



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF AGRICULTURE, ENVIRONMENT AND HEALTH SCIENCES

DEPARTMENT OF AGRICULTURAL SCIENCES

THIRD YEAR FIRST SEMISTER EXAMINATION FOR

BACHELOR OF SCIENCE IN AGRIBUSINESS MANAGEMENT AND TRADE

AGB 302: QUANTITATIVE TECHNIQUES IN AGRIBUSINESS

DATE: 24/8/2022

TIME: 8.30-10.30 AM

INSTRUCTIONS:

Answer **Question ONE** and **ANY TWO** other questions. Clearly show all your workings.

QUESTION ONE (30 MARKS)

- a) Explain three assumptions of linear programming (3 marks)
- b) Given $A = \{0,2,6\}$, $B = \{1,2,-3\}$, and $C = \{4,-8,3,0\}$, find:
- $B \cap C$ (1 mark)
 - $(A \cup C) \cap (B \cap \emptyset)$ (2 marks)
- c) A project activity has most likely, optimistic and pessimistic time estimates of 8, 6 and 12 days, respectively. Find the activity's:
- Mean duration (2 marks)
 - Variance of duration (2 marks)
- d) The table below shows the probability distribution of herbicide sales at a farm inputs shop. Calculate the expected sales for the period January-June (3 marks)

Sales in Thousands of Shillings (x)		200	700	850	1000
Probability [P(x)]	January-March	0.03	0.40	0.37	0.20
	April-June	0.15	0.27	0.35	0.23

- e) Suppose an economic model is represented by the following equation system. Solve for variables x , y and z using the elimination method (4 marks)

$$9x + 3y - 4z = 35$$

$$x + y - z = 4$$

$$2x - 5y - 4z + 48 = 0$$

- f) An agribusiness investor constructed the following payoff table for investment in broiler production. The figures are profits in millions of Kenya Shillings. Justifying your answer, advise the investor on the best decision using:

- i. The conservative approach (2 marks)
 ii. The minimax regret approach (3 marks)

Decision alternative	States of Nature	
	Weak demand (s1)	Strong demand (s2)
Small scale production (d1)	31.6	36.0
Medium scale production (d2)	22.4	102.5
Large scale production (d3)	-20.3	250.0

- g) Given $A = \begin{bmatrix} 3 & -2 \\ 5 & -2 \end{bmatrix}$, $B = \begin{bmatrix} 2 & -1 & 3 \\ -1 & 4 & -1 \\ 0 & -3 & 1 \end{bmatrix}$ and $C = \begin{bmatrix} 1 & 3 & -2 \\ -2 & -1 & -1 \\ 1 & -3 & 2 \end{bmatrix}$

Find:

- i. $[(2A)^T]^{-1}$ (4 marks)
 ii. $|B - C|$ (5 marks)

QUESTION TWO (20 MARKS)

- a) In June 2022, Kilimo microfinance had 200 employees working in Baringo County and 250 employees working in Nakuru County. The probability that employees move from Nakuru to Baringo each year is 0.1 while the probability of moving from Baringo to Nakuru each year is 0.2. Using the Markov Process, estimate the number of employees expected to be working in each county in June 2024. (10 marks)

- b) The following table shows rice seed sales data from Rafiki Ltd.

Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Sales volume (tons)	34	42	38	46	36	32	40	36

- i. Use a 4-month moving average to forecast sales for July, August, September and October (5 marks)
- ii. Forecast sales for April, May, June and July, using a smoothing constant of 0.1 (5 marks)

QUESTION THREE (20 MARKS)

Nafaka Ltd grows green grams and maize for the market and is interested in maximizing profits. The firm uses only land, labor and capital to produce the crops. One acre of green grams requires, 60 days of labor, while an acre of maize requires 40 days of labor. Capital requirements per acre are Ksh 36,000 for green grams and Ksh 14,400 for maize. An acre of green grams yields a profit of Ksh 60,000 while maize has a profit of Ksh 50,000 per acre. The firm has a total of 150 acres of land, 6,600 days labor, and capital amounting to Ksh 3,600,000.

- a) Formulate the linear programming problem (5 marks)
- b) Using the graphical method, find the optimal solution (12 marks)
- c) Calculate the amounts of inputs required (3 marks)

QUESTION FOUR (20 MARKS)

- a) The data below was extracted from records of Veggies Ltd.

Production costs (Ksh '000)	5	7	8	10
Output (tons)	2	3	4	6

- i. Develop a linear squares regression equation for expressing the relationship between output and production costs (8 marks)
- ii. Use the equation in (i) above to predict output if the firm spends KSh 12,000 in the production process (2 marks)
- b) A fruit juice producer has to make a decision on the marketing channel to use in order to maximize revenue from sale of 2000 litres of juice. The producer can sell directly to consumers or to a retailer, at high or low price. For direct consumers, high price is Ksh 47 per litre, and low price Ksh 40 per litre. For the retailer, the prices are Ksh 43 and 38 per litre, respectively. The table below shows the probabilities of buying at the different prices for each channel.

Channel	Probability of buying at:	
	High price	Low price
Direct consumers	0.2	0.8
Retailer	0.7	0.3

- i. Construct a decision tree for the above problem (5 marks)
- ii. What is the recommended decision? (5 marks)

QUESTION FIVE (20 MARKS)

a) Ojijo Farm produces potatoes and cabbages. In 2020, the farm earned a total profit of Ksh 280,000 from 5 acres of potatoes and 3 acres of cabbages. In 2021, the farm invested in 6 acres of potatoes and 2 acres of cabbages, earning a profit of Ksh 300,000. Using Cramer's rule:

- i. Compute the returns per acre of crop. (8 marks)
- ii. Determine whether the farm will be better off in 2022 than in 2021, by investing in 3 acres of potatoes and 5 acres of cabbages (2 marks)

b) The following table shows activities for a student research project.

Activity	A	B	C	D	E	F	G	H
Duration (days)	5	8	4	5	10	4	9	5
Predecessor	-	A	B	B,C	D	A,C	F,D	E,G

- i. Draw the project network using the activity on node approach (6 marks)
- ii. Determine the critical path (4 marks)