Final Exam

Due Dec 17, 2021 at 11:59am **Points** 100 **Questions** 19
Time Limit 120 Minutes

Instructions

Instructions:

- You will have 2 hours to complete the exam and submit your answers.
- This is an open book, open handouts, open-class-notes exam. You may view and download any course material from the current Canvas website and notes you have taken during the semester. You may **not** use any other material.
- The problems are not ordered by level of difficulty. Given that there are multiple questions, if you get stuck on one, move on and revisit the difficult question if time permits.
- **Clearly state any extra assumptions you have made (if any) as part of your solutions in the space provided.**

By submitting your exam you acknowledge the University of Maryland's Honor code (details at http://shc.umd.edu/SHC/HonorPledgeUse.aspx (http://shc.umd.edu/SHC/HonorPledgeUse.aspx)) and pledge on your honor that you have not given or received any unauthorized assistance on this test.

Attempt History

	Attempt	Time	Score
LATEST	Attempt 1	115 minutes	100 out of 100

Correct answers are hidden.

Score for this quiz: **100** out of 100
Submitted Dec 17, 2021 at 10:50am
This attempt took 115 minutes.

Question 1 **0 / 0 pts**

Honor Pledge:

On my honour, I pledge that I have neither given nor received unpermitted aid during this exam.

Your Answer:

Liangrui Lu

Question 2

20 / 20 pts

Modeling

TCL has two plants that produce identified 55" hd tv units. However, production costs at the two plants differ due to the technology and labor used. The total costs of production at the plants depends on the quantity produced, and are described as:

Total cost at plant 1: $2X_1^2 - X1_1 + 10$

Total cost at plant 2: $X_2^2 - 0.6* X1_2 + 15$

X_1 is the number of TVs produced at plant 1 and X_2 is the number of TVs produced at plant 2. Neither plant can produce more than 500 TVs. TVs can be shipped from either plant to satisfy demand from different customers. The unit shipping costs and demands for each customer are summarized in the following table.

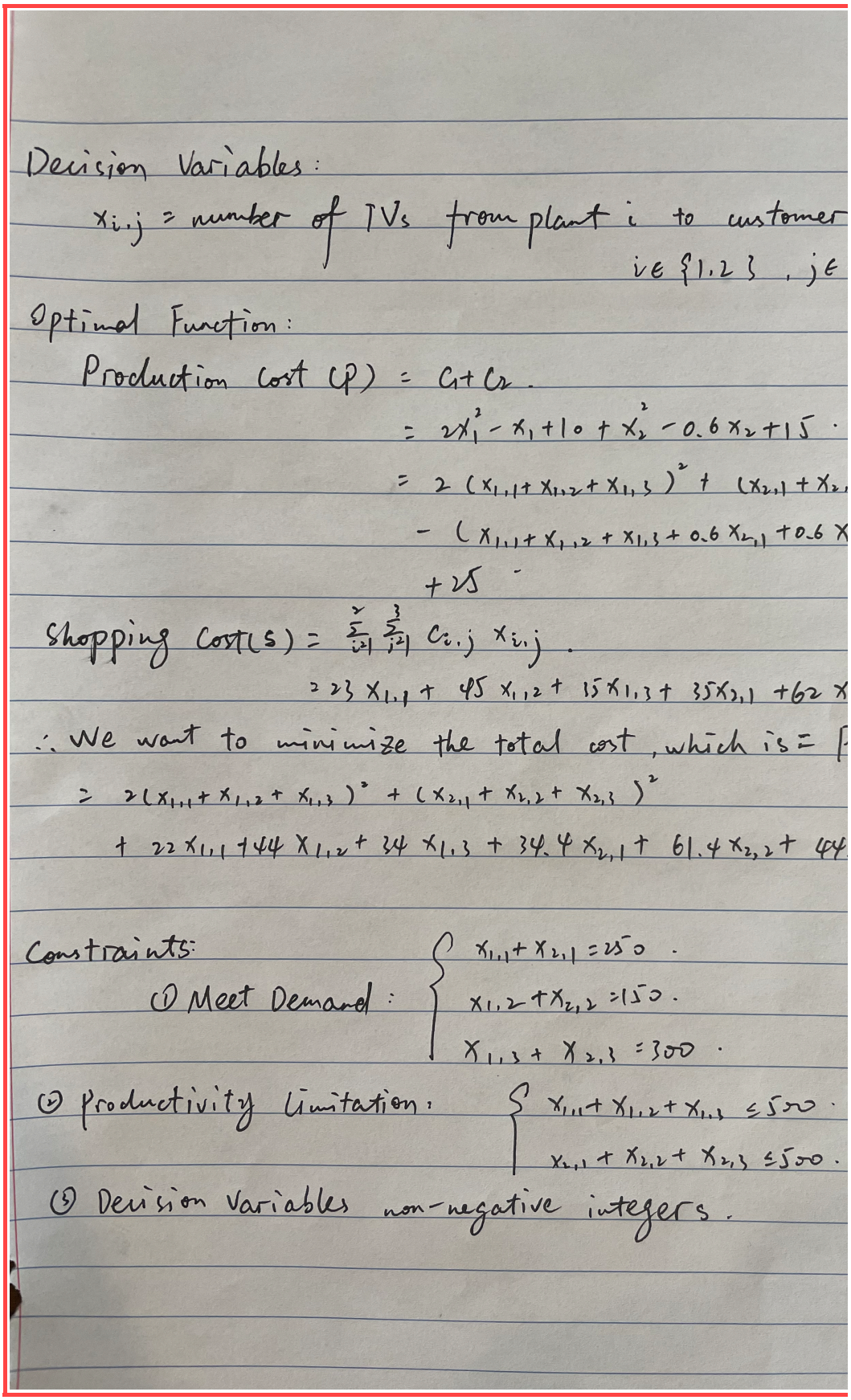
	Customer 1	Customer 2	Customer 3
Plant 1	$23	$45	$35
Plant 2	$35	$62	$45
Demand	250	150	300

What is the optimal production and shipping plan if management wants to meet customer demand at the lowest total cost?

Formulate a non-linear programming model for this problem. Clearly specify decision variables, objective function and constraint. (Please do not solve the model.)

You can type your formulation below or write it on paper and insert an image in the textbox.

Your Answer:



Decision Variables:

$x_{i,j}$ = number of IVs from plant i to customer

$i \in \{1,2\}$, $j \in$

Optimal Function:

Production cost (P) = $C_1 + C_2$.

$= 2x_1^2 - x_1 + 10 + x_2^2 - 0.6x_2 + 15$.

$= 2(x_{1,1} + x_{1,2} + x_{1,3})^2 + (x_{2,1} + x_{2,$

$- (x_{1,1} + x_{1,2} + x_{1,3} + 0.6x_{2,1} + 0.6x$

$+ 25$

Shopping Cost(S) = $\sum_{i=1}^{2} \sum_{j=1}^{3} c_{i,j} x_{i,j}$.

$= 23x_{1,1} + 45x_{1,2} + 15x_{1,3} + 35x_{2,1} + 62x$

∴ We want to minimize the total cost, which is = [

$= 2(x_{1,1} + x_{1,2} + x_{1,3})^2 + (x_{2,1} + x_{2,2} + x_{2,3})^2$

$+ 22x_{1,1} + 44x_{1,2} + 34x_{1,3} + 34.4x_{2,1} + 61.4x_{2,2} + 44$

Constraints:

① Meet Demand:

$$\begin{cases} x_{1,1} + x_{2,1} = 250. \\ x_{1,2} + x_{2,2} = 150. \\ x_{1,3} + x_{2,3} = 300. \end{cases}$$

② Productivity Limitation:

$$\begin{cases} x_{1,1} + x_{1,2} + x_{1,3} \leq 500. \\ x_{2,1} + x_{2,2} + x_{2,3} \leq 500. \end{cases}$$

③ Decision Variables non-negative integers.

Simulation

You just got yourself an early graduation present, an expensive car, and now need to purchase auto insurance. One insurance option has a $1000 deductible, so that if you have an accident and the damage is less than $1000, you pay for it out of your pocket. However, if the damage is greater than $1000, you pay the first $1000 and the insurance pays the rest. In the current year there is probability 0.025 that you will have an accident. If you have an accident, the damage amount is normally distributed with mean $3000 and standard deviation $750.

The rate of the insurance is awesome (very low, just $5) but you are a little concern with the deductible ($1000 sounds high for your starting salary). Obviously, you can always pay more and lower the deductible to $750, $500 or even zero! However, before you do that, you want to use your new skills in simulation to calculate the actual average amount that you will pay with each deductible option.

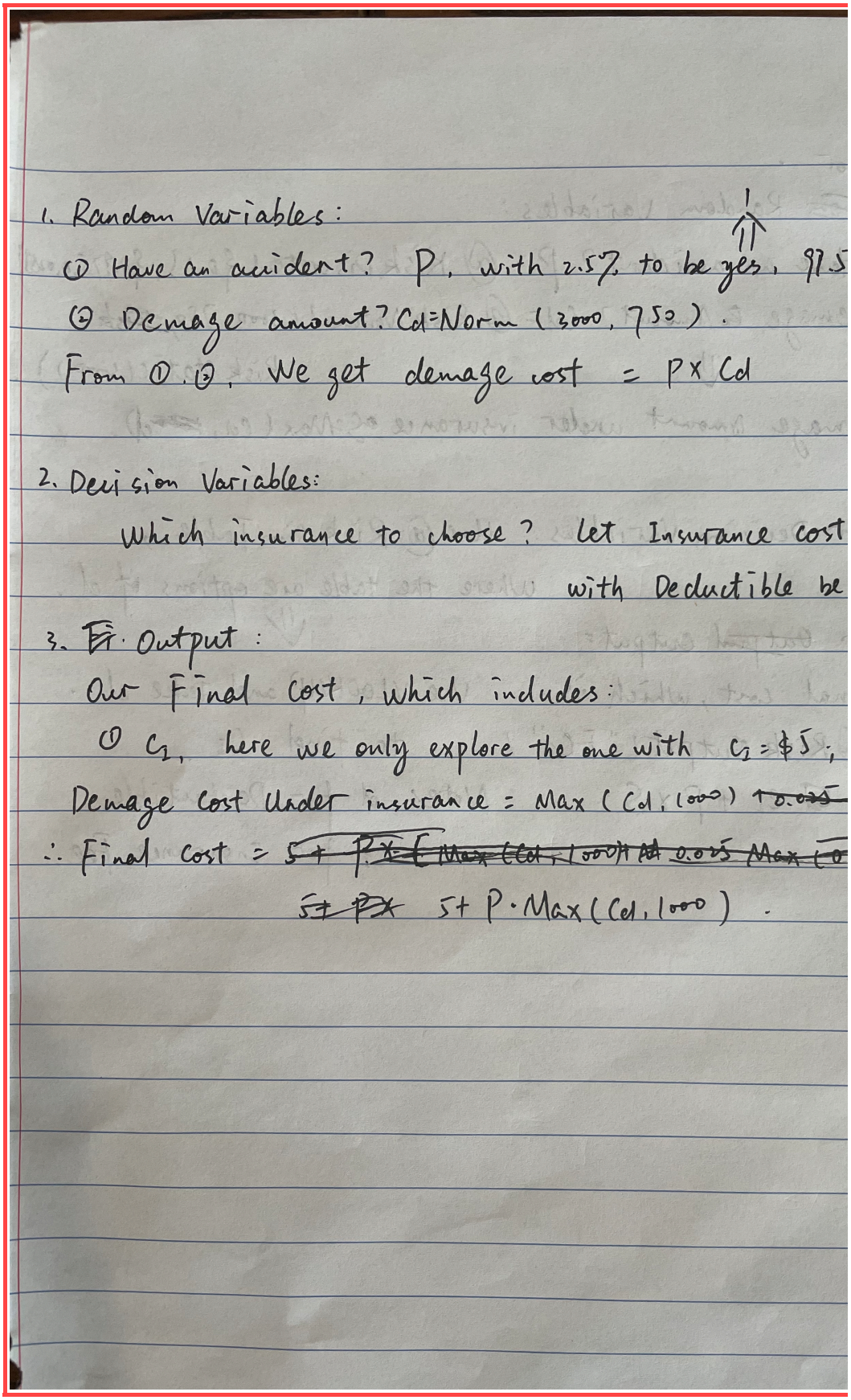
Question 3

6 / 6 pts

Determine the inputs and outputs for this problem:

1. What is(are) the input random variable(s)?
2. What is(are) the decision variable(s)?
3. What is(are) the output?

Your Answer:



1. Random Variables:

① Have an accident? P, with 2.5% to be yes, 97.5

② Demage amount? Cd = Norm (3000, 750).

From ①, ②, we get demage cost = P × Cd

2. Decision Variables:

Which insurance to choose? Let Insurance cost with Deductible be

3. ~~Fi~~ Output:

Our Final cost, which includes:

① C_1, here we only explore the one with $C_1 = \$5$;

Demage cost under insurance = Max (Cd, 1000) ~~+0.025~~

∴ Final cost = ~~5 + P × [Max (Cd, 1000)] 0.025 Max (0~~

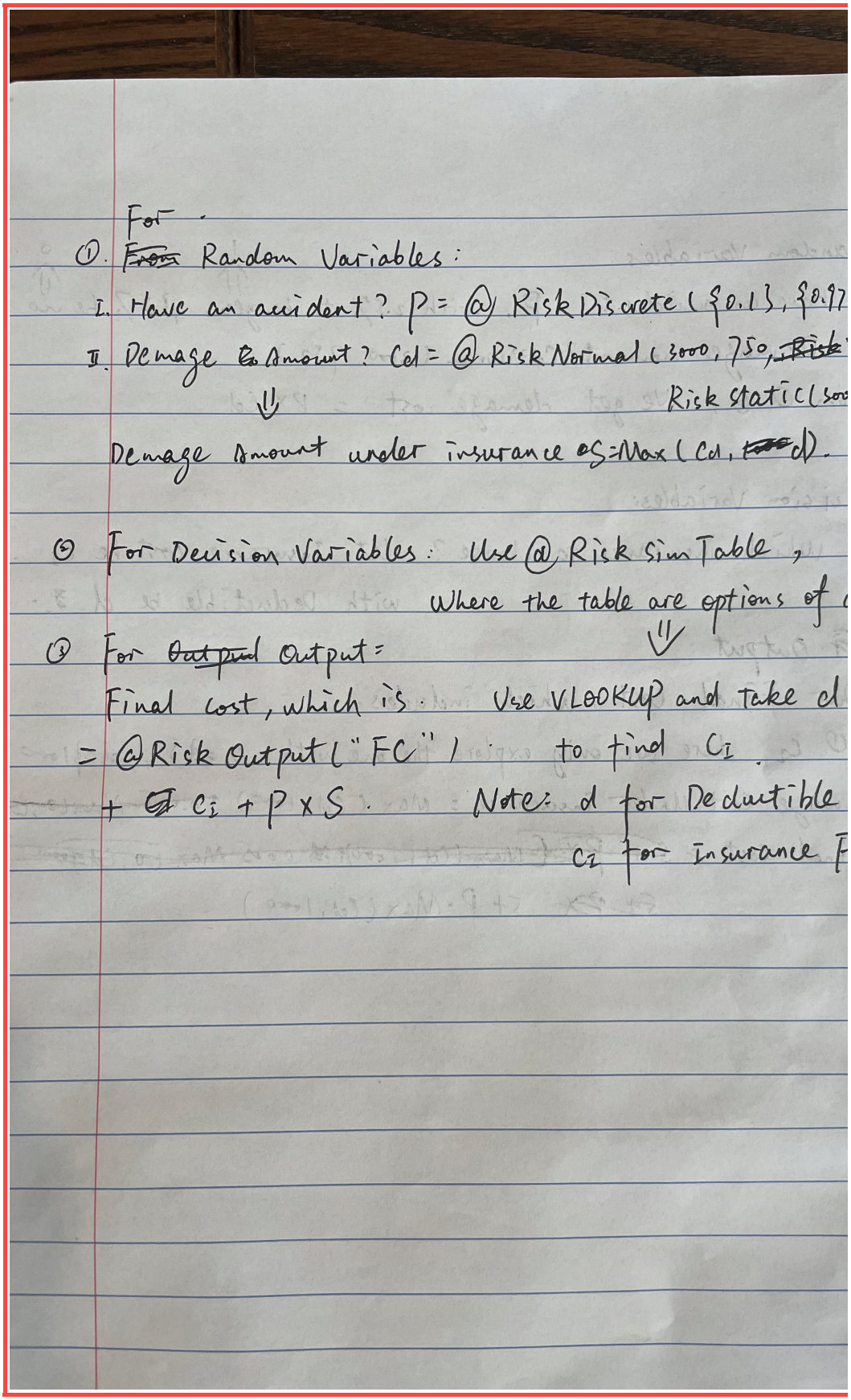
~~5 + P ×~~ 5 + P · Max (Cd, 1000).

Question 4

8 / 8 pts

Determine how to calculate the output from the input information and decision variables. Identify the random inputs and explain how to model them in Excel.

Your Answer:



For .

① ~~From~~ Random Variables:

I. Have an accident? P = @Risk Discrete ({0,1}, {0.9?

II. Demage & Amount? Cd = @Risk Normal (3000, 750, ~~Risk~~

Risk static (300

⇓

Demage Amount under insurance CS = Max (Cd, ~~Cd~~ d).

② For Decision Variables: Use @Risk SimTable,

Where the table are options of

③ For ~~Output~~ Output:

Final cost, which is: Use VLOOKUP and take d

= @Risk Output ("FC") to find C_i.

+ C_i + P × S. Note: d for Deductible

C_i for insurance F

Question 5

6 / 6 pts

Simulation

You call the insurance company and ask them give you quote for different deductible levels. They send you the following table:

Deductible	$0.00	$250.00	$500.00	$750.00	$1,000.00
Premium	$100.00	$50.00	$20.00	$10.00	$5.00

The table means that in order to eliminate the deductible, you need to pay $100. To lower the deductible to $500, you need to pay $20. And similarly for the other deductible levels.

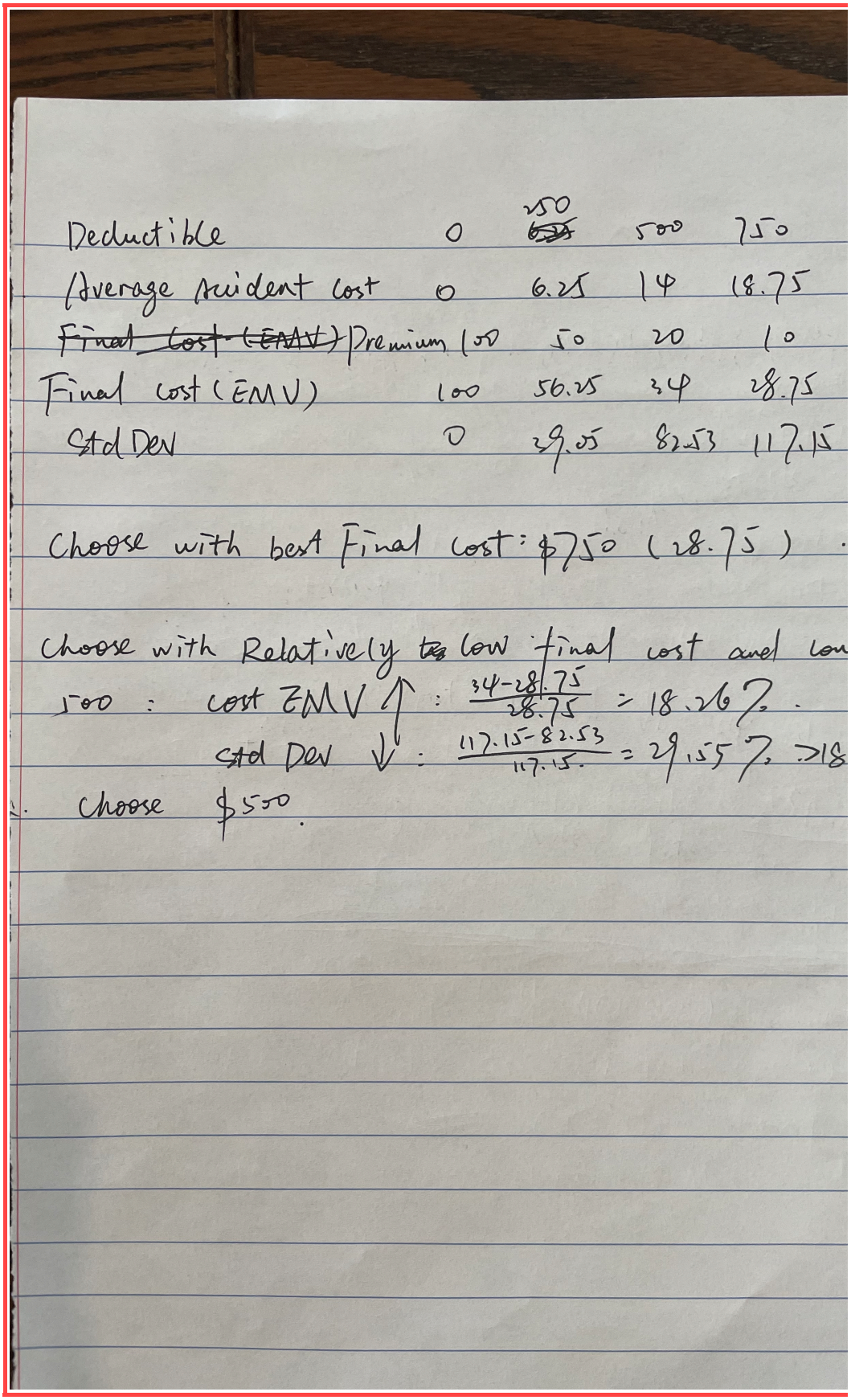
You run some simulations with different deductible levels and calculate the average cost to you from an accident. The table below shows your results.

Deductible	**$0.00**	**$250.00**	**$500.00**	**$750.00**	**$**
Average Accident Cost	$0.00	$6.25	$14.00	$18.75	$
Std Dev Accident Cost	$0.00	$39.05	$82.53	$117.15	$
P(Cost>500)	0.00%	0.00%	0.00%	2.60%	3

a) If you are risk-neutral, what deductible is the optimal choice? Explain your selection.

b) If you are risk-averse, what deductible is the optimal choice? Explain your selection.

Your Answer:



Deductible	0	~~250~~	500	750
Average accident cost	0	6.25	14	18.75
~~Final cost (EMV)~~ Premium	100	50	20	10
Final cost (EMV)	100	56.25	34	28.75
Std Dev	0	29.05	82.53	117.15

Choose with best Final cost: $750 (28.75).

Choose with Relatively low final cost and low

500 : cost EMV ↑ : $\frac{34-28.75}{28.75} = 18.26\%$.

Std Dev ↓ : $\frac{117.15-82.53}{117.15} = 29.55\% > 18$

∴ Choose $500.

Question 6

15 / 15 pts

Heuristics

Lex Rex is an aspiring rock band composed of college friends based in Raleigh, NC. They are planning a short tour that will take them to five other college towns throughout the Mid-Atlantic region over a 10 day period. The distances between each of the cities planned for their tour are given below:

Distances Between Cities in Miles

	Home	A	B	C	D	E
Home	0	210	353	457	65	125
A	210	0	530	797	176	173
B	353	530	0	571	755	771
C	457	797	571	0	477	395
D	65	176	755	477	0	792
E	125	173	771	395	792	0

Provide a model for this problem assuming that they want to minimize the total distance travelled. Define decision variables, objective function and constraints. Provide general details on how the objective function and constraints would be calculated.

Your Answer:

Decision Variables:

Order to visit, here we use.

To notes to ~~visit~~ be the decision, as:

	From	To.
1.	Home(x_0)	x_1
2.	x_1	x_2
3.	x_2	x_3
4.	x_3	x_4
5.	x_4	x_5
6.	x_5.	Home

Optimal Function:

Minimize total distance, as:

$\sum_{i=1}^{6} d_i$, where $d_i = d_{F,T}$, with $x_{i-1} = F$, $x_i = T$.

($d_{F,i}$ is the distance table).

Constraint:

① x are the citys: $x_1, x_2, x_3, x_4, x_5 \in \{A, B, C, D, E\}$

② city all visit anel different: $x_1 \neq x_2 \neq x_3 \neq x_4 \neq x_5$

Question 7

5 / 5 pts

Heuristics (continuation)

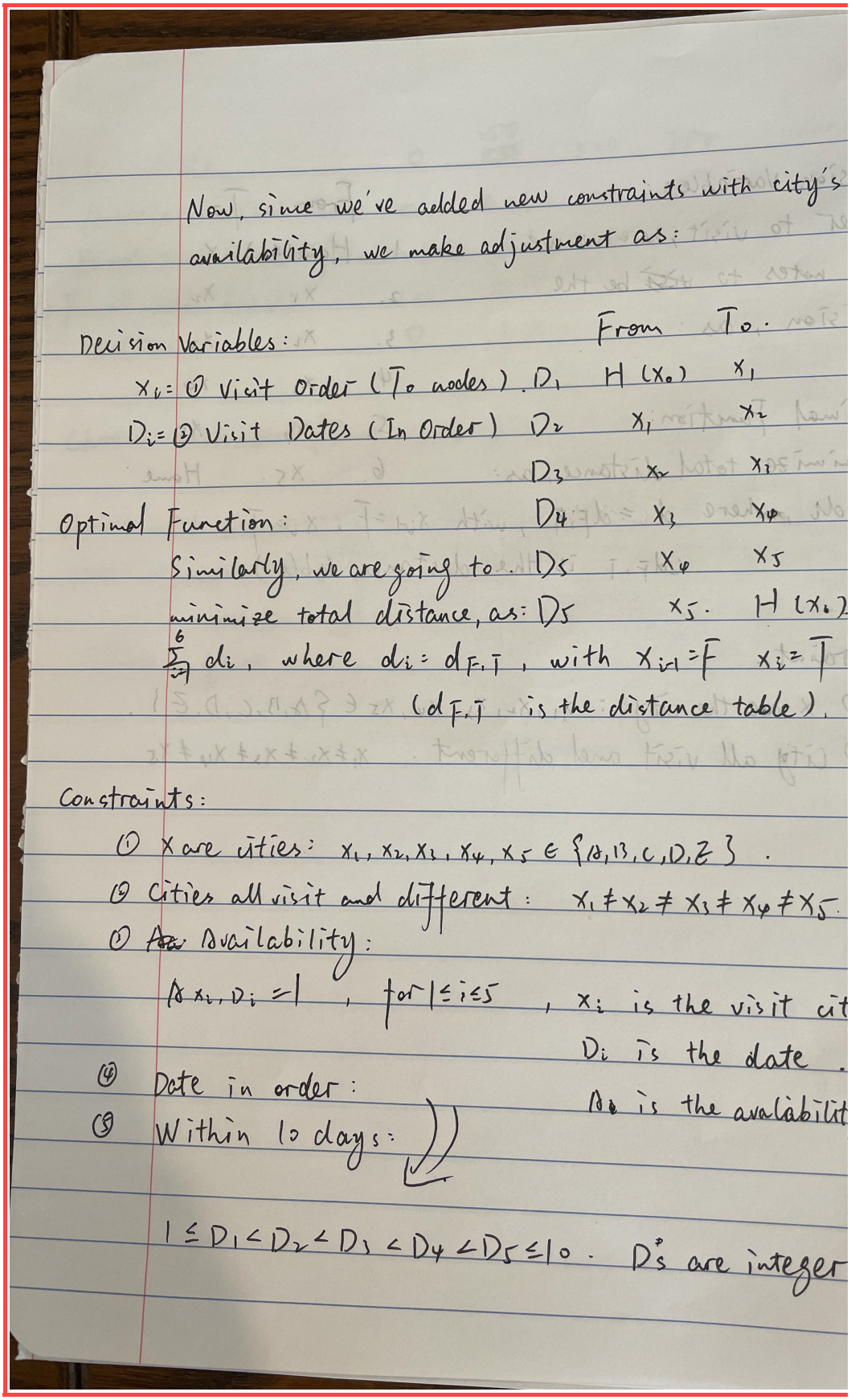
The venues where the band will perform have other acts booked on some dates the band will be on tour. The following table indicates (with entries of 1) the dates that venues are available in each of the cities.

Dates Available for Concerts (1 = Available, 0 = Not Available)

City	1	2	3	4	5	6
A	1	0	1	0	1	0
B	0	1	0	1	0	1
C	0	0	0	0	1	1
D	1	0	0	0	0	1
E	1	1	1	0	0	0

How can you modify your earlier model to account for dates when the venue is available and that they visit all locations within 10 days?

Your Answer:



Now, since we've added new constraints with city's availability, we make adjustment as:

Decision Variables:

X_i: ① Visit order (T_o nodes)

D_i: ② Visit Dates (In Order)

From T_o:

	From	To
D_1	$H(X_0)$	X_1
D_2	X_1	X_2
D_3	X_2	X_3
D_4	X_3	X_4
D_5	X_4	X_5
D_5	X_5	$H(X_0)$

Optimal Function:

Similarly, we are going to minimize total distance, as: $\sum_{i=1}^{6} d_i$, where $d_i = d_{F,T}$, with $X_{i-1} = F$ $X_i = T$

($d_{F,T}$ is the distance table).

Constraints:

① X are cities: $X_1, X_2, X_3, X_4, X_5 \in \{A, B, C, D, E\}$.

② Cities all visit and different: $X_1 \neq X_2 \neq X_3 \neq X_4 \neq X_5$.

③ ~~Ava~~ Availability:

$\delta_{X_i, D_i} = 1$, for $1 \leq i \leq 5$, X_i is the visit cit

D_i is the date.

D_0 is the availabilit

④ Date in order:

⑤ Within 10 days:

$1 \leq D_1 < D_2 < D_3 < D_4 < D_5 \leq 10$. D_i's are integer

Question 8

10 / 10 pts

What are some similarities and differences between branch-and-bound and GRG nonlinear?

Your Answer:

Difference:

1. branch-and-bound is the solving method for Integer LP models, while GRG is for nonlinear models.

2. branch-and-bound method follow the patterns of linear programming, but GRG is nonlinear, so their differences look like:

I. branch-and-bound cannot solve nonlinear problems

II. GRG cannot guarantee to find the global optimum

III. GRG's performance is related to the start point

Similarity:

1. They all include Partitions for the feasible solution space

2. They can both solve simpler problems, like solving most LP problems, as nonlinear method GRG is still able to do the Linear ones.

Question 9

10 / 10 pts

Provide some examples of the type of models that can be solved with each of the methods in the previous question.

Your Answer:

Branch-and-bound, Linear Models, like:

1. R&D Budgeting (binary)

2. Fixed-Cost (Fixed Charge) Models

3. Facility/Resource Location Models

GRG, Nonlinear Models, like:

1. The Economic Order Quantity (EOQ) Problem

2. Location Problem in real map and distance

3. Portfolio Optimization Problem

But again, they are both able, though not suitable, to solve simpler models, like linear models.

Question 10

2 / 2 pts

The first step in formulating a linear programming model is to define the objective function.

- ○ True
- ◉ False

Question 11

2 / 2 pts

The objective function is a linear relationship reflecting the objective of an operation.

- (•) True
- ( ) False

Question 12

2 / 2 pts

In the Solver window, the cell that contains the objective function is referred as

- ( ) Target cell
- ( ) Objective function
- (•) Objective cell
- ( ) Variable cell

Question 13

2 / 2 pts

Which of the following optimization tools is prepackaged with Excel?

- ( ) Lindo

- None of these
- Solver
- @Risk

Question 14

2 / 2 pts

The shadow price of non-binding constraint is

- zero
- any value
- greater than zero
- less than zero

Question 15

2 / 2 pts

If we change the constraint quantity to a value outside the sensitivity range for that constraint quantity, the shadow price will change.

- True
- False

Question 16

2 / 2 pts

In the linear programming formulation of a network flow problem,

- the total flow in and out of a node is constrained by the supply or demand at the node
- there is one constraint per node
- there is one variable per arc
- **all options are correct**

Question 17

2 / 2 pts

The difference between the assignment and the transportation problem is that:

- **each supply and demand value is 1 in the assignment problem.**
- total supply must equal total demand in the assignment problem.
- there is no difference.
- the number of origins must equal the number of destinations in the transportation problem.

Question 18

2 / 2 pts

The RAND() function in Excel® models which of the following probability distributions?

- (•) Uniform(0,1)
- ( ) Normal(-1,1)
- ( ) Normal(0,1)
- ( ) Uniform(-1,1).

Question 19

2 / 2 pts

A common guideline in constructing confidence intervals for the mean is to place upper and lower bounds one standard error on either side of the average to obtain an approximate 95% confidence interval.

- (•) False
- ( ) True

Quiz Score: **100** out of 100