Uganda Martyrs University
Faculty of Science
Department of Natural Sciences
Quantitative Mathematics I
End of Semester Exam, Date: December 19, 2022

Timing: 09:30am to 12:30 pm

Academic Year 2022/2023, Semester 1

Maximum mark: 100

Instructions:

1. *Carefully read through ALL the questions before attempting them.*

2. ***ANSWER ANY FIVE Questions*** *(Each question is 20 marks)*

3. *No **names** should be written anywhere on the examination book.*

4. *Ensure that your **Reg number** is indicated on all pages of the examination answer booklet.*

5. *Ensure your work is **clear** and **readable**. Untidy work shall be penalized*

6. *Any type of examination Malpractice will lead to automatic disqualification*

7. *Do not write anything on the questions paper.*

1. (a) Define the term "Quantitative data." (01 mark)

   (b) State two advantages of Quantitative data over Qualitative data. (02 marks)

   (c) Mr. Kavuma, a manufacturer of grocery items wishes to carry out market research on the performance of his products. As a student of Quantitative methods, explain how he can generate quantitative data to meet his task. (07 marks)

   (d) (i) Distinguish between Primary and Secondary data.
       (ii) Explain the two types of interviews.
       (iii) What are the advantages and disadvantages of interviewing, as a method of data collection. (10 marks)

2. (a) Using the graphical method, maximize the objective function $z = 300x_1 + 500x_2$, over the constraints:

   $$6x_1 + 4x_2 \leq 24,$$
   $$x_1 + 2x_2 \leq 6,$$
   $$-x_1 + x_2 \leq 1,$$
   $$x_2 \leq 2.$$

   For $x_1, x_2 \geq 0$. (10 marks)

   (b) A manufacturer produces three types of plastic fixtures. The time required for molding, trimming, and packaging is given in the Table below. (Times are given in hours per dozen fixtures.)

Process	Type A	Type B	Type C	Total Time Available
Molding	1	2	$\frac{3}{2}$	12000
Trimming	$\frac{2}{3}$	$\frac{2}{3}$	1	4600
Packaging	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{2}$	2400
Profit	$11	$16	$15	—

   How many dozen of each type of fixture should be produced to obtain a maximum profit? (10 marks)

3. (a) What is a Matrix? (01 marks)

   (b) Given the Matrices below;

   $$A = \begin{bmatrix} 1 & 2 & 3 \\ -1 & 0 & 2 \end{bmatrix} \qquad B = \begin{bmatrix} -1 & 5 & -2 \\ 2 & 2 & -1 \end{bmatrix}$$

   Determine;

   (i) $A + 2B$.
   (ii) $3A^T - B^T$. (04 marks)

(c) Using Crammer's rule, compute the determinant of Matrix A, such that:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 2 & 3 & 4 \\ 1 & 2 & 1 \end{bmatrix}$$

(05 marks)

(d) The quarterly sales of Jute, Cotton and Yam for the year 2002 and 2003 are given below: Determine the net quarterly sales for the year 2002 and 2003.**(05 marks)**

Year 2002

	Q1	Q2	Q3	Q4
J	20	12	22	14
C	10	26	18	19
Y	15	15	15	11

Year 2003

	Q1	Q2	Q3	Q4
J	10	15	20	20
C	5	20	23	10
Y	8	15	18	14

Figure 1:

(e) An automobile company uses three types of steel S_1, S_2 and S_3 for producing three types of cars C_1, C_2 and C_3. The steel requirement (in tons) for each type of car is given below:

	C_1	C_2	C_3
S_1	2	3	4
S_2	1	1	2
S_3	3	2	1

Determine the number of cars of each type which can be produced using 29, 13 and 16 tons of steel of the three types respectively. **(05 marks)**

4. (a) Differentiate the following with respect to x:

(i) $y = ax^n$

(iii) $y = \dfrac{(x+2)}{(x+4)}$

(iv) $y = (ax^2 + bx)^{\frac{1}{2}}$ **(07 marks)**

(b) A firm faces the demand curve given by $P = 17 - 3Q$

(i) Find an expression for TR in terms of Q

(ii) Find an expression for MR in terms of Q. **(05 marks)**

(c) Differentiate the functions with respect to x:

(i) $y = e^{-7x}$

(ii) $y = \ln(x^2 + 2x + 1)$ **(05 marks)**

(d) If the (inverse) Demand equation is,

$$P = 20040 \ln(Q + 1).$$

Calculate the price elasticity of demand when $Q = 20$. (03 marks)

5. (a) Distinguish between discrete and continuous quantitative data. (02 marks)

   (b) (i) Define the term "Problem" as used in Quantitative Methods.

   (ii) Explain the different stages of decision making process. (10 marks)

   (c) Assuming you are a manager of a company that has many challenges.

   (i) Identify one of the challenges.

   (ii) Using the challenge identified above, briefly explain how you can carry out quantitative analysis.

   (iii) Identify the difficulties you would meet in (ii) above.

   (08 marks)

6. (a) What are mutually exclusive events. (01 mark)

   (b) Events A and B are such that; P(A) = 0.4, P(B) = 0.6 and P(A∪B) = 0.7. Determine:-
   (i) $P(A \cap B)$ (ii) $P(A^1 \cap B^1)$ (iv) Test whether events A and B are independent or mutually exclusive. (06 marks)

   (c) A sales man experiences that each contact with a customer results in a sale with a probability of 45%. During a given day, three customers appear. Determine the probability that:-

   (i) Two customers will buy the product.

   (ii) No customer will buy the product.

   (iii) At least one customer will buy the product. (06 marks)

   (d) State two uses of Expected Monetary value. (02 marks)

   (e) Lisa plays a game in which there are only two outcomes. The cost to play a game is $100. If she wins, she receives $500. The probability of winning is 20%.

   (i) What is the expected value of winning a single game on average.

   (ii) If Lisa attempts 10 times, what is the expected value of winning the 10 games on average. (05 marks)

Best wishes