



MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR
BACHELOR OF EDUCATION (SCIENCE)

BACHELOR OF EDUCATION (ARTS)

SMA 461: OPERATION RESEARCH II

DATE: 18/12/2017

TIME: 8:30 – 20:30 AM

INSTRUCTION: Answer Question One 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)

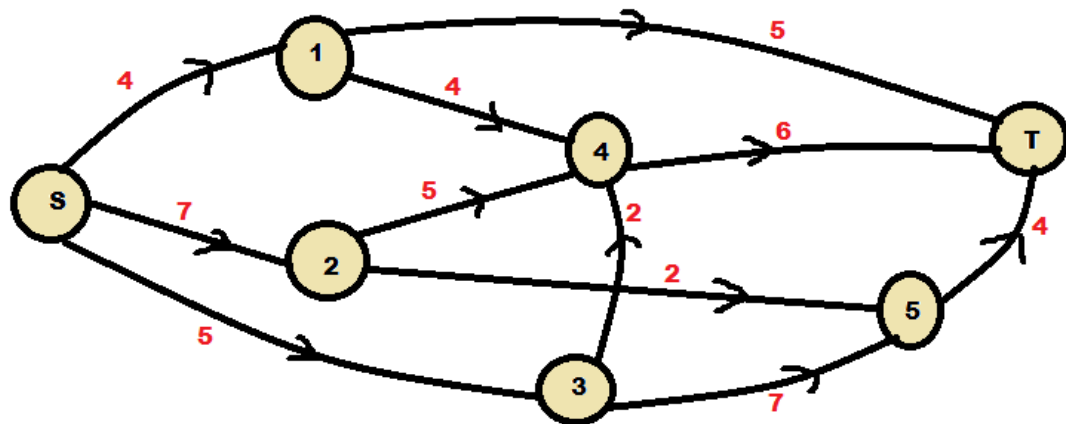
- c) A company has an annual demand of 16000 units of item L each costing sh. 200. The cost per order is sh. 1000 while the cost of capital is 24%. To purchase 10,000 or more units the price is sh.190. Justify why the management should buy with or without the discount. (6 marks)
- d) A lorry can carry 4 tones, 3 types of objects that can be loaded. Their values and weights (tones) are given below.

Item (i)	V_i	W_j
1	31	2
2	47	3
3	14	1

- Determine the load which maximizes the value of the objects in the lorry (6 marks)
- e) Highlight four negative impacts of traffic jam (4 marks)

QUESTION TWO (20 MARKS)

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

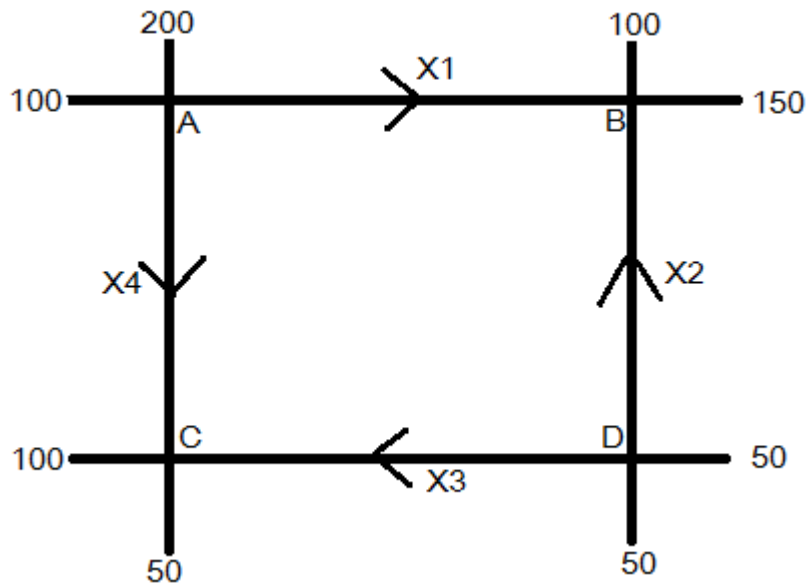


- b) Using the project activities details recorded below
- Draw the network to represent the project and mark the critical path
 - Compute the total float for the non critical activities
 - Determine the probability that the project is completed within 26 weeks
- (10 marks)

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

QUESTION THREE (20 MARKS)

- a) The figure below represents four road junctions A, B, C and D



Using the figure above

- Construct the mathematical model to represent the traffic flow
 - Determine the minimum flow along AB and the flows along DB, DC and AC at that moment. (10 marks)
- b) Given the spot speeds are 50, 80, 60, 55 and 45, determine the time mean speed and space mean speed (6 marks)
- c) Distinguish between the critical path method (CPM) and project evaluation and review technique (PERT) (4 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;

i. Re-order level

ii. Average stock level (4 marks)

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

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

i. What will be the market vector in $(n+1)^{\text{th}}$ stage

ii. Calculate the market share in the equilibrium situation. (8 marks)

A firm has five positions and five applicants, given the utility matrix A, determine the optimal assignment

$$A = \begin{pmatrix} 7 & 2 & 8 & 4 & 3 \\ 5 & 4 & 6 & 3 & 3 \\ 6 & 3 & 7 & 4 & 5 \\ 5 & 2 & 5 & 2 & 4 \\ 3 & 0 & 4 & 3 & 1 \end{pmatrix}$$

(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) The Kulima limited company has designed a new pesticide whose production requires mainly two ingredients X_1 and X_2 . With the production function $y = \sqrt{x_1 x_2}$ where x_1 and x_2 are the units of ingredient 1 and 2 respectively required to produce one sachet of y .

The price of each sachet and the cost of the ingredients are random variables such that

SP (y)	Probability
4000	0.15
4500	0.35
5000	0.20
5500	0.30

Cost (x_1)	Probability
1000	0.1
1500	0.05
2000	0.35
2500	0.50

Cost (x_2)	Probability
1500	0.20
2000	0.25
2500	0.15
3000	0.40

- i. Given that the daily usage of x_1 and x_2 are set at 250 and 360 units respectively.

Determine the expected profit of the company. (6 marks)

- ii. Simulate the company's profit for 10 days using the random numbers;

58,71,96,30,24,18,09,24,18,46,23,34,27,85,13,99,24,44,49,79,49,74,16,32,23,02,56,88,87,
,59. (10 marks)