



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EMM 413 OPERATION RESEARCH

DATE: 15/12/2021

TIME: 8:30 – 10:30 AM

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS) (COMPULSORY)

- a) Explain the following terms
- i. Optimism (Maximax or Minimin) Criterion (3 marks)
 - ii. Pessimism (Maximin or Minimax) Criterion (3 marks)
- b) A firm makes two products X and Y, and has a total production capacity of 9 tonnes per day. Both X and Y require the same production capacity. The firm has a permanent contract to supply at least 2 tonnes of X and at least 3 tonnes of Y per day to another company. Each tonne of X requires 20 machine hours of production time and each tonne of Y requires 50 machine hours of production time. The daily maximum possible number of machine hours is 360. All of the firm's output can be sold. The profit made is Ksh 80 per tonne of X and Ksh.120 per tonne of Y. Formulate this problem as an LP model and solve it by using graphical method to determine the production schedule that yields the maximum profit. (8 marks)

- c) A company deals with three products A , B and C . They are to be processed in three departments X , Y and Z . Products A require 2 hours of department X , 3 hours of department Y and product B requires 3 hours, 2 hours and 4 hours of department X , Y and Z respectively. Product C requires 2 hours in department Y and 5 hours in department Z respectively. The profit contribution of A , B and C are Ksh. 3/, Ksh.5/ and Ksh. 4/ respectively. In the coming planning period, 8 hours of department X , 15 hours of department Y and 10 hours of department Z are available for production. Find the optimal product mix for maximizing the profit (16 marks)

QUESTION TWO (20 MARKS)

- a) Explain four basic requirement and relationship of linear programming model. (2 marks)
- b) A company has three production facilities S_1 , S_2 and S_3 with production capacity of 7, 9 and 18 units (in 100s) per week of a product, respectively. These units are to be shipped to four warehouses D_1 , D_2 , D_3 and D_4 with requirement of 5, 8, 7 and 14 units (in 100s) per week, respectively. The transportation costs (in shillings) per unit between factories to warehouses are given in the Table 1 below:

Table 1: transportation cost from facilities to markets

	D_1	D_2	D_3	D_4	Supply
S_1	19	30	50	10	7
S_2	70	30	40	60	9
S_3	40	8	70	20	18
Demand	5	8	7	14	34

- i) Formulate transportation algorithm (2 marks)
- Determine the feasible solution using the following methods
- ii) North West Corner methods (5 marks)
- iii) Least cost method (5 marks)
- iv) Vogel Approximation Method (6 marks)

QUESTION THREE (20 MARKS)

- a) Describe any five characteristics of a queuing system (5 marks)
- b) Ms. Rose runs a one-person beauty parlor in Machakos Town. She does not make appointments, but runs parlour on a first come first served basis. It is assumed that customers arrive according to a Poisson process with a mean arrival rate of 5 per hour. Because of her excellent reputation, customers always are willing to wait. The customer processing time was exponentially distributed with average of 10 minutes.

Calculate

- i. The average number of customers in the system (3 marks)
- ii. Average number of customers in the queue (4 marks)
- iii. Idle time of Rose (4 marks)
- iv. Average number of customers waiting there is at least one person waiting (4 marks)

QUESTION FOUR (20 MARKS)

- a) Explain any four characteristics of dynamic programming in operation research.(8 marks)
- b) A firm has divided its marketing area into three zones. The amount of sales depends upon the number of salesmen in each zone. The firm has been collecting the data regarding sales and salesmen in each area over a number of the past years. The information is summarized in Table 2

Table 2. salesmen in different zones

No of salesmen	Zone 1	Zone 2	Zone 3
0	30	35	42
1	45	45	54
2	60	52	60
3	70	64	70
4	79	72	82
5	90	82	95
6	98	93	102
7	105	98	110
8	100	100	110
9	90	100	110

For the next year, firm has only 9 salesmen and the problem is to allocate these salesmen to three different zones so that the total sales are maximum. (12 marks)

QUESTION FIVE (20 MARKS)

- a) Explain the importance of simulation in solving operation research problems (6 marks)
- b) Observations of past data show the following patterns in respect of inter arrival durations and service durations in a single channel queuing system are as shown in Table 3 and Random numbers given in Table 4.

Table 3. Inter arrival and service time

Inter arrival time (min)		Service time(min)	
2	0.15	1	0.10
4	0.23	3	0.22
6	0.35	5	0.35
8	0.17	7	0.23
10	0.10	9	0.10

Table 4. Random numbers (start ffrom North west corner and proceed along the row)

93	14	72	10	21
81	87	90	38	10
29	17	11	68	99
51	40	30	52	71

Using the random number table above and assuming the saloon opens at 9.00am, simulate the queue behavior for a period of 60 minutes and determine

- i) Average queue length (2 marks)
- ii) Average waiting time of customer before service (3 marks)
- ii) Average service idle time (3 marks)
- iv) Average service time (3 marks)
- v) Time a customer spends in the system (3 marks)