



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FOURTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 413 OPERATION RESEARCH

DATE: 22/7/2019

TIME: 11.00-1.00 PM

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE- 30 MARKS (COMPULSORY)

- a) Explain four characteristics of dynamic programming (4 marks)
- b) Explain the term Monte Carlo simulation (6 marks)
- c) A firm that makes products x and y has a total production capacity of 9 tonnes per day, x and y requiring the same production capacity. The firm has a permanent contract to supply at least 2 tonnes of x and 3 tonnes of y per day to another company. Each one of x requires 20 machine hrs. Production time and y requires 50 machine hrs production time. The daily maximum possible number of machine hours available is 360. All the firm's output can be sold, and the profit set is ` 80 per tonne of x and ` 120 per tonne of y. Determine the production schedule to maximize the firm's profit using graphical method (8 marks)
- d) An investor has up to Ksh.150, 000 to invest in any of three areas: stocks, bonds, or a money market. The annual rates of return are estimated to be: 5%, 9%, 8%, respectively. No more than Ksh.75, 000 can be invested in any one of these areas.
 - i) formulate linear programming models

- ii) using simplex method determine how much should be invested in each area in order to maximize the annual income (12 marks)

QUESTION TWO – 20 MARKS

- 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
- ii) Least cost method (10 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

$$\text{Maximize } z = 3x_1 + 4x_2 + 5x_3$$

Subject to

$$x_1 + x_3 \geq 3$$

$$x_2 + x_3 \geq 4$$

(4 marks)

$$x_1, x_2, x_3 \geq 0$$

- c) An average of 10 cars per hour arrives at a single-server drive-in teller. Assume that the average service time for each customer is 4 minutes, and both inter arrival times and service times are exponential.
- What is the probability that the teller is idle?
 - What is the average number of cars waiting in line for the teller? (A car that is being served is not considered to be waiting in line.)
 - What is the average amount of time a drive-in customer spends in the bank parking lot (including time in service)?
 - On the average, how many customers per hour will be served by the teller?

(10 marks)

QUESTION FOUR (20 MARKS)

- a) The owner of a chain of four grocery stores has purchased six crates of fresh strawberries. The estimated probability distribution of potential sales of the strawberries before spoilage differs among the four stores. The following table gives the estimated total expected profit at each store, when it is allocated various numbers of crates: For administrative reasons, the owner does not wish to split crates between stores. however he is willing to distribute zero crates to any of his stores. Determine the maximum profit that can be generated

No of crates	Stores			
	1	2	3	4
0	0	0	0	0
1	4	3	6	2
2	6	4	8	3
3	7	6	8	4
4	7	8	8	4
5	7	9	8	4
6	1	10	8	4

(10 marks)

- b) A company is planning for its sales targets and the strategies to achieve these targets. The data in terms of three sales targets, their respective utilities, various strategies and

appropriate probability distribution are given in the table given below. What is the optimal strategy?

	50	75	100		
Utility	4	7	9		
	Prob.	Prob.	Prob.		
Strategies					
S ₁	0.6	0.3	0.1		
S ₂	0.2	0.5	0.3		
S ₂	0.5	0.3	0.2		

(10 marks)

QUESTION FIVE (20 MARKS)

- a) Explain the term
- decision making under risk
 - decision making under uncertainty
- (6 marks)
- b) The managers of an organization is 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, collect 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, determine

- average time a truck spends waiting for loading or unloading.
 - average idle.time of the truck
 - average idle time of the server
- (14 marks)