



(Knowledge for Development)

**KIBABII UNIVERSITY**  
**UNIVERSITY EXAMINATIONS**  
**2022/2023 ACADEMIC YEAR**  
**SECOND YEAR SECOND SEMESTER**  
**SPECIAL/SUPPLEMENTARY EXAMINATION**  
**FOR THE DEGREE OF BACHELOR OF EDUCATION AND**  
**BACHELOR OF SCIENCE**

**COURSE CODE: MAA 222/MAT 322**

**COURSE TITLE: OPERATION RESEARCH I**

**DATE: 17/8/2023**

**TIME: 8 AM -10 AM**

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**INSTRUCTIONS TO CANDIDATES**

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 5 Printed Pages. Please Turn Over

**QUESTION ONE (30 MARKS)**

- (a) Explain the following terms
- (i) Operation research (2marks)
  - (ii) Slack variable (2marks)
  - (iii) Objective function (2marks)
  - (iv) Basic variable (2marks)
- b) State five stages of development of operation research (5 marks)
- c) Name three tools and techniques used in operation research (2 marks)
- d) You are given the following linear programming problem

$$\text{Max } z = 2x_1 + x_2$$

$$\text{Subject to } x_1 \geq 0, x_2 \geq 0 \text{ and } x_1 + x_2 \leq 6, \quad 2x_1 - 2x_2 \leq 1.$$

- i) Let  $s_1$  and  $s_2$  be the slack variables, write down the canonical form of the problem. (2marks)
- ii) Construct the initial tableau, and identify the basic and non-basic variable (4marks)

c) After a few steps of simplex iterations, the following tableau is found:

| Basis | $x_1$ | $x_2$ | $x_3$ | $x_4$ | Solution |
|-------|-------|-------|-------|-------|----------|
| $x_3$ | 0     | 2     | 1     | -0.5  | $11/2$   |
| $x_1$ | 1     | -1    | 0     | 0.5   | $1/2$    |
| $z$   | 0     | -1    | 0     | 1     | 1        |

Is the tableau already optimal? Give your reasons. If it is not, use the simplex method to continue the calculation and find the optimal solution. (4mks)

- (b) A company has received a contract to supply gravel for three new construction projects located in towns A, B, and C. Construction engineers have estimated the required amount of gravel that will be needed for these construction projects as shown below:

| Project location | Weekly requirement (truck load) |
|------------------|---------------------------------|
| A                | 72                              |
| B                | 102                             |
| C                | 41                              |

The company has three gravel plants X, Y and Z located in three different towns. The gravel required by the construction projects can be supplied by these three plants. The amount of gravel which can be supplied by each plant as follows

| Plant | A mount available/week (truck load) |
|-------|-------------------------------------|
| X     | 76                                  |
| Y     | 62                                  |
| Z     | 77                                  |

The company has computed the delivery cost from each plant to each project site. These costs (in rupees) are shown in the following table:

**Cost per truck load**

| Plant | Cost per truck load |    |    |
|-------|---------------------|----|----|
|       | A                   | B  | C  |
| X     | 4                   | 8  | 8  |
| Y     | 16                  | 24 | 16 |
| Z     | 8                   | 16 | 35 |

Schedule the shipment from each project in such a manner so as to minimize the total transportation cost within the constraints imposed by plant capacities and project requirements using Vogel's approximation methods and hence compute the minimum cost (10 marks)

(c) Use the simplex method to find the maximum value

$$Z = 2x_1 - x_2 + 2x_3 \quad (4\text{marks})$$

Subject to the constraints

$$2x_1 + x_2 \leq 10$$

$$x_1 + 2x_2 - 2x_3 \leq 20$$

$$x_2 + 2x_3 \leq 5$$

$$\text{Where } x_1 \geq 0, x_2 \geq 0 \text{ and } x_3 \geq 0$$

### QUESTION TWO (20 MARKS)

A company has factories F1, F2 and F3 that supply products to warehouses W1, W2 and W3. The weekly capacities of the factories are 200, 160 and 90 units respectively. The weekly warehouse requirements are 180, 120 and 150 units respectively. The units shipping cost in Kshs are as follows.

| Source | W1  | W2  | W3  | Capacity |
|--------|-----|-----|-----|----------|
| F1     | 16  | 20  | 12  | 200      |
| F2     | 14  | 8   | 18  | 160      |
| F3     | 26  | 24  | 16  | 90       |
| Demand | 180 | 120 | 150 |          |

Determine the optimal distribution for this company in order to minimize its total shipping cost using

- (i) North west corner method (8 marks)
- (ii) Least cost method (6 marks)
- (iii) Vogel's approximations (6 marks)

### QUESTION THREE (20 MARKS)

(a) A manufacturing company has four jobs U, V, X, and Y and four machines A, B, C, and D. The given matrix shows returns in shillings of assigning job to a machine. Using Hungarian techniques assign the jobs to machines so as to maximize total returns. (10mks)

| Jobs | A | B  | C  | D  |
|------|---|----|----|----|
| U    | 5 | 11 | 8  | 9  |
| V    | 5 | 7  | 9  | 7  |
| X    | 7 | 8  | 9  | 9  |
| Y    | 6 | 8  | 11 | 12 |