Strathmore
UNIVERSITY

STRATHMORE BUSINESS SCHOOL
BACHELOR OF SUPPLY CHAIN MANAGEMENT
END OF SEMESTER EXAMINATION
BSCM 4105 Operations Research

DATE: 11th December 2023 Time: 08:00 – 10:00 Hrs

Instructions

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

Question One (30 Marks)

(a) Explain the difference between the following terms in *Operations Research*

(i) Balanced and unbalanced transportation problems. (2 Marks)
(ii) Unbounded solution and bounded solution of linear programming problems (2 Marks)
(iii) Linear and non-linear programming problems (2 Marks)

(b) Name and explain any three characteristics of *Operations Research* (6 Marks)

(c) A farmer has a 320-acre farm on which she plants two crops: corn and soybeans. For each acre of corn planted, her expenses are $50 and for each acre of soybeans planted, her expenses are $100. Each acre of corn requires 100 bushels of storage and yields a profit of $60; each acre of soybeans requires 40 bushels of storage and yields a profit of $90. If the total amount of storage space available is 19,200 bushels and the farmer has only $20,000 on hand

(i) Formulate the linear model (3 Marks)
(ii) Using the graphical method, determine how many acres of each crop should she plant in order to maximize her profit (4 Marks)
(iii) Find her profit be if she follows this strategy (1 Mark)

(d) Consider a problem of assigning four different categories of machines to four tasks. The machines differ in efficiency (time to accomplish the tasks) and the tasks differ in their intrinsic difficulty. The estimate of time each machine would take to accomplish each task is given in the matrix below.

Machine	**task**			
	1	**2**	**3**	**4**
A	14	13	17	14
B	16	15	16	15
C	18	14	20	17
D	20	13	15	18

(i) Formulate the problem as a linear model (3 Marks)
(ii) Determine how the tasks should be allocated one to one machine so as to minimize the total man hours (7 Marks)

Question 2 (20 Marks)

(a) Explain any two assumptions in Linear programming problem (2 Marks)

(b) The following primal problem

Maximize $Z = 3x_1 + 2x_2 + x_3$

Subject to

$$x_1 + 4x_2 + x_3 \leq 8$$

$$x_1 + 2x_2 \leq 4$$

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

Required:

(i) Write the dual for the above Linear Programming Problem. (3 Marks)

(ii) Write the standard form for the dual problem (3 Marks)

(iii) Using the primal problem, solve for the optimum values of solution, Z using the simplex method. (12 Marks)

Question 3 (20 Marks).

(a) Explain the objective of a transportation problem (2 Marks)

(b) Name and Explain any two applications of transportation models (2 Marks)

(c) Explain three general steps in solving transportation model (3 Marks)

(d) A company has three cement factories. A, B and C and four area distributors W, X Y and Z, with identical cost of production at three factories. The only variable cost involved is the transportation cost. The monthly production capacity of the three factories in tones monthly demand of four distributors and the transportation costs per ton (in dollars) from different factories to different locations of distribution centers are as follows:

Destinations					
Plants	W	X	Y	Z	**Supply**
A	20	25	50	10	45,000
B	45	50	15	40	50,000
C	22	10	45	35	55,000
Demand	50,000	40,000	30,000	30,000	

Suggest an optimal transportation schedule and find the minimum transportation cost.

Using the North_ West corner cell algorithm, Determine

(i) the initial basic Feasible Solution (10 Marks)

(ii) the total least cost incurred by the company. (3 Marks)

Question 4 (20 Marks)

(a) Five projects are being evaluated over a 3 year planning horizon. The following table gives expected returns for each project and the associated yearly expenditure

Project	Expenditure (in millions kshs)			Returns (in millions Kshs)
	1	2	3	
1	5	4	8	20
2	4	7	10	40
3	3	9	2	20
4	7	4	1	15
5	8	6	10	30
Available funds (in million, Kshs)	25	25	25	

Formulate the model as an integer programming model (5 Marks)

(b) A research firm has come up with a mathematical data for two products X_1 and X_2 which a firm manufacture. It has been found that this is a non-linear programming problem having linear constraints and the objective function is of quadratic form. The data gathered is as follows:

$$\text{Maximixe } Z = 8x_1 - x_1^2 + 8x_2 - x_2^2$$

$$\text{Subject to the constraints } \begin{aligned} x_1 + x_2 &\le 12 \\ x_1 - x_2 &\le 4 \\ x_1, x_2 &\ge 0 \end{aligned}$$

Determine the maximum contribution and the number of units that can be expected from these products. (15 Marks)

Question 5 (20 Marks)

The activities for buying a new car are summarized in the table below:

Activity	*Description*	*Required Predecessor*	*Duration* (days)
A	Conduct feasibility study	(None)	3
B	Find a potential customer for present car	A	14
C	List possible models	A	1
D	Research all possible models	C	3
E	Conduct interviews with mechanics	C	1
F	Collect dealer propaganda	C	2
G	Compile and organize all pertinent information	D,E,F	1
H	Choose top three models	G	1
I	Test drive all three choices	H	3
J	Gather warranty and financing information	H	2
K	Choose one	I,J	2
L	Compare dealers and choose dealer	K	2
M	Search for desired color and options	L	4
N	Test drive chosen model once again	L	1
O	Purchase new car	B,M,N	3

(i) Draw the network model (5 Marks)

(ii) Determine the slacks and critical path (14 Marks)

(iii) Hence, find the project completion time (1 Mark)