# KIRIRI WOMENS' UNIVERSITY OF SCIENCE AND TECHNOLOGY
## UNIVERSITY EXAMINATION, 2023/2024 ACADEMIC YEAR
## THIRD YEAR, SECOND SEMESTER EXAMINATION
## FOR THE DEGREE OF BACHELOR OF SCIENCE IN
## COMPUTER SCIENCE
## KMA 312 : OPERATION RESEARCH I

Date: 20th April, 2023
Time: 4.00  - 6.00pm

**INSTRUCTIONS TO CANDIDATES**
**ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS**
**QUESTION ONE (30 MARKS)**

a)  State four advantages of linear programming in decision making.  **(4 Marks)**

b)  Discuss any three characteristics of a queuing system.  **(6 Marks)**

c)  Find the dual of the problem;  **(4 Marks)**

$$\text{Minimize } y_0 = 5y_1 + 2y_2$$
$$\text{Subject to } y_1 + 2y_2 \geq 5$$
$$2y_1 - y_2 \geq 12$$
$$y_1 + 3y_2 \geq 4$$
$$y_1 \geq 0, y_2 \geq 0$$

d)  Kiriri supermarket, the cashier serves 48 customers per hour on average. The customers arrive at the rate of 40 customers per hour. Assuming that the arrivals are random and follow Poisson distribution and that the service times are random and follow a negative exponential distribution, find the probability that a customer will not queue on arrival.

**(6 Marks)**

e)  Apply North West Corner Rule to solve the problem.  **(6 Marks)**

|            | Destination |     |     |        |
|------------|-----|-----|-----|--------|
| Source     | P   | Q   | R   | Supply |
| A          | 8   | 5   | 6   | 120    |
| B          | 15  | 10  | 12  | 80     |
| C          | 3   | 9   | 10  | 80     |
| Demand     | 150 | 80  | 50  |        |

State the characteristics of a linear programme in canonical form.  **(4 Marks)**

## QUESTION TWO (20 MARKS)

a)    A manufacturer is to market a new fertilizer which is to be a mixture of two ingredients A and B.

The properties of the two ingredients are given in the table.

|  | Bone meal | Nitrogen | Lime | Phosphates | Cost (Shillings) |
|---|---|---|---|---|---|
| Ingredient A | 20% | 30% | 40% | 10% | 12 |
| Ingredient B | 40% | 10% | 45% | 5% | 8 |

- It has been decided that:
  - i)    The fertilizer will be sold in bags containing 100 kgs.
  - ii)   It must contain at least 15% nitrogen.
  - iii)  It must contain at least 8% phosphates
  - iv)  It must contain at least 25% bone meal.
- The manufacture wishes to meet the above requirements at the minimum cost possible.
  - **Required:**
    - i)    Formulate a liner programming model for the problem.          **(7 Marks)**
    - ii)   Apply graphical method to solve the problem.                **(7 Marks)**
    - iii)  State the minimum ingredients required hence the minimum cost of producing a 100kg kilo bag.          **(2 Marks)**

b)    What is the disadvantage of using graphical method in solving linear programming problems?

**(4 Marks)**

## QUESTION THREE (20 MARKS)

a)    Distinguish between transportation and assignment models.          **(4 Marks)**

b)    Consider a distribution system having the following constraints.

| Factory | Capacity (Units) |
|---|---|
| A | 45 |
| B | 15 |
| C | 40 |

| Warehouse | Demand (Units) |
|---|---|
| X | 25 |
| Y | 55 |
| Z | 20 |

The transportation costs per unit (in Kshs) associated with each route are as follows

|  | To | | |
|---|---|---|---|
| From | X | Y | Z |
| A | 10 | 7 | 8 |
| B | 15 | 12 | 9 |
| C | 7 | 8 | 12 |

Determine the minimum cost of transport using the Vogel's approximation method (V.A.M)

**(8 Marks)**

c)      A company has four factories each of which can manufacture any of the company's four products. Production costs differ from the plant to another as do the costs of raw materials. Given the production data below assign the products to plants so as to realize maximum profits and state the maximum profit.

**(8 Marks)**

|   | Products (profit in '000' Kshs) | | | |
|---|---|---|---|---|
|   | A | B | C | D |
| 1 | 1 | 8 | 4 | 1 |
| 2 | 5 | 7 | 6 | 5 |
| 3 | 3 | 5 | 4 | 2 |
| 4 | 3 | 1 | 6 | 3 |

## QUESTION FOUR (20 MARKS)

Auto mobiles arrive at the drive through window at the rate of 4 every 10 minutes. The average service time is 2 minutes. The Poisson distribution is appropriate for the arrival rate and service times are exponentially distributed.

   a)      What is the average time a car is in the system?                                    **(2 Marks)**
   b)      What is the average time car spend waiting to receive services?              **(2 Marks)**
   c)      What is the average number of cars in the system?                               **(3 Marks)**
   d)      What is the average number of cars in line behind the customer receiving service?

                                                                                                                **(3 Marks)**
   e)      What is the probability that there are no cars at the window?                  **(2 Marks)**
   f)      What percentage of the time is the service provider busy?                      **(2 Marks)**
   g)      What is the probability that there are exactly 2 cars in the system?          **(3 Marks)**
   h)      What is the probability of there being three or more cars in the system?    **(3 Marks)**


## QUESTION FIVE (20 MARKS)

a)      A food vending company supplies food to a large University.  Because the students offer kick the machines out of anger and frustration, management has a constant repair problem.  The machines break down on average of 3 per hour and the breakdowns are distributed in a Poisson manner.  Down time costs the company 25 dollars per hour per machine and each maintenance worker gets 4 dollars per hour.  One worker can service machines at an average rate of 5 per hour, distributed exponentially. Two workers working together can service machines at a rate of 7 per hour distributed exponentially and a team of 3 workers can do eight per hour distributed exponentially.  What is the optimal maintenance crew size for servicing the machines?

                                                                                                                **(10 Marks)**
b)      Apply simplex method to solve the linear program.                                 **(10 Marks)**

$$\text{Minimize} \quad z = x_1 - 3x_2 + 3x_3$$

Subject to: $3x_1 - x_2 + 2x_3 \leq 7$

$$2x_1 + 4x_2 \geq -12$$

$$-4x_1 + 3x_2 + 8x_3 \leq 10$$

$$(x_1, x_2, x_3) \geq 0$$