



Machakos University

SUPPLEMENTARY EXAMINATION

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

FOURTH YEAR SECOND SEMENSTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MATHEMATICS

SMA 462: OPERATIONS RESEARCH III

Date 21/10/2020

Time 8.30-10.30 AM

INSTRUCTION: Answer Question *ONE* which is compulsory and any other *TWO* Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Why is it a challenge to execute manpower planning blueprint in many Kenyan organization? (6 marks)
- b) Briefly discuss the following Markov chain properties;
- Irreducibility
 - Absorbing state
 - Recurrence
 - Transience
- (8 marks)
- c) Beta ltd co. has developed the following nonlinear programming model to determine the optimal number of Jars (x_1) and mugs (x_2) to produce per day. Maximize

$$Z = \text{Ksh } 7x_1 - 0.3x_1^2 + 8x_2 - 0.4x_2^2$$

subject to

$$4x_1 + 5x_2 = 100 \text{ hours}$$

Then determine the optimal solutions to the nonlinear programming model using the substitution method (8 marks)

- d) Kasiwa Ltd. produces two soft drinks Alpha and Berry. Both drinks are made of two food stuffs I and II. Production of one Kg of Alpha requires 7 units of food stuff I and 4 units of food stuff II whereas for producing one Kg of Berry, 4 units of food stuff I and 3 units of food stuff II are required. The company has 145 units of food stuff I and 90 units of food stuff II. The profit per Kg of Alpha is Ksh 120 while that of Berry is Ksh 90. The manager wants to earn a maximum profit of Ksh. 2700 and to fulfil the demand of 12 Kgs of Alpha. Formulate a goal programming problem for this situation. (8 marks)

QUESTION TWO (20 MARKS)

- a) Explain the necessity of goal programming for organizations operations (2 marks)
- b) Use Lagrangian multiplier method to solve the NLPP:-

$$\text{Minimize } Z = x_1^2 + x_2^2 + x_3^2$$

$$\text{Subject to } 4x_1 + x_2^2 + 2x_3 = 14$$

$$x_1, x_2 \geq 0$$

(8 marks)

- c) A caretaker in Sunset hotel in Kisumu has observed a newly married couple is either in the room or in the lodge relaxing or in the lodge taking a meal. He has established that if the couple doesn't show up in the lodge, there is 0.25 probability of not showing up the following day, 0.50 probability of only coming to relax and 0.25 probability of relaxing and taking a meal. When the couple just relaxes in the lodge there is 0.5 probability they will just relax again the following day and 0.5 probability they will take a meal, but if they relax and take a meal, there is 0.33 probability of not getting out the following day or 0.33 probability of only coming out to relax or 0.34 probability of showing up and taking a meal.

i. Present the above information in a transition matrix (5 marks)

ii. Present the information in a graph (5 marks)

QUESTION THREE (20 MARKS)

- a) Briefly distinguish between the Kuhn–Tucker and Pareto optimality optimization criteria (4 marks)
- b) The Integrity Furniture Corporation manufactures tables and chairs. A table requires 1 hour of labor and 9 units of wood. A chair requires 1 hour of labor and 5 units of wood. Currently 6 hours of labor and 45 units of wood are available. Each table contributes US\$8 to profit, and each chair contributes US\$5 to profit. Formulate and solve an IP to maximize Integrity Furniture's profit

(16 marks)

QUESTION FOUR (20 MARKS)

- a) Discuss any two main elements of decision making in an organization

(4 marks)

- b) Table 1 gives summary of the inter-industry transactions in KSh '000'.

Table 1: inter-industry Transactions

Industries	Input to agricul'	Input to manuf'	Services	Final demand	Total output
Agriculture	15	20	30	35	100
Manufacturing	30	10	45	115	200
Services	20	60	0	70	150

Using the data and the information in the table

- i. Calculate the technical input- output matrix (M) (4 marks)
- ii. Determine Leontief (input- output) inverse (6 marks)
- iii. Advise if the economic system is feasible (2 marks)
- iv. Suppose the new demand for agriculture, manufacturing and services are 250, 300 and 200 respectively. Determine the corresponding new output vector. (4 marks)

QUESTION FIVE (20 MARKS)

- a) Mavoko House Construction Company (MHCC) is indifferent between two projects whose associated costs and proceeds are as summarized below.

Costs/ Proceeds	Project 1 (KSH)	Project 2 (KSH)
Construction cost (per unit)	800,000	700,000
Sale proceeds (per unit)	1,000,000	1,100,000
Administrative costs of sale	1,000,000	2,000,000
Sales staff salaries (p.a)	2,000,000	1,500,000
Number of units	300	200

Project 1 would last in two years with a financing cost of Ksh 20,000,000 while project 2 would last in one year with a financing cost of Ksh 15,000,000. If project 1 can rent out 50 units for 10 years at Ksh 300,000 p.a and they can be sold after the 10 years for Ksh 6,000,000, while project 2 can rent out 25 units for 5 years at Ksh 350,000 p.a and they can be sold after the 5 years for Ksh 7,000,000. Advise the CEO of MHCC the better option (8 marks)

- b) Some historical stock exchange data shows that, for a week characterized by a bull market trend there is a 90% chance that another bullish week will follow. Additionally, there is a 7.5% chance that the bull week instead will be followed by a bearish one, or a 2.5% chance that it will be a stagnant one. After a bearish week there's 80% chance that the upcoming week also will be bearish, or 5% stagnant. The following week after the stagnant one there is 25% and 50% chance of bearish and stagnant respectively.
- Compile these probabilities into a transition matrix M:
 - By setting the current week as bearish determine the probabilities of a bull, bear, or stagnant; (a) one week from now (b) Fifty weeks from now (12 marks)