



THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

SEPTEMBER –DECEMBER 2021

FACULTY OF ARTS AND SOCIAL SCIENCES

DEPARTMENT OF ECONOMICS

REGULAR PROGRAMME

ECN 305: OPERATIONS ANALYSIS

Date: DECEMBER 2021

Duration: 2 Hours

INSTRUCTIONS: Answer Question ONE and any TWO Questions

Q1.

- a) Briefly explain the following concepts
- i) Dual problem (1 Mark)
 - ii) Dominant strategies (1 Mark)
 - iii) Unbalanced transportation problem (1 Mark)
 - iv) Degeneracy in transportation (1 Mark)
- b) A firm produces three products X_1 , X_2 , and X_3 . It uses two resources; man-hours and raw materials. The following additional information is given about the production process.
- 1. To produce a unit of X_1 , the firm requires 6 hours and 2 units of raw materials.
 - 2. To produce a unit of X_2 , the firm requires 3 hours and 2 units of raw materials.
 - 3. To produce a unit of X_3 , the firm requires 5 hours and 10 units of raw materials.

4. Only 30 man-hours and 50 units of raw materials are available. If profits per unit of product X_1 , X_2 , and X_3 are 30, 24, and 60 respectively;
- Formulate this problem as a linear programming problem in a standard way **(5 Marks)**
 - What should be the production of each type of product? Use simplex method to solve **(8 marks)**
 - Interpret your solution as thoroughly as possible. Be sure to interpret the shadow prices/ marginal values for the resources **(4 Marks)**
- c) Seven Jobs must be processed by 3 machines in the order M_1 , M_2 , M_3 . The machine times in hours are shown below:-

		A	B	C	D	E	F	G
Machines	M_1	3	8	7	4	9	8	7
	M_2	4	3	2	5	1	4	3
	M_3	6	7	5	11	5	6	13

- Determine the optimal sequencing order of the Jobs. **(3 Marks)**
- Calculate the idle time for M_2 and M_3 **(3 Marks)**
- If a start-up cost of Shs. 10,000 is required for each machine, and the running cost is estimated to be Shs. 20 per machine hour, estimate the total cost of production. **(3 Marks)**

Q2.

- The Acem manufacturing company has a current transportation schedule, which the Board is questioning whether or not it is optimal. The company has three factories and five depots. The necessary data regarding costs in dollars, factory capacities, and depot requirements are given below:

Depots	Factories			Depot Requirements
	1	2	3	
A	5.00	4.00	8.00	800
B	3.00	5.00	4.00	400
C	8.00	7.00	4.00	500
D	6.00	7.00	6.00	400
E	6.00	7.00	6.00	600
Factory Capacity	1100	900	700	

- i) Using the North-West Corner solution, determine the initial feasible transportation schedule **(5 Marks)**
- ii) Find the optimal solution using the modified distribution method (MOD) or the stepping stone method (SSN) **(8 Marks)**
- b) Assume there are four contractors and four jobs to be done. The bids for each job by each contractor are summarized in the following table where C= contractor and J= job.

	C₁	C₂	C₃	C₄
J₁	15	13	14	17
J₂	11	12	15	13
J₃	13	12	10	11
J₄	15	17	14	16

Obtain the optimal assignments of the contractors to the jobs **(7 Marks)**

Q3.

- a) A testing laboratory has seven samples to test for some properties. Each test is in two parts. Each sample is always subjected to test 1 first, then test 2. The laboratory has only one machine of the type required for each part of the test. The time in minutes it takes for every sample in each test is given below

Sample	1	2	3	4	5	6	7
Test 1	2	7	10	5	6	4	8
Test 2	3	9	8	2	11	3	11

Determine the order in which the samples should be tested to minimize the total elapsed time. **(10 Marks)**

- b) Obtain the dual problem of the following the primal problem **(10 Marks)**

$$\text{Max } \pi = 5 X_1 + 3 X_2$$

s. t

$$6 X_1 + 2 X_2 \leq 36$$

$$5 X_1 + 5 X_2 \leq 40$$

$$2 X_1 + 4 X_2 \leq 28$$

$$X_1, X_2 \geq 0$$

Q4.

- a) Consider a market comprising two firms, Firm A and Firm B, and a choice of two Strategies for each: advertise or don't advertise. Each firm expects to earn higher profits if it advertises than if it does not. But the actual level of profits for each firm depends on whether the rival firm advertises or not. Thus, each firm's strategy (i.e., advertise or don't advertise) can be associated with each of the rival's strategies (also to advertise or don't advertise). The possible outcomes and payoffs are illustrated by the payoff matrix in the table below.

	FIRM B
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FIRM A		Advertise	Don't Advertise
	Advertise	4, 3	5, 1
	Don't Advertise	2, 5	3, 2

- i) Represent the information in the table on a game tree **(4 Marks)**
- ii) Show the dominated and dominant strategies **(4 marks)**
- iii) Derive the Nash Equilibrium **(4 Marks)**
- b) Using a payoff matrix discuss your understanding of the prisoners' dilemma **(5 Marks)**
- c) Explain the role of operations analysis in business **(3 Marks)**

Q5.

Given the following project details,

Activity	Activity Description	Duration in Weeks	Preceding Activities
a	Administrative Set-up	3	-
b	Hire Personnel	4	a
c	Obtain materials	4	a
d	Transport materials to the lake	2	c
e	Gather measuring team	4	a
f	Planning	6	c
g	Assemble equipment	3	d,b
h	Plan evaluation	1	e
i	Oxygenation	12	f,g
j	Measurement & Evaluation	2	i,h

- i) Briefly explain three main functions in project management. **(6 Marks)**
- ii) Set up the project network showing the various activities and durations **(7 Marks).**
- iii) Determine the critical path hence the critical activities of the project **(4 Marks).**
- iv) What is the longest period that the project can take to complete? **(3 Marks)**

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