(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2019/2020 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

SPECIAL/SUPPLEMENTARY EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

(PHYSICS)

COURSE CODE: **MAT 322**

COURSE TITLE: **OPERATION RESEARCH I**

DATE: 25/11/2022 **TIME:** 2:00 PM - 4:00 PM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

QUESTIONE 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

Max $z = 2x_1 + x_2$
Subject to $x_1 \geq 0$, $x_2 \geq 0$ and $x_1 + x_2 \leq 6$, $2x_1 - 2x_2 \leq 1$.

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)

e) 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 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 town A, B and C. Construction engineers have estimated the required a mount of gravel which will be needed at these construction project 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		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 (4marks)

$$Z = 2x_1 - x_2 + 2x_3$$

Subject to the constraints

$$2x_1 + x_2 \leq 10$$

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

$$x_2 + 2x_3 \leq 5$$

Where $x_1 \geq 0, x_2 \geq 0$ 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

(b) Suppose an industry is manufacturing 2 products P_1 and P_2, the profit per kg are Ksh 300 and Ksh 400 respectively. These two products require processing in three types of machines. The following table shows the available machine $hrs/\ day$ and the time required on each machine to produce 1kg of P_1 and P_2. Formulate the problem in the form of linear programming model.

Profit	P_1 $Ksh:\ 300$	P_2 $Ksh:\ 400$	Total availability machine (hrs/day)
Machine 1	3	2	600
Machine 2	3	5	800
Machine 3	5	6	1100

(4mks)

(c) List six steps in a simplex maximization problem. (6mks)

QUESTION FOUR (20 MARKS)

(a) State steps to be followed while formulating a linear programming model (4 marks)

(b) Use Big M method to solve the following LP problem (16 marks)

Minimize $Z = 10x_1 + 15x_2 + 20x_3$

Subject to constraints

$$2x_1 + 4x_2 + 6x_3 \geq 24$$

$$3x_1 + 9x_2 + 6x_3 \geq 30$$

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

QUESTION FIVE (20 MARKS)

(a) Explain any two assumption of linear programming (2mks)

(b) Solve the transportation problem, where s_i are factories (shippers) and the D_i are the warehouses (receivers). The shipping costs are shown in the table. Begin by finding an initial basic feasible solution with North west corner method. Find the minimum shipping cost.

Destination

Source	D_1	D_2	D_3	D_4	**Supply**
S_1	19	30	50	10	**7**
S_2	70	30	40	60	**9**
S_3	40	8	70	20	**18**
Demand	**5**	**8**	**7**	**14**	

(8mks)

(c) A manufacturing factory is producing a single product and selling it through agencies situated in different cities. All of a sudden there is demand for the product in another four cities not having any agencies of the factory. The factory is faced with the problem of deciding how to assign the existing agencies to distinguish the product. The distance between surplus and deficit cities are given in the following distance matrix

Surplus/deficit cities	Program/ sales region			
	I	II	III	IV
A	10	22	12	14
B	16	18	22	10
C	24	20	12	18
D	16	14	24	20

Determine the optimum assignment schedule such that the total sales are maximized (10 marks)