IE 3315-001/002/900
Operations Research I
Fall 2020

Exam 2
100 points

SHOW YOUR WORK
EXPLAIN YOUR ANSWERS

First / Given Name: _____

Last / Family / Surname: _____

Student ID: _____

My signature below indicates that I did not give or receive any assistance on this exam and that the solutions submitted are wholly my own.

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Signature of the student

1. (15 points) An automobile manufacturer has assembly plants located in the Northwest, Midwest and Southeast. The cars are assembled and sent to major markets in the Southwest, East, West and Northeast. The appropriate distance matrix, availabilities and demands are given by the following table:

	Southwest	East	West	Northeast	*availability*
Northwest	1200	8500	1850	2250	*2,500,000*
Midwest	400	800	900	1400	*1,800,000*
Southeast	800	1200	1000	1100	*1,600,000*
demand	*2,000,000*	*1,500,000*	*1,200,000*	*1,200,000*	

a) (10 points) Assuming that the cost is proportional to distance. Formulate the problem to minimize the total cost of transportation.

b) (5 points) Can the problem from part (a) be solved using the simplex method? Explain your answer.

2. (15 points) The University is in the process of forming a committee to handle students' grievances. The administration wants the committee to include at least one female, one male, one student, one administrator, and one faculty member. Ten individuals (*identified, for simplicity, by the letter a to j*) have been nominated. The mix of these individuals in the different categories is given as follows:

Category	**Individuals**
a	Female, Student
b	Female, Administrator
c	Female, Student
d	Female, Faculty
e	Female, Administrator
f	Male, Administrator
g	Male, Student
h	Male, Faculty
i	Male, Faculty
j	Male, Student

The University wants to form the smallest committee with representation from each of the five categories.

(a) (10 points) Formulate the problem as an ILP.

(b) (5 points) State which algorithm can be used to find the optimum solution.

3. (20 points) Consider the following function:

$$f(x) = 3x_1^2 + 9x_1 + 2x_2 - x_1x_2 + 4$$

(a) [12 points] Determine whether the function f is convex, concave, or neither.

(b) [8 points] Suppose x^* is a stationary point of the function f. Is it a local max, local min, global max, global min, or none of these? **Explain your answer**.

4. (30 points) Consider the following nonlinear program.

$$\begin{aligned} \max \quad & x(y-2) \\ s.t. \quad & x = 33 - 3y \\ & y \geq 2 \end{aligned}$$

(a) [12 points] Derive the KKT necessary conditions for the nonlinear program.
(b) [18 points] Solve the nonlinear program using the KKT necessary conditions.

5. (20 points) A project is considered completed when activities A-I have all been completed. The precedence relationships and duration of each activity are given in the table below:

Activity	**Immediate Predecessors**	**Duration (in week)**
A	-	2
B	-	3
C	B	1
D	A, C	5
E	B	7
F	C	5
G	D, F	2
H	E, F	6
I	G, H	4

a) (10 points) Draw the project network diagram.
b) (7 points) Determine the critical path and critical activities of this project.
c) (3 points) What is the earliest the project can be completed?

GOOD LUCK