# MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

## FACULTY OF ENGINEERING, APPLIED SCIENCES & TECHNOLOGY

## DEPARTMENT OF APPLIED STATISTICS
## DEPARTMENT OF MINING & MINERALS PROCESSING

**MODULE: OPERATIONS RESEARCH**

**CODE: ASTA 224/ENGPT 316**

SESSIONAL EXAMINATIONS
**APRIL 2023**

**DURATION: 3 HOURS**

**EXAMINER: NYAKUAMBA T**

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**INSTRUCTIONS**

1. *Answer **All questions** in Section A*
2. *Answer **three** questions in Section B.*
3. *Start a new question on a fresh page*
4. *Total marks 100*

***Additional material(s):*** Non-programmable electronic scientific calculator

**SECTION A (40 Marks)**

**ANSWER ALL QUESTIONS**

**A1** (a) Briefly describe what you understand by the term operations research [3]

(b). List any four techniques that are used in operations research [4]

(c). Distinguish between decision making under uncertainty and decision making under risk. [3]

**A2.** Define the following terms:

(a). Expected Monetary Value [2]

(b). Opportunity loss [2]

(c). Slack of an activity [2]

(d). States of nature [2]

(e). pay off [2]

**A3.**

Mabasa Manufacturing Company must decide whether to purchase a component from a supplier or manufacture the component at its Mutare plant. If demand is high Mabasa could profitably manufacture the component. However if demand is low, Mabasa's unit manufacturing cost would be high due to underutilization of equipment. The following table shows the project profit (in thousands of dollars) for Mabasa's make or buy decision.

| Decision alternative | Demand | | |
|---|---|---|---|
| | Low | Medium | High |
| Manufacture (d1) | -20 | 40 | 100 |
| Purchase (d2) | 10 | 45 | 70 |

The states of nature have the following probabilities:

$$p(\textbf{low demand}) = 0.35$$
$$P(\textbf{medium demand}) = 0.35$$
$$p(\textbf{high demand}) = 0.30$$

(a). Use a decision tree to recommend a decision [5]

(b). What is the expected value of perfect information (EVPI)? [5]

**A4.**

T and N company have been manufacturing Industrial vacuum system for a number of years. A member of the company's new-product research team submitted a report suggesting that the company considers manufacturing a code less vacuum cleaner. The company's management would like to study the feasibility of manufacturing the new product. The researcher suggests the activity list of the new product as below

| ACTIVITY | DESCRIPTION | PREDECESSOR | COMPLITION TIME |
|---|---|---|---|
| A | develop product design | --- | 5 |
| B | plan market research | --- | 6 |
| C | prepare manufacturing engineering | A | 4 |
| D | build prototype model | A | 3 |
| E | prepare marketing brochure | A | 1 |
| F | prepare marketing brochure | C | 4 |
| G | prepare cost estimates | D | 14 |
| H | preliminary product testing | B, E | 12 |
| I | complete pricing and forecast report | H | 2 |
| J | prepare final report | F, G, L | 3 |

(a). Develop the network diagram [5]

(b). Determine the critical path and the project completion time. [5]

SECTION B [60 marks] ANSWER ANY 3 QUESTIONS

B5

(a) . Briefly explain the following terms as used in inventory control:

(i). inventory [3]

(ii). Lead time [3]

(iii). inventory system [3]

(b) . The demand for an item is 17000 units per month. The holding cost per unit is $14.40 per year and the cost of ordering is $400. No shortages are allowed and the replacement rate is instantaneous.
Determine:

(i). The optimum order quantity [3]

(ii). The total cost per year if the cost of one unit is $2 [5]

(iii). The number of orders per year. [3]

B6.

(a). Explain the following queueing systems:

(i). (M/M/1): (FIFO/∞/∞) [3]

(ii). (M/EK/1): (SIRO/N/M) [3]

(iii). (GI/G/c): (GD/N/M) [3]

(b).

Customers arrive at a drive-in bottle shop in a Poisson fashion. The mean number of arrivals is 15 per hour and service time per customer is

exponential with a mean of 3 minutes. There is only one server to attend the customers. The space of the drive way can accommodate 5 cars including the car under service. However other people can wait on the drive way on the road.

i. What is the probability that an arriving car can be served immediately? [2]
ii. What is the probability that an arriving car can drive into the drive way of the bottle shop? [3]
iii. What is the probability that an arriving car has to wait on the road side?[2]
iv. How long does a driving car has to wait before starting service? [2]
v. What is the mean waiting time in the system? [2]

B7

(a). A company is in the process of preparing a budget for launching a new product. The following table provides the associated activities and their duration:

| ACTIVITY | DESCRIPTION | PREDECESSOR | DURATION |
|---|---|---|---|
| A | forecast sales volume | --- | 10 |
| B | study competitive market | --- | 7 |
| C | design item and facilities | A | 5 |
| D | prepare production | C | 3 |
| E | estimate cost of production | D | 2 |
| F | set sales prices | B, E | 1 |
| G | prepare budget | F | 14 |

i. Construct the project network and determine the critical path and the project duration. [10]
ii. What is a dummy activity? [1]
iii. What is the special role played by the dummy activity? [1]

(b). A company stocks an item that is consumed at the rate of 50 units per day. It costs the company $20 each time an order is placed. An inventory unit held in stock for a week will cost $0.35

(i). Determine the optimum order quantity, assuming a lead time of one weak.

[3]

(ii)Determine the optimum number of orders per year (365 days). [5]

B8.

A company manufactures and sells x units per month. The monthly cost and price equations are:

$$C(x) = 720000 + 600x$$

$$P(x) = 2000 - \frac{x}{4} \qquad for\ 0 \leq x \leq 6000$$

Calculate the

(a). Maximum revenue. [5]

(b). The production level that will realize the maximum profit. [5]

(c). Maximum profit. [5]

(d). The price the company should charge for each unit. [5]

**END OF QUESTION PAPER**