Kasarani Campus
Off Thika Road
Tel. 2042692 / 3
P. O. Box 49274, 00100
NAIROBI
Westlands Campus
Pamstech House
Woodvale Grove
Tel. 4442212
Fax: 4444175

KIRIRI WOMENS' UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATION, 2022/2023 ACADEMIC YEAR
THIRD YEAR, SECOND SEMESTER EXAMINATION
FOR THE DEGREE OF BACHELOR OF SCIENCE
(MATHEMATICS AND COMPUTER SCIENCE)

Date: 26th July, 2022
Time: 8.30am –10.30am

KMA 312 - OPERATIONS RESEARCH 1

INSTRUCTIONS TO CANDIDATES

ANSWER **QUESTION ONE (COMPULSORY)** AND **ANY OTHER TWO** QUESTIONS

QUESTION ONE (30 MARKS)

a) List out the applications of operations research. (5 marks)

b) What are the three components of linear programming model? (3 marks)

c) Solve the following linear programming problem by graphical method

Minimize $Z = 20X_1 + 10X_2$

Subject to $X_1 + 2X_2 \leq 40$

$3X_1 + X_2 \geq 30$

$4X_1 + 3X_2 \geq 60$

$X_1, X_2 \geq 0$

(6 marks)

d) Solve the following problem linear programming problem by using the simplex method.

Maximize :

$$Z = X_1 + 2X_2 + X_3$$

Subject to :

$$2X_1 + 3X_2 + 3X_3 \leq 11$$

$$X_1, X_2, X_3 \geq 0$$

(6 marks)

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

i) Determine the mean service rate and the mean arrival rate. (2 marks)

ii) Determine the mean time a customer spends in the queue and in the system. (3 marks)

f) Define game theory and state three managerial applications of game theory (5 marks)

QUESTION TWO (20 MARKS)

a) Give features of OR. Briefly discuss techniques and tools of OR.

(8 marks)

b) Calculate the maximal and minimal value of z = 5x + 3y for the following constraints.

$x + 2y \leq 14$

$3x - y \geq 0$

$x - y \leq 2$ (12 marks)

QUESTION THREE (20 MARKS)

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

$Maximize\ z = 5x1 - 2x2$

$subject\ to$

$3x1 + 2x2 \geq 16$

$x1 - x2 \leq 4$

$x1 \geq 5$

$x1 \geq 0,2\ is\ unconstrained$ (4 marks)

b) Consider the following reward matrix

Player I	Player II		
	1	2	3
1	17	23	48
2	17	3	51
3	3	17	-2

Which strategy should each of the two players choose? One answer must be obtained by applying the concept of dominated strategies to rule out a succession of inferior strategies until only one choice remains. (12 marks)

c) 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, state the linear programming problem to maximize profits?

(4 marks)

QUESTION FOUR (20 MARKS)

a) Find out the minimum initial feasible solution for the following transportation problem, using North West Corner Rule method

FROM	TO			
	P	Q	R	supply
A	16	19	12	14
B	22	13	19	16
C	14	28	8	12
Demand	10	15	17	

(7 marks)

b) Machineco has four machines and four jobs to be completed. Each machine must be assigned to complete one job. The time required to set up each machine for completing each job is shown in the table below. Machineco wants to minimize the total setup time needed to complete the four jobs. Use Hungarian method to solve this problem.

TIME

MACHINE	JOB1	JOB2	JOB3	JOB4
1	14	5	8	7
2	2	12	6	5
3	7	8	3	9
4	2	4	6	10

(11 marks)

c) What is the importance of transportation model in operations research? (2 marks)

QUESTION FIVE (20 MARKS)

a) Suppose that customers arrive about every 3 minutes on average to JMU Bookstore according to a Poisson process. There is one counter open for service, with two employees working. One employee fixes a customer's order and another employee takes their money. It take an average of two minutes (exponentially distributed) to complete each customer order

i) What is the average arrival rate to the window at JMU Bookstore?
ii) What is the average number of customers waiting to order?
iii) What is the average number of customers at JMU Bookstore?
iv) What is the average amount of time spent in line by customers at JMU Bookstore?
v) What is the probability that a customer will have to wait in line to get served at JMU Bookstore?
vi) How long, on average, does it take a customer to get served at JMIII Bookstore

(11 marks)

b) KPLC has three electric power plants that supply the needs of four cities. Each power plant can supply the following numbers of kilowatt-hours (kwh) of electricity: plant 1— 35 million; plant 2—50 million; plant 3—40 million (see the table below). The peak power demands in these cities, which occur at the same time (2 P.M.), are as follows (in kwh): city 1—45 million; city 2—20 million; city 3—30 million; city 4—30 million. The costs of sending 1 million kwh of electricity from plant to city depend on the distance the electricity must travel. Formulate an LP to minimize the cost of meeting each city's peak power demand.

TO

FROM	CITY1	CITY2	CITY3	CITY4	SUPPLY
PLANT1	8	6	10	9	35
PLANT2	9	12	13	7	50
PLANT3	14	9	16	5	40
DEMAND	45	20	30	30	

(9 marks)