Time: 3 hours

🖘 - JUN 2023

Candidates should attempt ALL questions in this section

Answer any **two** questions from section A and any other two questions from Section B to give a total of **four** questions

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SECTION A (50 marks)

A1. A contractor pays his subcontractors a fixed fee plus mileage for work performed. On a given day the contractor is faced with three electrical jobs associated with various projects. Given below are the distances between the subcontractors and the projects.

<u>Project</u>

Subcontractor	<u>A</u>	<u>B</u>	<u>C</u>
Westside	50	36	16
Federated	28	30	18
Goliath	35	32	20
Universal	25	25	14

(a) How should the contractors be assigned to minimize total distance (and total cost) using a network representation? [11]

(b) Given the following decision variables. [6]

Decision Variables Defined

x_{ij} = 1 if subcontractor i is assigned to project j

= 0 otherwise

where: i = 1 (Westside), 2 (Federated),

3 (Goliath), and 4 (Universal)

$$j = 1 \text{ (A)}, 2 \text{ (B)}, \text{ and } 3 \text{ (C)}$$

Formulate a linear programming equation that minimizes the total distance.

(c) Formulate the constraints for the solution. [8]

A2. The city of Erstville is faced with a severe budget shortage. Seeking a long-term solution, the city council votes to improve the tax base by condemning an inner-city housing area and replacing it with a modern development. The project involves two phases: (1) demolishing substandard houses to provide land for the new development and (2) building the new development. The following is a summary of the situation.

1. As many as 300 substandard houses can be demolished. Each house occupies a 0.25-acre lot.

The cost of demolishing a condemned house is $2000.

2. Lot sizes for new single-, double-, triple-, and quadruple-family homes (units) are 0.18, 0.28, 0.4, and 0.5 acre, respectively. Streets, open space, and utility easements account for 15% of available acreage.

3. In the new development, the triple and quadruple units account for at least 25% of thetotal. Single units must be at least 20% of all units, and double units at least 10%.

4. The tax levied per unit for single, double, triple, and quadruple units is $1000, $1900, $2700 and $3400, respectively.

5. The construction cost per unit for single-, double-, triple-, and quadruple-family homes is $50,000, $70,000, $130,000, and $160,000, respectively.

6. Financing through a local bank is limited to $15 million.

Formulate the LP solution and all the constraints.

A3. Sun Ray Transport Company ships truckloads of grain from three silos to four mills. The supply (in truckloads) and the demand (also in truckloads)

together with the unit transportation costs per truckload on the different routes are summarized in Table below. The model seeks the minimum cost shipping schedule between the silos and the mills.

	Mill 1	Mill 2	Mill 3	Mill 4	Supply
Silo 1	10	2	20	11	15
Silo 2	12	7	9	20	25
Silo 3	4	14	16	18	10
Demand	5	15	15	25	

a) Formulate the LP model and the constraints. [7]
b) Use the Northwest Corner method to solve the LP.[6]
c) Use The Least-Cost method to solve the LP.[6]
d) Use Vogel's Approximation method to solve the LP.[6]

SECTION B (50 Marks)

B1. a) Neon lights on the U of A campus are replaced at the rate of 100 units per day. The physical plant orders the neon lights periodically. It costs $100 to initiate a purchase order. A neon light kept in storage is estimated to cost about $0.02 per day. The lead time between placing and receiving an order is 12 days. Determine the optimal inventory policy for ordering the neon lights. [12]

a) Lube Car specializes in fast automobile oil change. The garage buys car oil in bulk at $3 per gallon discounted to $2.50 per gallon if the order quantity is more than 1000 gallons. The garage services approximately 150 cars per day, and each oil change takes 1.25 gallons. Lube Car stores bulk oil at the cost of $.02 per gallon per day. Also, the cost of placing an order is $20. There is a 2-day lead time for delivery. Determine the optimal inventory policy. [13]

B2.a) Joe Klyne's three children, John, Karen, and Terri, want to earn some money for personal expenses. Mr. Klyne has chosen three chores for his children: mowing the lawn, painting the garage door, and washing the

family cars. To avoid anticipated sibling competition, he asks them to submit individual (secret) bids for what they feel is fair pay for each of the three chores. The table below summarizes the bids received. The children will abide by their father's decision regarding the assignment of chores. Solve using the Hungarian method. [15]

	Mow	Paint	Wash
John	$15	$10	$9
Karen	$9	$15	$10
Terri	$10	$12	$8

a) In the table below, four jobs (J1, J2, J3, and J4) need to be executed by four workers (W1, W2, W3, and W4), one job per worker. The matrix below shows the cost of assigning a certain worker to a certain job. The objective is to minimize the total cost of the assignment. Determine the job assignment using the Hungarian method. [10]

	J1	J2	J3	J4
W1	82	83	69	92
W2	77	37	49	92
W3	11	69	5	86
W4	8	9	98	23

B3.a) Consider the following LP with two variables:

$$\text{Min } z = 2x_1 + 3x_2$$

Subject 2

$$2x_1 + x_2 \leq 4$$

$$x_1 + 2x_2 \leq 5$$

$$x_1 , x_2 \leq 0$$

Provides the graphical solution space for the problem   [15]

b) TOYCO uses three operations to assemble three types of toys—trains, trucks, and cars. The daily available times for the three operations are 430, 460, and 420 minutes, respectively, and the revenues per unit of toy train, truck, and car are $3, $2, and $5, respectively. The assembly times per train at the three operations are 1, 3, and 1 minutes, respectively. The corresponding times per train and per car are (2, 0, 4) and (1, 2, 0) minutes (a zero time indicates that the operation is not used).

Formulate a LP solution to maximise the revenue [15]