

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY

ECC 501 OPERATIONS RESEARCH

END OF SEMESTER EXAMINATION -2013/2014

Instructions to candidates

This paper consists of 5 questions

Please, answer any four questions

Question 1

- With the aid of a flow chart, briefly describe the basic steps in operations research modeling approach. [9 Marks]
- Explain any four qualities of operation research approach to problem solving. [10 Marks]
- Discuss briefly three principle components of an operation research model. [7 Marks]

Question 2

Sirikwa Quarry Limited intends to produce three types of aggregate, Class 1, Class 2, and Class 3. Two basic raw materials 5 mm and 10 mm size aggregates are required. The maximum weekly availability of 5 mm size aggregate is 6 tons and that of 10 mm size aggregate is 18 tons. The weekly requirements of the two raw materials in the manufacture of the three classes of aggregate are given below.

Raw material	Class 1	Class 2	Class 3
5 mm size	2	1	0
10 mm size	1	2	3

The profit per ton of each class of aggregate is expected to be as follows:-

Aggregate class	Price per ton (KES)
Class 1	40,000.00
Class 2	50,000.00
Class 3	30,000.00

- Formulate this as a linear programming problem model. [6 Marks]
- Use the simplex method to find the optimum number of tons of each class of aggregate that should be produced. [16 Marks]
- Interpret the results on the final simplex tableau. [3 Marks]

[25 Marks]

Question 3

Nairobi Water Services Company Limited has 3 water treatment plants that supply the needs of 4 Estates in the city. Each treatment plant can supply the following litres of water: plant 1 – 3 million; plant 2 – 7 million; plant 3 – 5 million. The peak water demands in these estates, which occur at the same time (6am), are as follows (in litres): Estate 1 – 4 million; Estate 2 – 3 million;

Estate 3 –4 million; Estate 4 - 4 million. The costs of sending a litre of water from plant to estate depend on the distance the water must travel and are as shown in the table below.

	Estate 1	Estate 2	Estate 3	Estate 4
Plant 1	8	6	10	9
Plant 2	9	12	13	7
Plant 3	14	9	16	6

Use the transportation algorithm to determine the cheapest supply schedule. Formulate an LP to minimize the cost of meeting each estate's peak water demand. [25 Marks]

Question 4

A construction project has the following eight activities: recruitment of casuals, site improvement, masonry, plumbing, electrical, carpentry, finishing and landscaping. Masonry cannot be started until site improvement is completed. Electrical and carpentry cannot be started until casual recruitment and masonry are completed. Plumbing cannot be started until Electrical has been finished. Landscaping can be done after plumbing and finishing are completed. Finishing cannot start until carpentry is completed. About each job the following is known.

Table Q3

Job	Normal time (days)	Crash time (Days)	Cost of crashing per day, KES (x 1000)
Recruitment of casual	10	7	4
Site improvement	5	4	2
Masonry	3	2	2
Plumbing	4	3	3
Electrical	5	3	3
Carpentry	6	3	5
Finishing	5	2	1
Landscaping	5	4	4

Note: The overhead cost is KES 5,000.00

- i. Determine the optimal duration of the project in terms of crashing and overhead costs. [19 Marks]
- ii. Develop an optimal project schedule. [6 Marks]

Question 5

- i. Visitors' parking at MMUST students' hostel is limited to five spaces. Cars making use of this space arrive according to a Poisson distribution at the rate of six cars per hour. Parking time is exponentially distributed with a mean of 30 minutes. Visitors who cannot find an empty space immediately on arrival may temporarily wait inside the lot until a parked car leaves. That temporary space can only hold three cars. All other cars that cannot park or find temporary waiting space must go elsewhere. Determine the following:-
 - a. The probability P_n of n cars being in the system; [3 Marks]
 - b. The effective rate at which cars arrive at the lot. [3 Marks]
 - c. The average number of cars in the lot. [2 Marks]
 - d. The average time a car waits for a parking space inside the lot. [2 Marks]
 - e. The average number of occupied parking spaces [2 Marks]

- ii. A construction company estimates to use 1,000,000 bags in its works in a certain year. The ordering cost is KES 1,440 per order. Storage and interest costs have been estimated at KES 60 per bag per year based on the average annual stock. The price per bag is KES 900.00.
 - a. Determine the Economic Order Quantity by use of graphical (trial and error) method. [3 Marks]
 - b. The supplier has offered a 2% quantity discount if the printer purchases 450,000 or more packets at any one time. Advice if the offer should be accepted. [10 Marks]