



KENYATTA UNIVERSITY

EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

(GAS AND PETROLEUM ENGINEERING)

EPL 408: OPERATIONS RESEARCH

1st SEMESTER 2022/2023

TIME: 2 HOURS

INSTRUCTIONS:

Answer Question One and any other two Questions.

Question One

- (a) Define Operations research. (1 mark)
- (b) State conditions for a mathematical model to be a Linear Program, (3 marks)
- (c) Outline the **four** basic assumptions in Linear Programming. (4 marks)
- (d) State the **four** aspects of decision making. (4 marks)
- (e) In a supermarket one cashier is there to serve the customers. The arrival rate is 9 customers for every 5 minutes and the cashier can serve 10 customers in 5 minutes. Assuming Poisson arrival rate and exponential distribution for service rate.

Find:

- (i) Average number of customers in the system.
- (ii) Average number of customers in the queue or average queue length.
- (iii) Average time a customer spends in the system.
- (iv) Average time a customer waits before being served.
- (f) State the **four** cases that occur when Linear Program is solved. (4 marks)
- (g) KM Co makes shirts, shorts, and pants using the limited labor and cloth described below. Determine product mix that maximizes profit. (9 marks)

	Shirts	Pants	Total Avail
Labor (hrs/wk)	3	6	150
Cloth (m2/wk)	4	4	160
Profit	12	15	

SECTION B: ANSWER ANY TWO (2) QUESTIONS FROM THIS SECTION

Question Two

- (a) Outline the steps to follow in solving operations research problem. (7 marks)
- (b) Consider the following problem.
- Write the dual of the given Primal
 - Work through the simplex method step by step in tabular form to solve the problem of the primal. (13 marks)

$$\text{Maximize } z = 3x_1 + 2x_2 + x_3$$

subject to

$$2x_1 + 2x_2 + x_3 \leq 10$$

$$x_1 + 2x_2 + 3x_3 \leq 15$$

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

Question Three

- (a) The management of Power Oil company is considering the use of a newly discovered chemical which, when added to Diesel, will make the fuel Jet fuel, thus eliminating the necessity of using kerosene in jet fuel production.

The management is considering at present time, these three alternative strategies.
S1 = Add the new chemical to the currently marketed Diesel and sell it under label 'New Improved Jet fuel'.

S2 = Introduce a brand new Jet fuel under the name of 'Super Jet fuel'

S3 = Develop a new product and enter the Oil market under the name 'E Jet fuel'.

The management has decided for the time being that only one of the three strategies is economically feasible (under current market condition). The marketing research department is requested to develop a conditional payoff matrix for this problem. After conducting sufficient research, based on personal interviews and anticipating the possible reaction of the competitors, the marketing research department submits the payoff matrix given below. Select the optimal strategy under the following approaches.

(10 marks)

- Pessimistic,
- Optimistic,
- Equal probability,
- Regret,

Strategies.	State of nature.		
	N_1	N_2	N_3
Utility of Payoffs.			
S_1	15	12	18
S_2	9	14	10
S_3	13	4	26

- (b) A company is planning for its sales targets and the strategies to achieve these targets. The data in terms of three sales targets, their respective utilities, various strategies and appropriate probability distribution are given in the table given below. What is the optimal strategy? (10 marks)

Sales targets ($\times$ KShs)	50	75	100
Utility	4	7	9
	Prob.	Prob.	Prob.
Strategies			
S_1	0.6	0.3	0.1
S_2	0.2	0.5	0.3
S_3	0.5	0.3	0.2

Question Four

The Works worker Company produces two parts (products 1 and 2) that require both frame parts and electrical components. Management wants to determine how many units of each product to produce so as to maximize profit. For each unit of product 1, 1 unit of frame parts and 2 units of electrical components are required. For each unit of product 2, 3 units of frame parts and 2 units of electrical components are required. The company has 200 units of frame parts and 300 units of electrical components. Each unit of product 1 gives a profit of KSh1, and each unit of product 2, up to 60 units, gives a profit of KSh2. Any excess over 60 units of product 2 brings no profit, so such an excess has been ruled out.

- Formulate a linear programming model for this problem.
 - Use the graphical method to solve this model. What is the resulting total profit?
- (20 marks)

Question Five

Oil refiners has three power plants that supply the needs of four cities. Each power plant can supply the following numbers of kwh of electricity: plant 1, 35 million; plant 2, 50 million; and plant 3, 40 million. The peak power demands in these cities 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 is given in the table below. To minimize the cost of meeting each city's peak power demand, formulate a balanced transportation problem in a transportation tableau and represent the problem as a LP model. Get distribution using North West Corner Method and optimize using stepping stone method. (20 marks)

From	To (KSh)			
	City 1	City 2	City 3	City 4
Plant 1	8	6	10	9
Plant 2	9	12	13	7
Plant 3	14	9	16	5