



MACHAKOS UNIVERSITY

University Examinations for 2020/2021

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE STATISTICS & PROGRAMMING

BACHELOR OF SCIENCE (COMPUTER SCIENCE)

BACHELOR OF SCIENCE (MATHEMATICS)

SMA 461: OPERATION RESEARCH II

DATE: 11/8/2021

TIME: 2:00 – 4:00 PM

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

QUESTION ONE (COMPULSORY) (30 MARKS)

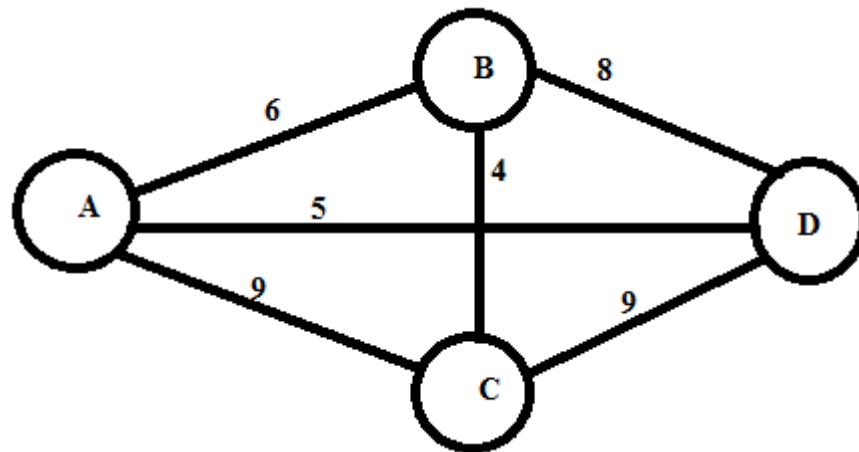
- a) Distinguish the following terms in reference to queuing theorem
- i) Microscopic and Macroscopic traffic flow models
 - ii) Space head way and time head way
 - iii) Jockey and Balking queuing customers
 - iv) Customer inter-arrival and inter-service time in queuing theorem
- (8 marks)
- b) State the Birkoff- Newman theorem and hence write the doubly stochastic matrix H as a convex combination of permutation matrices

$$H = \begin{pmatrix} 0 & 0.5 & 0.5 \\ 0.8 & 0.2 & 0 \\ 0.2 & 0.3 & 0.5 \end{pmatrix}$$

(6 marks)

- c) A company has an annual demand of 16000 units of item L each costing sh. 200. The cost per order is sh. 1000 while the cost of capital is 24%. To purchase 10,000 or more units the price is sh.190. Justify why the management should buy with or without the discount. (6 marks)

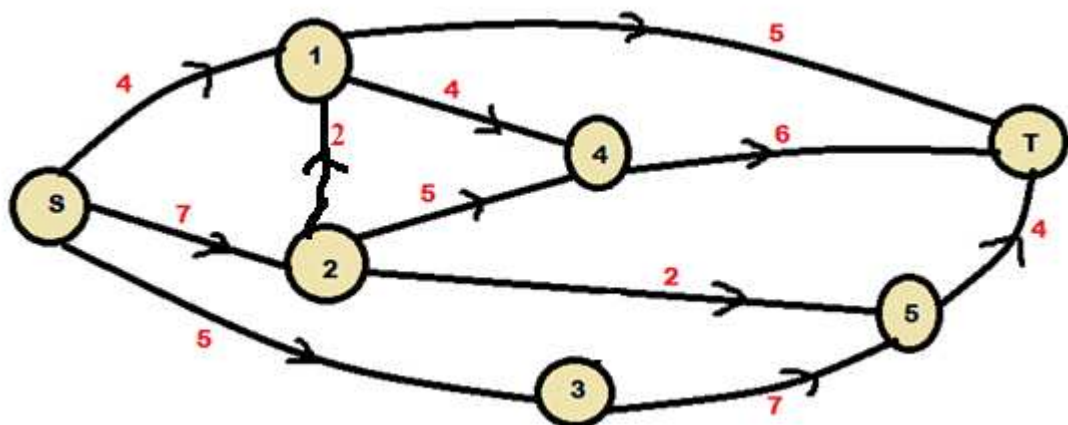
- d) Summarized below is the time in hours taken by car between the city pairs within East Africa. Find the tour of the salesman so that the time of travel is minimal. (8 marks)



- e) Highlight two negative impacts of traffic jam (2 marks)

QUESTION TWO (20 MARKS)

- a) Determine the maximum flow and the minimum cut in the following network (10 marks)



- b) Using the project activities details recorded below

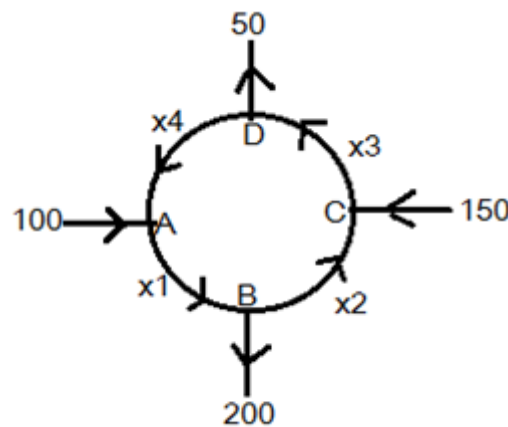
Activity	Preceding activity	Duration (weeks)	Standard deviation
A	----	5	1.5
B	----	6	2.0
C	A	7	2.5
D	A	4	1.0
E	A,B	2	0.5
F	C,D,E	4	1.5
G	D,E	10	3.0
H	F,G	3	1.5

- Draw the network to represent the project and mark the critical path
- Compute the total float for the non-critical activities
- Determine the probability that the project is completed within 26 weeks

(10 marks)

QUESTION THREE (20 MARKS)

- a) The figure below represents a roundabout (rotary). Assuming a one way flow and the numbers representing the number of vehicles per hour



- Construct the mathematical model to represent the traffic flow (4 marks)
- Discuss any four city planning and urban design practices which can help to ease the human traffic and vehicles congestion within the CBD (8 marks)

- b) A marketing manager wants to assign a salesman to each of the four cities. He has four salesmen of varying experience. The possible profit for each salesman in each city is given in the following table.

		Cities			
		A	B	C	D
Salesmen	Q	25	27	28	38
	P	28	34	29	40
	M	35	24	32	33
	K	24	32	25	28

Determine an assignment which maximizes the profit. (8 marks)

QUESTION FOUR (20 MARKS)

- a) The following details relate to item K10 an input in a production process. Normal consumption is 100,000kg per week, maximum consumption is 150,000kg per week, minimum consumption is 50,000kg per week, re-order quantity is 600,000kg and re-order period is 4-6 weeks. Determine;

- Re-order level
- Average stock level (4 marks)

- b) In the brand switching challenge, the transition probability matrix is given by

$$\begin{pmatrix} 0.5 & 0.4 & 0.1 \\ 0.2 & 0.7 & 0.1 \\ 0.1 & 0.2 & 0.7 \end{pmatrix} \text{ If the market share vector at } n^{\text{th}} \text{ share is } (0.4, 0.3, 0.3)$$

- What will be the market vector in $(n+1)^{\text{th}}$ stage
 - Calculate the market share in the equilibrium situation. (8 marks)
- c) There are five workers (x_i) who demand different pay for various five jobs (y_j) as summarized by matrix D.

$$D = \begin{pmatrix} \infty & 10 & 3 & 6 & 9 \\ 5 & \infty & 5 & 4 & 2 \\ 4 & 9 & \infty & 7 & 8 \\ 7 & 1 & 3 & \infty & 4 \\ 3 & 2 & 6 & 5 & \infty \end{pmatrix}$$

Determine the lowest-cost way to assign the jobs. (8 marks)

QUESTION FIVE (20 MARKS)

- a) Highlight four conditions that may necessitate the use of simulation in modeling a system behavior (4 marks)
- b) There is a new drinking juice in Machakos town named malcjuice whose main ingredients are x_1 and x_2 with a random variables cost due to their scarcity and a random selling price such that the production cost function is $y = x_1 + x_2$

X1-Cost	Freq
1000	20
1500	10
2000	70
2500	100

X2-Cost	Freq
1500	40
2000	50
2500	30
3000	80

Selling	Freq
3500	20
2000	40
4500	50
5000	90

- i) Determine the expected cost of the juice. (6 marks)
- ii) Simulate the juice profit for 5 days using the random numbers;
58,71,96,30,24,18,09,24,18,46,23,34, 27,70,88 (10 marks)