MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF AGRICULTURE, ENVIRONMENT AND HEALTH SCIENCES

DEPARTMENT OF AGRICULTURAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE AGRIBUSINESS MANAGEMENT AND TRADE

AGB 302: QUANTITATIVE TECHNIQUES IN AGRIBUSINESS

DATE:17/1/2024 **TIME:8:30-10:30 A.M**

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

QUESTION ONE (30 MARKS)

a) Given the sets A= {0,2,6,-4}, B= {1,2,-3,0}, and C= {6,-8,3,0}, find:
   i) B ∩ C (1 marks)
   ii) (A ∪ C) ∩ (B ∩ ∅) (2 marks)

b) Explain three assumptions of linear programming (3 marks)

c) A project activity has most likely, optimistic and pessimistic time estimates of 4, 3 and 6 weeks, respectively. Find the activity's:
   i) Mean duration (2 marks)
   ii) Variance of duration (2 marks)

d) Given $A = \begin{bmatrix} 2 & -1 & 3 \\ -1 & 4 & -1 \\ 0 & -3 & 1 \end{bmatrix}$ find $|A^T|$ (5 marks)

e) The table below shows the probability distribution of fertilizer sales at a farm inputs shop. Compare the expected sales between the two months (4 marks)

Sales in 50-kg bags (x)		**100**	**500**	**700**	**900**
Probability [P(x)]	July sales	0.35	0.47	0.13	0.05
	October sales	0.12	0.29	0.35	0.24

f) Suppose an economic model is represented by the following equation system. Solve for variables x, y and z using the elimination method (5 marks)

$$8x + 3y - 4z = 45$$
$$2x + y - z = 10$$
$$6x - 5y + 4z - 49 = 0$$

g) An agribusiness investor constructed the following payoff table for investment in pig farming. The figures in the table are profits in millions of Kenya Shillings.

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

Justifying your answer, advise the investor on the best decision using the:

i) Optimistic approach (1 marks)
ii) Pessimistic approach (2 marks)
iii) Minimax regret approach (3 marks)

QUESTION TWO (20 MARKS)

Shamba Ltd grows tomatoes and kales for the market and is interested in maximizing profits. The firm uses only land, labor and capital to produce the crops. One acre of tomatoes requires 90 days of labor, while an acre of kales requires 60 days of labor. Capital requirements per acre are Ksh 162,000 for tomatoes and Ksh 60,750 for kales. An acre of tomatoes yields a profit of Ksh 500,000 while kales earn a profit of Ksh 300,000 per acre. The firm has a total of 150 acres of land, 54,000 days labor, and capital amounting to Ksh 14,580,000.

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

QUESTION THREE (20 MARKS)

a) Masaku Farm produces maize and green grams. In 2022, the farm earned a total profit of Ksh 560,000 from 10 acres of maize and 3 acres of green grams. In 2023, the farm invested in 6 acres of maize and 2 acres of green grams, earning a profit of Ksh 600,000. Using Cramer's rule:
   i) Compute the returns per acre of crop. (8 marks)
   ii) Determine whether the farm will be better off in 2023 than in 2022, by investing in 3 acres of maize and 5 acres of green grams (2 marks)

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

Activity	A	B	C	D	E	F	G	H
Duration (months)	10	16	8	10	20	8	18	10
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)

QUESTION FOUR (20 MARKS)

a) In January 2023, Action-Africa, a non-governmental organization, had 100 employees working in Narok County and 150 employees working in Kitui County. The probability that employees move from Narok to Kitui each year is 0.3 while the probability of moving from Kitui to Narok each year is 0.1. Using the Markov Process, estimate the number of employees expected to be working in each county in January 2025.

   (10 marks)

b) The following table shows data on production of tea leaves by Chai Ltd.

Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Production (tons)	68	84	76	92	72	64	80

   i) Use a three-month moving average to forecast the production for September, October, November and December (5 marks)
   ii) Forecast the production for July, August, September and October, using a smoothing constant of 0.1 (5 marks)

QUESTION FIVE (20 MARKS)

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

Fertilizer costs (Ksh '000)	5	7	8	9
Wheat output (tons)	1	2	4	5

i) Develop a least squares regression equation for expressing the relationship between fertilizer costs and output (8 marks)

ii) Use the equation developed in (i) above to predict wheat output if the firm spends KSh 15,000 on fertilizer. (2 marks)

b) An orange farmer wants to make a decision on the marketing channel to use in order to maximize revenue from sale of 20,000 kg of fruits. The farmer can sell directly to consumers or to a retailer, at high or low price. For direct consumers, high price is Ksh 90 per kg, and low price Ksh 50 per kg. For the retailer, high and low prices are Ksh 75 and 55 per kg, 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	0.3	0.7
Retailer	0.8	0.2

i) Construct a decision tree for the above problem (5 marks)

ii) What is the recommended decision? (5 marks)