MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FOURTH YEAR SECOND SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 413 OPERATION RESEARCH

DATE: **TIME:**

INSTRUCTIONS

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Explain four characteristics of dynamic programming (4 marks)

b) Explain the term Monte Carlo simulation (4 marks)

c) A company purchasing scrap material has two types of scarp materials available. The first type has 30% of material X, 20% of material Y and 50% of material Z by weight. The second type has 40% of material X, 10% of material Y and 30% of material Z. The costs of the two scraps are Ksh.120 and Ksh.160 per kg respectively. The company requires at least 240 kg of material X, 100 kg of material Y and 290 kg of material Z. Find the optimum quantities of the two scraps to be purchased so that the company requirements of the three materials are satisfied at a minimum cost. (7 marks)

d) A road transport company has one reservation clerk on duty at a time. He handles information of bus schedules and makes reservations. Customers arrive at a rate of 8 per hour and the clerk can, on an average, service 12 customers per hour. After stating your assumptions, answer the following:

i) What is the average number of customers waiting for the service of the clerk? (5 marks)

ii) What is the average time a customer has to wait before being served? (5 marks)

iii) Management is contemplating to install a computer system for handling information and reservations. This is expected to reduce the service time from 5 to 3 minutes. The additional cost of having the new system works out to Ksh 50 per day. If the cost of goodwill of having to wait is estimated to be Ksh.12 per minute spent waiting, before being served, should the company install the computer system? Assume an 8 hours working day (5 marks)

QUESTION TWO (20MARKS)

a) Explain any four characteristics of queuing model (4 marks)

b) The table below show the transportation cost from plant to warehouses as shown

FACTORY	**WAREHOUSES**				**FACTORY CAPACITY**
	W1	**W2**	**W3**	**W4**	
F1	19	30	50	10	7
F2	70	30	40	60	9
F3	40	8	70	20	18
Demand (Tons)	5	8	7	14	

Determine the cheapest route and cost using the following methods

i) North West corner method (5 marks)

ii) Least cost method (5 marks)

c) Solve the following transportation problem using Vogel Approximation method

	D1	**D2**	**D3**	**D4**	**SUPPLY(Ton)**
A1	2	2	2	1	**3**
A2	10	8	5	4	**7**
A3	7	6	6	8	**5**
Demand (Ton)	**4**	**3**	**4**	**4**	

(6 marks**)**

QUESTION THREE (20 MARKS)

a) Explain any four the applications of operation research (6 marks)

b) Find the dual of the following problem

Maximize $z = 3x_1 + 4x_2 + 5x_3$

Subject to

$x_1 + x_3 \geq 3$

$x_2 + x_3 \geq 4$

$x_1, x_2, x_3 \geq 0$ (4 marks)

d) 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 using Simplex method (10 marks)

QUESTION FOUR (20MARKS)

a) Explain the term

i) decision making under risk (3 marks)

ii) decision making under uncertainty (3 marks)

b) The managers of an organization are concern about lines of trucks waiting for loading and unloading of food grains in one of its units. He is interested in simulating this process and therefore, collects the data for arrival and service time (loading or unloading) distribution. There is a single line and two serving stations.

Inter-arrival Time (min)	**Frequency**	**Service time (minutes)**	**Frequency**
12	8	15	5
13	16	16	10
14	30	17	18
15	22	18	37
16	17	19	20
17	7	20	15

Assume the company opened at 10.00 am and using a simulated samples of 15 arrivals, Take the random numbers for arrival to be 24, 57,77, 68, 64, 88, 98,48, 93, 15, 56,91,77,53 and 45 while random numbers for service time are 39, 45, 27, 29, 35, 68,51,93, 2, 55, 41, 91, 49,88 and 26. Determine

i) Average time a truck spends waiting for loading or unloading (5 marks)
ii) Average idle time of the truck (5 marks)
iii) Average idle time of the server (4 marks)

QUESTION FIVE (20 MARKS)

a) Explain four basic requirement and relationship of linear programming model (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 have only 9 salesmen. Determine how to allocate these salesmen to three different zones so that the total sales are maximum. (12 marks)