

**OPERATIONS RESEARCH ASSIGNMENT I, TO BE SUBMITTED AFTER EXACTLY
TWO WEEKS AT 1 PM, NO ASSIGNMENT WILL BE COLLECTED AFTER THIS
SAID DATE, MR.KICHE.**

SECTION A

Q1 i) Define the term operations research.

ii) Give a detailed description of the origin of operations research .

iii) Explain the methodology of operations research.

iv) Define the following terms as used in operations research

Model, Objective function, Constraints , Model formulation, Feasible solution, Transportation problems, Allocation problems, Non-negative conditions.

v) State and explain the operations research techniques.

Q2 i) Discuss the significance of operations research.

ii) Identify the limitations of operations research.

iii) Outline and briefly explain the five principle phases of operations research.

iv) Define the term linear programming and outline the five steps followed when formulating a linear programming model mathematically.

v) List the basic properties of linear programming models

Q3i) A farmer has 10 acres to plant in wheat and rye. He has to plant at least 7 acres. However, he has only \$1200 to spend and each acre of wheat costs \$200 to plant and each acre of rye costs \$100 to plant. Moreover, the farmer has to get the planting done in 12 hours and it takes an hour to plant an acre of wheat and 2 hours to plant an acre of rye. If the profit is \$500 per acre of wheat and \$300 per acre of rye how many acres of each should be planted to maximize profits?

ii). A gold processor has two sources of gold ore, source A and source B. In order to keep his plant running, at least three tons of ore must be processed each day. Ore from source A costs \$20 per ton to process, and ore from source B costs \$10 per ton to process. Costs must be kept to less than \$80 per day. Moreover, Federal Regulations require that the amount of ore from source B cannot exceed twice the amount of ore from source A. If ore from source A yields 2 oz. of gold per ton, and ore from source B yields 3 oz. of gold per ton, how many tons of ore from both sources must be processed each day to maximize the amount of gold extracted subject to the above constraints?

iii) .A publisher has orders for 600 copies of a certain text from San Francisco and 400 copies from Sacramento. The company has 700 copies in a warehouse in Novato and 800 copies in a warehouse in Lodi. It costs \$5 to ship a text from Novato to San Francisco, but it costs \$10 to

ship it to Sacramento. It costs \$15 to ship a text from L-odi to San Francisco, but it costs \$4 to ship it from Lodi to Sacramento. How many copies should the company ship from each warehouse to San Francisco and Sacramento to fill the order at the least cost?

iv) A company is involved in the production of two items (X and Y). The resources need to produce X and Y are twofold, namely machine time for automatic processing and craftsman time for hand finishing. The table below gives the number of minutes required for each item:

		Machine time	Craftsman time
Item	X	13	20
	Y	19	29

The company has 40 hours of machine time available in the next working week but only 35 hours of craftsman time. Machine time is costed at £10 per hour worked and craftsman time is costed at £2 per hour worked. Both machine and craftsman idle times incur no costs. The revenue received for each item produced (all production is sold) is £20 for X and £30 for Y. The company has a specific contract to produce 10 items of X per week for a particular customer.

Formulate the problem of deciding how much to produce per week as a linear program.

Solve this linear program graphically.

SECTION B

Q1) A company has four factories and three warehouses located in market areas. The capacities of supply points are [350 450 520 340] and the demands of the destination are [460 500 480]. The cost associated with transporting one unit of the resource from a supply point to a destination is as follows

	D1	D2	D3
S1	3	2	1
S2	1	1	2
S3	2	1	1
S4	1	2	3

By making the initial allocation using North West Corner Rule, Least Cost Method and Vogel Approximation Method determine optimal allocation that minimises the transportation cost

Q2) i) Define a transportation problem.

ii) Consider the transportation problem presented in the following table:

Origin	Destination			Supply
	1	2	3	
1	2	7	4	50
2	3	3	1	80
3	5	4	7	70
4	1	6	2	140
Demand	70	90	180	340

Use North West Corner Rule to determine the initial feasible minimum cost of transportation hence use MODI(Modified Distributed Algorithm) to determine the optimal solution.

Use Least Cost Method to determine the minimum cost of transportation.

Use Vogel Approximation Method to determine the minimum cost of transportation.

SECTION C

Q1) A simple queuing system has the mean interval time of 8 minutes and a mean service time of 4 minutes .

- Determine the mean service rate and the mean arrival rate.
- Determine the traffic intensity.
- Determine the mean time a customer spends in the queue and in the system .
- What is the expected number of customers in the queue and in the system.
- What is the probability of having at most four customers in the system.

Q2) Arrivals at a telephone booth are considered to be Poisson with an average time of 10 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean of 3 minutes.

- What is the probability that a person arriving at the booth will have to wait?
- What is the average length of the queues that form time to time?
- The telephone department will install a second booth when convinced that an arrival would expect to have to wait at least three minutes for the phone. By how much must the flow of arrivals be increased in order to justify a second booth?

Q3) Trucks at a single platform weigh-bridge arrive according to Poisson probability distribution. The time required to weigh the truck follows an exponential probability distribution. The mean arrival rate is 12 trucks per day, and the mean service rate is 18 trucks per day. Determine the following:

- i) The probability that no trucks are in the system.
- ii) The average number of trucks waiting for service.
- iii) The average time a truck waits for weighing service to begin.
- iv) The probability that an arriving truck will have to wait for service.

SECTION D

Q1) Find the dual program of the following linear programming problem.

$$\begin{aligned}
 &\text{Maximize} \quad z = 5x_1 - 2x_2 \\
 &\text{subject to} \\
 &\quad 3x_1 + 2x_2 \geq 16 \\
 &\quad x_1 - x_2 \leq 4 \\
 &\quad x_1 \geq 5 \\
 &\quad x_1 \geq 0, \quad x_2 \text{ is unconstrained}
 \end{aligned}$$

Q2) Find the dual program of the following linear programming problem.

$$\begin{aligned}
 &\text{Minimize} \quad Z = 30x_1 - 50x_2 + 10x_3 \\
 &\text{subject to} \\
 &\quad 3x_1 + 2x_2 - x_3 \geq 44 \\
 &\quad x_1 - x_2 + x_3 = 7 \\
 &\quad x_1 \text{ is unconstrained}, \quad x_2 \geq 0, \quad x_3 \geq 0,
 \end{aligned}$$

Q3) Find the dual program of the following linear programming problem.

$$\begin{aligned}
 &\text{Minimize} \quad P = 16x - 2y - 5z \\
 &\text{subject to} \\
 &\quad x + 4y - z \geq 120 \\
 &\quad x + y + 3z \leq 130 \\
 &\quad x \geq 0, \quad y \geq 0, \quad z \text{ is unrestricted.}
 \end{aligned}$$

SECTION E

Q1i) Mr. Odongo is the inventory manager for office supplies in a large office supply warehouse. The annual demand for paper punches is 20000 units. The ordering cost is \$100 per order and carrying(holding) cost is \$5per unit per year. Determine the expected ordering quantity and the fixed order.

ii) A retailer expects to sell about 200 units of a product per year. The storage space taken up in his premises by one unit of this product is costed at £20 per year. If the cost associated with ordering is £35 per order, what is the economic order quantity given that interest rates are expected to remain close to 10% per year and the total cost of one unit is £100.

iii) The holding cost of a certain item is 20% of its cost and the corresponding economic order quantity is 120. Find the new EOQ if the holding cost decreases to 15% of its cost.

Q2i) State and explain the three main reasons for holding inventory and give a few reasons why only minimal inventories should be held.

ii) Define the term economic order quantity hence explain what FNSD inventory analysis involve.

iii) Explain the steps involved in the calculation of EOQ for discounted quantities, explain briefly ABC analysis as used in inventory control.

Q3) A supermarket purchases 6,000 special toys per year for sale. Each order costs 80/= and inventory holding cost is 15% of the unit price. The supplier has provided the following list

Order quantity	Price per unit
1 to 1000	40/=
1000 to 2000	38/=
Over 2000	35/=

Assuming instantaneous delivery, find

- Economic order quantity.
- Optimum total cost
- Number of orders per year.
- Time between orders (in days)