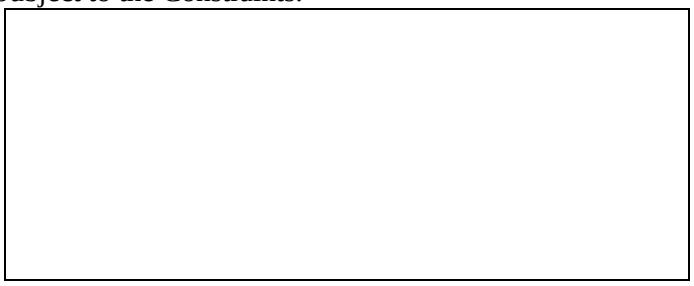
The Internal Revenue Service (IRS) estimates that during each of the next 4 months it will need the numbers of supercomputers indicated in row 9 of the spreadsheet shown below. To meet these requirements the IRS rents supercomputers for a period of 1, 2, or 3 months. The rental costs are shown in rows 4-6. The IRS has no supercomputers at the beginning of month 1. The IRS must decide how many computers to rent for each amount of time, starting at the beginning of each month, so as to satisfy the requirements at minimum total cost. For example, cell C17 will contain the number of computers to rent starting at the beginning of month 2 for 3 months (that is, till the end of month 4). Since the original requirements are estimates, the IRS wants to solve this problem for several different levels of requirements. In this case, in each month, the requirement being considered is 10% higher (see cell B11) than the original requirement. These "adjusted requirements" are calculated by Excel in row 21.

a. (20 points) Suppose the decision variables are B15:E17. Specify the Excel file below. Make sure to record *all the necessary formulas*.

	A	B	C	D	E
1	**Supercomputer rentals at IRS**				
2					
3	Rentals costs per computer				
4	For one month	$1,000			
5	For two months	$1,800			
6	For three months	$2,500			
7					
8		Month 1	Month 2	Month 3	Month 4
9	Original requirements	800	1000	600	500
10					
11	Percent increase in requirements	10%			
12					
13					
14	Rental plan	Month 1	Month 2	Month 3	Month 4
15	# rented for one month				
16	# rented for two months				
17	# rented for three months				
18					
19	Number on hand for this month				
20					
21	Adjusted requirements for this month				
22					
23	Total rental cost				

b. (8 points) Specify Solver:

Set Objective: _____
To: ○ Max ○ Min ○ Value of: _____
By Changing Variable Cells: _____
Subject to the Constraints:



□ Make Unconstrained Variables Non-Negative
Select a Solving Method: Simplex LP

c. (4.5 points) Based on your Solver results,

How many supercomputers the IRS should rent for 2 months in Month 1? _____
How many supercomputers the IRS should rent for 3 months in Month 2? _____
How many supercomputers the IRS should rent for 1 month in Month 3? _____

d. (7.5 points) Sensitivity analysis:

- The optimal total rental cost would _____ (increase / decrease / remain unchanged) if percent increase in requirement is changed to 20%.
- The optimal total rental cost would _____ (increase / decrease / remain unchanged) if rental cost per computer for one month is $800.
- The optimal total rental cost would _____ (increase / decrease / remain unchanged) if original requirement for Month 2 is 1200.