

**MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**P.O. Box 972-60200 – Meru-Kenya**

**Tel: 020-2069349, 061-2309217. 064-30320 Cell phone: +254 712524293, +254 789151411**

**Fax: 064-30321**

**Website:** [**www.must.ac.ke**](http://www.must.ac.ke) **Email:** [**info@must.ac.ke**](mailto:info@must.ac.ke)

**University Examinations 2015/2016**

SECOND YEAR SECOND SEMESTER EXAMINATION

FOR THE DEGREE OF

BACHELOR OF COMMERCE

**SMB 3425: OPERATIONS RESEARCH**

**DATE: AUGUST 2016 TIME: 2 HOURS**

**INSTRUCTIONS:** *Answer question* ***one*** *and any other* ***two***questions.

**QUESTION ONE (30 MARKS)**

1. A construction company has four engineers for designing. The general manager is facing the problem of assigning four projects to these engineers. It is also found that Engineer E2 is not competent to design project 4. Given the time estimate required by each engineer to design a given project, find an assignment plan that minimizes the total time.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | P1 | P2 | P3 | P4 |
| E1 | 6 | 5 | 13 | 2 |
| E2 | 8 | 10 | 4 | - |
| E3 | 10 | 3 | 7 | 3 |
| E4 | 9 | 8 | 6 | 2 |

(5 marks)

1. Arrivals at an M-pesa agent are considered to be random and poisson with an average time of 10 minutes between arrivals. The service time is assumed to be distributed exponentially with a mean of 3 minutes.
2. Find the probability that a customer arriving at the M-pesa agent will have to wait. (3 marks)
3. What is the average length of queues that form from time to time. (2 marks)
4. A company purchases in lots of 500 items which is a 3-month supply. The cost per items is Sh.50 and the ordering cost is Sh.100. The inventory carrying cost is estimated at 20% of the unit value.

Find

1. The total cost of the existing inventory policy (2 marks)
2. How much money will be saved by employing the economic order quantity (3 marks)
3. Given the primal problem

Maximize 

Subject to



Write down its dual problem. (5 marks)

1. The Waffles manufacturing company has a current transportation schedule which is being questioned by the top management as to whether or not it is optimal. The firm has 3 factories and five warehouses. The necessary data in terms of unit transportation cost in shillings, factory capacities and warehouse requirements are given below

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Warehouse | Factories | | | Warehouse requirements |
| A | B | C |
| 1 | 50 | 40 | 80 | 400 |
| 2 | 80 | 70 | 40 | 400 |
| 3 | 60 | 70 | 60 | 500 |
| 4 | 60 | 60 | 60 | 400 |
| 5 | 30 | 50 | 40 | 800 |
| Factory availability | 800 | 600 | 110 |  |

Find a feasible solution using the least cost method. (5 marks)

1. The various activities carried out for a project of erection of a steel works shed are as under

|  |  |  |
| --- | --- | --- |
| Activity Code | Description | Prerequisites |
| A | Erect site workshop | None |
| B | Fence site | None |
| C | Bend Reinforcement | A |
| D | Dig foundation | B |
| E | Fabricate steel works | A,C |
| F | Install complete plan | B |
| G | Place reinforcement | C,D |
| H | Concrete foundation | G,F |
| I | Point steel works | E |
| J | Erect steel works | H,I |
| K | Give finishing touch | J |

Draw a network diagram for the project. (5 marks)

**QUESTION TWO (20 MARKS)**

1. State 3 assumptions of linear programming (3 marks)
2. State 2 limitations of linear programming (2 marks)
3. Machine time available on two machines A and B is to be allocated to production of some quantity of two products 1 and 2. The two machines A and B have 80 hours and 60 hours of time available. The two products 1 and 2 require different amounts of time on each of the machines as shown in the table below:

|  |  |  |
| --- | --- | --- |
| Product | Time on machine A | Time on machine B |
| 1 | 2 hours | 3 hours |
| 2 | 4 hours | 2 hours |

Each unit of product 1 is sold at Ksh.60 and each unit of product 2 is sold at Ksh.50.

Required:

1. Formulate a LP model that will maximize the production (5 marks)
2. Find the number of units of each product that should be produced in order to maximize the returns. (10 marks)

**QUESTION THREE (20 MARKS)**

1. A company employs service engineers based at various locations throughout the country to service and repair their equipment installed in customer’s premises. Four requests for service have been received and the company finds that four engineers are available. The distance each of the available engineers is from the various customers is as given in the following table. The company wishes to assign engineers to the customers in such a way that the total distance travelled is minimized.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Customers | | | |
| Engineers | W | X | Y | Z |
| E1 | 25 | 18 | 23 | 14 |
| E2 | 38 | 15 | 53 | 23 |
| E3 | 15 | 17 | 41 | 30 |
| E4 | 26 | 28 | 36 | 29 |

Establish an assignment schedule that meets the company’s wishes. (6 marks)

1. A local distributor Gofoam tyre company expects to sell approximately 9600 steel belted radial tyres of a certain size and tread design next year. Annual carrying cost is $16 per tyre and the ordering cost is $75. The distributor operates for 288 days a year.
2. Find the Economic order quantity (3 marks)
3. How many times per year does the store reorder (2 marks)
4. What is the length of the order Cycles? (2 marks)
5. What is the optimal total annual cost? (2 marks)
6. At a one-man barber shop, customers arrive according to the poisson distribution with a mean arrival rate of 4 persons per hour. The hair cutting time is negatively exponentially distributed with an average of 12 minutes per hair-cut. There is no restriction in the queue length.

Find:

1. Expected time in minutes that a customer has to spend in the queue. (3 marks)
2. Percentage of time the border is idle in a 8-hour day. (2 marks)

**QUESTION FOUR (20 MARKS)**

1. A project consists of nine tasks A, B, C, D, E, F, G, H and I with the following precedence relations and time estimates

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Time estimates in days | | |
|  |  | Optimistic  to | Most likely  tm | Pessimistic  te |
| Job | Predecesssor(s) |
| A |  | 3 | 6 | 15 |
| B |  | 2 | 5 | 14 |
| C | A,B | 6 | 12 | 30 |
| D | A,B | 2 | 5 | 8 |
| E | B | 5 | 11 | 17 |
| F | D,E | 3 | 6 | 15 |
| G | C,F | 3 | 9 | 27 |
| H | D,E | 1 | 4 | 7 |
| I | G,H | 2 | 5 | 8 |

Required:

1. Draw a PERT network diagram for the project (5 marks)
2. Determine the expected job duration (5 marks)
3. Identify the critical path. (2 marks)
4. A company has four plants, each of which can manufacture any one of the four products. Production cost differs from one plant to another as do the costs of raw materials. Given the profit data below, assign the products to plants so as to realize maximum profit and state the maximum profit.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Products (profit “000” Sh) | | | |
| Plant | A | B | C | D |
| 1 | 1 | 8 | 4 | 1 |
| 2 | 5 | 7 | 6 | 5 |
| 3 | 3 | 5 | 4 | 2 |
| 4 | 3 | 1 | 6 | 3 |

(8 marks)

**QUESTION FIVE (20 MARKS)**

1. Explain the objectives of a transport model. (2 marks)
2. By citing relevant examples, explain two areas in business where the transportation model is applicable. (2 marks)
3. A firm of office equipment suppliers has 3 depots located in various towns. It receives orders for a total of 15 special filing cabinets from four customers. In total in the 3 depots there are 15 of the current filing cabinets available and the management wish is to minimize delivery costs by dispatching the filing cabinets from the appropriate depot for each customer.

Details of the availabilities, requirements and transport costs per filing cabinet are given in the following table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Customer  Depot | Customer A | Customer B | Customer C | Customer D | Supply capacity |
| X | 13 | 11 | 15 | 20 | 2 |
| Y | 17 | 14 | 12 | 13 | 6 |
| Z | 18 | 18 | 15 | 12 | 7 |
| Demand | 3 | 3 | 4 | 5 |  |

Using Vogel’s approximation method, obtain a dispatch plan for the cabinets. (8 marks)

1. A firm of wholesale domestic equipment suppliers with 3 warehouses received orders for a total of 100 deep freezers for 4 retail shops. In total, there are 110 freezers available and the management wishes to minimize the transportation costs. The table below shows the details of requirements and unit transport costs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Shop  Warehouses | A | B | C | D | Available |
| W1 | 3 | 16 | 9 | 2 | 40 |
| W2 | 1 | 9 | 3 | 8 | 20 |
| W3 | 4 | 5 | 2 | 5 | 50 |
| Requirements | 25 | 25 | 42 | 8 |  |

Obtain the initial feasible solution using

1. North –west corner method. (4 marks)
2. Least cost method. (4 marks)