



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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University Examinations 2021/2022

**THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF BUSINESS INFORMATION TECHNOLOGY, BACHELOR OF COMPUTER
TECHNOLOGY AND BACHELOR OF INFORMATION TECHNOLOGY**

SECOND YEAR FIRST SEMESTER BACHELOR OF ACTUARIAL SCIENCE

SMC 3255/SMS 3255: OPERATIONS RESEARCH

DATE: JANUARY 2022

TIME: 2 HOURS

INSTRUCTIONS: *Answer question **one** and any other **two** questions*

QUESTION ONE (30 MARKS)

- a) Distinguish between optimization and linear programming (2 marks)
- b) When OR is used to solve a problem of an organization, a seven step procedure is followed, state and briefly explain any such two steps (4 marks)
- c) Customers arrive at an ATM at the rate of 15 per hour and the machine can serve customers at a rate of one every 3 minutes. Assuming Poisson arrivals and exponential service, find the average number of customers in the waiting line (4 marks)
- d) Find the dual of the LPP

$$\begin{aligned}
 \text{minimize } C &= 2x + 6y + 4z \\
 \text{subject to } 2x + 5y + 2z &\geq 38 \\
 4x + 2y + 3z &\geq 57 \\
 x + 3y + 5z &\geq 57 \\
 x, y, z &\geq 0
 \end{aligned}$$

Write down its dual problem

(4 marks)

- e) The following table give the activities in a construction project and the duration of the activities in days

Activity	1-2	1-3	2-3	2-4	3-4	4-5
Duration(days)	20	25	10	12	6	10

Draw a network diagram for the project and determine the project duration(4 marks)

- f) Find the initial basic feasible solution of the following transportation problem using North West corner rule

(6 marks)

Factory					Supply
	W1	W2	W3	W4	W1
F1	14	25	45	5	6
F2	65	25	35	55	8
F3	35	3	65	15	16
demand	4	7	6	13	

- g) A manager at an oil company wants to find optimal mix of two blending processes. The data is provided below

Process	Input (crude. Oil)		Output (Gasoline)	
	Grade A	Grade B	X	Y
P1	6	4	6	9
P2	5	6	5	5

Profit per operation: Process (P₁)=kes. 4,000 and process (P₂)= kes. 5,000

Maximum availability of crude oil: Grade A=500 units and grade B=400 units

Minimum demand for gasoline: X=300 units and Y =200 units

Formulate a LPP for the data (6 marks)

QUESTION TWO (20 MARKS)

a) What is the difference between CPM and PERT as used in project management

(2 marks)

b) An organization has listed the following activities in respect of a project

Activity	Preceding activity	Duration(days)
A	-	2
B	A	3
C	A	5
D	A	8
E	B	6
F	C	1
G	C	2
H	C and D	3
I	E and F	7
J	G and H	4
K	I and J	5

i. Construct the network diagram for the project (6 marks)

ii. Determine the critical activities and the critical path hence find the project completion time (3 marks)

iii. Calculate the total float and free float for non-critical activities (6 marks)

- c) At a certain retail counter, customers' arrival follows a Poisson process with an average time of 5 minutes between arrivals. The time interval between services at the counter follows exponential distribution and as such the time taken to service a unit is 2 minutes. Calculate the expected average queue length (3 marks)

QUESTION THREE (20 MARKS)

- a) State and explain two assumptions of linear programming (4 marks)
- b) Three products are processed through three different operations. The times in minutes required per unit of each product, the daily capacity of the operations (in minute per day) and the product per unit sold of each product (in Ksh) are in the table

TIME PER UNIT (MINUTES)				
Operation	Product 1	Product 2	Product 3	Operation capacity (min/day)
1	1	2	1	430
2	3	0	2	460
3	1	4	0	420
Profit/unit	300	200	500	

Required:

- Formulate a linear program governing this data (4 marks)
- Convert the linear program to standard form (4 marks)
- Apply simplex method to determine the maximum profit (8 marks)

QUESTION FOUR (20 MARKS)

- a) The cost (000 KES) of transporting one ton of wheat from each grain store to each mill is given in the following table

	MILL					
	Unga	Maisha	Afya	Dola	Pembe	Supply
Nanyuki	4	1	2	6	9	100
Nakuru	6	4	3	5	7	120
Eldoret	5	2	6	4	8	120
Demand	40	50	70	90	90	

Apply Vogel's approximation method (VAM) to obtain the initial basic solution, hence apply MODI to obtain the optimal solution (12 marks)

- b) KFF ha four football games and four teams of officials on a particular afternoon. KFF office wants to assign the officials to games so as to minimize the total distance in kilometres for each team of officials to each game location as shown in the table below

OFFICIALS	GAME SITES			
	P	Q	R	S
A	210	90	180	160
B	100	70	130	200
C	175	105	140	170
D	80	65	105	120

Find the optimal assignment of officials to the sites (8 marks)

QUESTION FIVE (20 MARKS)

- a) The arrival rate of customers at a banking counter follows a Poisson distribution with a mean of 30 per hour. The service rate of the counter clerk follows exponential distribution with mean of 45 per hour. Find
- Average number of customers waiting in the system (3 marks)
 - Average waiting time of customers in the queue (3 marks)
 - What is the probability of having zero customers in the system? (4 marks)
- b) A firm manufacturers two types of bearings, A and B, each of which requires processing time on lathes, grinders and polishers. The machine time needed for each type of bearing are given in the table

Bearing type	Time required in (hours)		
	Lathe	Grinder	Polisher
A	2	8	5
B	5	5	2

The total machine time available is 250 hours on lathes, 310 hours on grinders and 160 hours on polishers. The net profit per bearing of type A is k\$9 and of type B is K\$10.

Apply graphical method to determine the number of each type of bearing to be produced in order to maximize profit and state the maximum profit (10 marks)