MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF ECONOMICS & STATISTICS

BACHELOR OF ECONOMICS AND FINANCE

BACHELOR OF ECONOMICS

EES 402: OPERATIONS RESEARCH II

DATE: 14/12/2021 **TIME: 11.00-1.00 PM**

INSTRUCTIONS:

(i) Answer Question **ONE** and any other **TWO** questions

(ii) Show all your workings clearly

QUESTION ONE (COMPULSORY) (30 marks)

a) Owen sells animal feeds in his shop. The annual demand for the animal feed is 25600 bags. Each bag cost $ 16 and the inventory carrying charges is 25% per annum. If the cost of procurement is $ 200 determine the following.

i) Economic order quantity

ii) Number of orders per year

iii) Time between two consecutive orders

iv) Optimal cost (8 marks)

b) During the launch of registration for Huduma number six people arrived every one hour at a certain centre for registration. The staff took five minutes on average to register each one of them. Assuming that the arrivals follow a Poisson distribution and the serving time follows an exponential distribution determine the following.

i) The percentage of time that there was no one being served at the centre (2 marks)

ii) The average number of people who would be in the centre for registration (2 marks)

iii) The average time one had to wait to be registered (2 marks)

iv) The average number of people waiting for their turn to be registered (2 marks)

v) The average time a person spent in the centre. (2 marks)

$$\rho = \frac{\lambda}{\mu} \qquad N_q = \frac{\lambda^2}{\mu(\mu-\lambda)} \quad N_s = \frac{\lambda}{\mu-\lambda} \quad T_q = \frac{\lambda}{\mu(\mu-\lambda)} \quad T_s = \frac{1}{\mu-\lambda}$$

c) Heri Homes ltd won a tender from the government to build affordable houses under the Big Four agenda. The planning department produced the following schedule for the activities constituting the Project with their respective prerequisites, times in months and cost in millions of Kenya Shillings

Activity	Prerequisites	Normal time	Crash time	Normal cost	Crash cost
A	-	5	3	50	72
B	-	3	2	20	30
C	-	2	1	15	30
D	C	3	1	8	20
E	B	4	4	30	30
F	C&E	8	4	13	21
G	F	5	1	45	65
H	F	2	1	45	52
I	F	2	2	40	40
J	A	3	2	22	34
K	J & E	5	3	23	33
L	D & G	7	5	34	38
M	K& H	8	6	12	18

i) Draw the network diagram and determine the critical path and project duration. (4 marks)

ii) Crash the relevant activities systematically and determine the optimal project time and cost (4 marks)

iii) Determine and interpret the total and independent floats of the non-critical activities (4 marks)

QUESTION TWO (20 MARKS)

a) Briefly explain the term simulation as applied in operations research highlighting its merits and demerits. (6 marks)

b) Mr. Juma, a mechanic, operates a garage for regular repairs and maintenance. He schedules all the cars in need of service for 60 minutes appointments. Some of the cars take more or less than 60 minutes depending on the type of mechanical service and repairs to be done. The

following summary shows the various categories of service and repairs, the probabilities of the garage getting such work and the actual time taken to complete the work.

Category	Time required in minutes	Probability of category
Wheel balancing	45	0.40
Shocks repairs	60	0.15
Tyres Puncture	15	0.15
Body works	45	0.10
Regular service	15	0.20

Assume that all the cars are brought at their scheduled arrival time starting at 8 am. Use the following random numbers: 40 82 11 34 25 66 17 79 46 57.

Required

Simulate the mechanic's garage for five hours and determine the average waiting time for each car in need of service as well as the idleness of the mechanics in the garage. (14 marks)

QUESTION THREE (20 MARKS)

a) Explain briefly five ways linear programming can be used to enhance optimal production. (5 marks)

b) A company produces two electronic products P and Q using two main inputs, iron and wood. Product P requires one unit of iron and three units of wood. Product Q requires one unit of iron and one unit of wood. The company allocates three and five units of iron and wood per day respectively. The selling prices of products P and Q are $ 80 and $ 60 per unit respectively.

i) Formulate a linear program (3 marks)

ii) Find the optimal product mix using graphical method (5 marks)

iii) Determine the shadow price for each input and advise which one should get a higher priority in case the company would want to increase using graphical method. (5 marks)

iv) Determine the feasibility range for each input. (2 marks)

QUESTION FOUR (20 MARKS)

a) Briefly explain the following situations in transport models

i) Degeneracy (2 marks)

ii) Transhipment (2 marks)

b) Three coffee growing farms, Chana, Saswa and Rurwa supply 160, 100 and 180 bags of coffee weekly to coffee processing factories located at five regions, Toro, Nuna, Mawi, Boma and Zora. The weekly demands for the factories located at Toro, Nuna, Mawi, Boma and Zora are 80, 80, 100, 80 and 160 bags of coffee respectively. The farms hire a transport company whose charges per unit of bag are given as follows

Farm/Factory	Toro	Nuna	Mawi	Boma	Zora
Chana	5	8	6	6	3
Saswa	4	7	7	6	6
Rurwa	8	4	6	6	3

i) Determine the initial feasible solution using Vogel's Approximation Method (6 marks)

ii) Find the optimum transport solution and its associated cost (10 marks)

QUESTION FIVE (20 MARKS)

a) Briefly explain the following terms as applied in network analysis

i) Total float

ii) Free float

iii) Independent float (6 marks)

b) A textile manufacturing company makes three different designs of a certain dress labelled A, B and C. The production process requires some leather material in squared feet, two types of skilled labour: sewing and finishing in man-hours. The following table gives the availability of the resources, their usage by the three products and selling price per unit in dollars.

	Resource requirement per unit			
Resources	A	B	C	Availability
Leather (ft^2)	8	4	4	60 ft^2
Sewing (Hours)	8	8	32	80 hrs
Finishing (Hours)	8	12	4	128 hrs
Price per unit	120	80	40	

i) Solve the linear program above to find the number of units for each design of dress that the company should make in order to maximize its revenue. (8 marks)

ii) Find how much additional revenue will be generated if each input was increased by one unit. (6 marks)