CERTIFIED PUBLIC ACCOUNTANT
FOUNDATION LEVEL 1 EXAMINATIONS
F1.1: BUSINESS MATHEMATICS AND QUANTITATIVE
METHODS
DATE: THURSDAY, 29 APRIL 2021

INSTRUCTIONS:

1. **Time Allowed: 3 hours 15 minutes** (15 minutes reading and 3 hours writing).
2. This examination has **seven** questions and only **five** questions **Should** be attempted.
3. Marks allocated to each question are shown at the end of the question.
4. Show all your workings where applicable.

QUESTION ONE

a) **Describe the objective of an assignment problem as a decision maker.** (4 Marks)

b) A psychologist has interviewed 250 school children throughout Kigali City and found that 80% of them spend at least 25 hours a week watching television.

Required:

(i) **Identify the population and the sample.** (2 Marks)

(ii) **Identify the population parameter and the sample statistic of interest.** (2 Marks)

c) The sales manager of Mbonye Company Ltd collected information on the number of the sales calls made and the number of products sold for a random sample of 10 sales representatives. As a part of her presentation at the upcoming sales meeting. Ms Teta, the sales manager, would like to offer specific information about the relationship between the number of sales calls and the number of products sold. Data are illustrated in the table below:

Sales representatives	Sales calls	Product sold
Alice	20	30
John	40	60
Joseph	20	40
José	30	60
Olive	10	30
Olivier	10	40
Aaron	20	40
Maurice	20	50
Eric	20	30
Joyce	30	70

Required:

(i) **Use the least square method to determine a linear equation and express the relationship between the variables.** (6 Marks)

(ii) **What is the expected number of products sold by a representative who makes 50 calls?** (2 Marks)

d) **Consider a simple trial of a perfectly round and balanced coin six times. Find the probability of getting:**

(i) **Exactly three heads** (1 Mark)

(ii) **At least three heads** (1.5Marks)

(iii) **Not more than two heads**. (1.5 Marks)

(Total :20 Marks)

QUESTION TWO

a) **What are the main purposes of project crashing?**   (2 Marks)

b) A CPA examination officer has announced that the grades on a Business Mathematics and Quantitative Methods exam have a mean value of 72 and a standard deviation of 6.

Required:

Using the Empirical Rule, what can you say about the proportion of grades that are between:

    (i)   66 and 78?   (2 Marks)

    (ii) 60 and 84?   (2 Marks)

    (iii) 54 and 90?   (2 Marks)

c) A real estate company wishes to expand its activities by constructing renting rooms for the university students to recover the financial and economic stability after the covid-19 pandemic. The project consists of seven activities with the following estimated time.

Activity	Predecessor activity	Optimistic time estimate (O) in days	Most likely time estimate (M) in days	Pessimistic time estimate (P) in days
A	-	2	5	8
B	A	2	3	4
C	A	6	8	10
D	A	2	4	6
E	B	2	6	10
F	C	6	7	8
G	D,E,F	6	8	10

Required:

    (i)   Find the estimated time for each activity.   (4 Marks)

    (ii) Draw a project network.   (4 Marks)

    (iii) Find the critical path.   (2 Marks)

    (iv) Find the probability that the project will be completed in 30 weeks or less.

                                                            (2 Marks)

                                                           (Total: 20 Marks)

QUESTION THREE

a) **Identify any three properties of measure of central tendency?**   (3 Marks)

b) A young woman graduated from one of the universities in Rwanda in academic year 2018/2019. She invested different amounts at 8%; $8\frac{3}{4}$%; and 9%, all at simple interest. Altogether she invested Frw 400,000 and she earns Frw 34, 550 per year.

Required:

Using matrix inverse only, how much has she invested at each rate if she has invested Frw 40,000 more at 9% than 8%.   (7 Marks)

c) The unit price (p) of producing food is related to the number of units sold, x, by the demand equation $p = 400 - \frac{x}{1,000}$; the cost of producing x units is given by $C(x) = 50x + 1600$. The number of units produced and sold; x is increasing at a rate of 200 units per week.

Required:

When the number of units produced and sold is 10,000, determine the instantaneous rate of change with respect to time, t (in weeks) of:

   (i)   **Revenue.**   (2 Marks)
   (ii)   **Cost.**   (2 Marks)
   (iii) **Profit.**   (2 Marks)

d) The relationship between profit p and advertising cost x is given by $p = \frac{4,000x}{500+x} - x$.

Required:
Find the value of x which maximises profit (p).   (4 Marks)
(Total: 20 Marks)

QUESTION FOUR

a) **Consider any two manufacturing items I and II, or investing in three different options A, B, or C. Using the concept of decision tree technique to discuss about the alternative decision you may consider as a Chief Executive Officer (CEO) at any Commercial Bank.**

                                        (4 Marks)

b) A country has the following payoff table for Real Estate Investments:

Decision (Purchase)	States of Nature	
	Good Economic condition (0.60)	**Poor Economic condition (0.40)**
Apartment building	Frw 50,000,000	Frw 30,000,000
Office building	Frw 100,000,000	Frw -40,000,000
Warehouse	Frw 30,000,000	Frw 10,000,000

Required:
As CFO in this project, advice the Government to choose the best investment among others using tree diagram.   (6 Marks)

c) The table below shows potential "payoff" in (Frw 000) depending upon likely economic conditions of three projects in Rwanda after covid-19 as given below:

Alternative	Economic conditions		
	Recession	Normal	Boom
Project A	4,075	5,000	6,100
Project B	0	5,250	12,080
Project C	2,500	7,000	10,375

Required:

Use Maximin, Maximax, Minimax regret and Laplace decision criterion, choose the best project among others, and explain each decision criterion. (8 Marks)

d) **Compare the Expected Monetary Value (EMV) and Expected Opportunity Loss (EOL).**
(2 Marks)

(Total 20 Marks)

QUESTION FIVE

a) **List and explain any four components of time series.** (4 Marks)

b) Inezahirwa Ltd is willing to evaluate their trend behaviour on the competitive markets in the period of one year from now by considering the data containing 12 observations taken over time (in monthly basis) and Y_t(millions); as an individual consultant in the Business domain consider the data taken from Data Analysis Unit as shown hereafter.

Time (month)	1	2	3	4	5	6	7	8	9	10	11	12
Y_t(millions)	71	70	69	68	64	65	72	78	75	75	75	70

Required:

(i) **Find all data you may use to fit the trend using exponential smoothing technique with the parameter $\alpha = 0.25$.** (6 Marks)

(ii)**Compute the MSE.** (2 Marks)

c) **Discuss about the errors committed in statistical hypothesis testing.** (4 Marks)

d) In industry XYZ Ltd two catalysts are being analysed to determine how they affect the mean yield of industrial chemical process. Specifically, catalyst 1 is currently in use, but catalyst 2 is acceptable. Since Catalysts 2 is cheaper, it should be adopted, providing it does not change the process yield. A test is run in the pilot plant and results are shown in the following table. Use $\alpha = 0.05$.

Type of Catalyst	Sample size	Sample Mean	Variance
Catalyst 1	$n_1 = 8$	$\overline{x_1} = 92.255$	$s_1^2 = (2.39)^2$
Catalyst 2	$n_2 = 8$	$\overline{x_2} = 92.733$	$s_2^2 = (2.98)^2$

Required:

Is there any difference between the mean yields? (4 Marks)

(Total 20 Marks)

QUESTION SIX

a) **(i) Discuss about the descriptive and enumerative methods in set theory and provide any example.** (2 Marks)

(ii) What are the applications of set theory? (2 Marks)

b) UNHCR conducted a survey of 1,000 households in Rwamusave refugee camp which produced different results and recorded as follows: 320 households were fed on beans, 200 households were fed on rice, 450 households were fed on potatoes,150 households were fed on beans and potatoes,

70 households were fed on beans and rice,100 households were fed on rice and potatoes, 300 households were fed on none of the three types of food.

Required:
(i) **Present the above information in the form of a Venn diagram;** (4Marks)
(ii) **The number of households who were fed on all the three types of food,** (1 Mark)
(iii) **The number of households who were fed on exactly one of the three types of food.**
(1 Mark)
(iv) **The number of households who were fed on at least two types of food.** (1 Mark)

c) The Manufacturing Company produces blue and red masks. Each blue mask (in container) takes four hours of labour from the design department and two hours of labour from the finishing department. Each red mask (in container) requires three hours of design and one hour of finishing. During a week, 240 hours of design time are available and 100 hours of finishing time. Each blue mask produced gives a profit of Frw 70,000 and each red mask gives a profit of Frw 50,000.

Required:
(i) **How many red and blue masks should be produced to optimally utilise available hours;**
(7 Marks)
(ii) **How much profit will be earned from optimum production?** (2 Marks)
(Total 20 Marks)

QUESTION SEVEN

a) **Discuss about the advantages and disadvantages of linear programming.** (4 Marks)
b) A Human Resource Manager wishes to recruit two staff and six candidates sat for the written test and scored as follows: 50,30, 27, 30, 27, 29, and 36.

Required:

(i) **Find the mean and mode mark;** (2 Marks)
(ii) **What are the differences between quartile and median?** (2 Marks)
c) **Describe briefly the difference between Laspeyre's and Paasche's indexes and their relationship with Fisher price index.** (4 Marks)
d) During covid-19 pandemic in Rwanda, a manufacturing company must decide how many boxes of speciality masks to produce each day. From the past experience, the sales manager is aware that the daily demand for the face masks ranges from 0 to 3 boxes. Each box contains 1000 masks and costs Frw 300,000 to produce and sells at Frw 800,000. We assume that any unsold boxes of masks are thrown in the garbage at the end of the day.
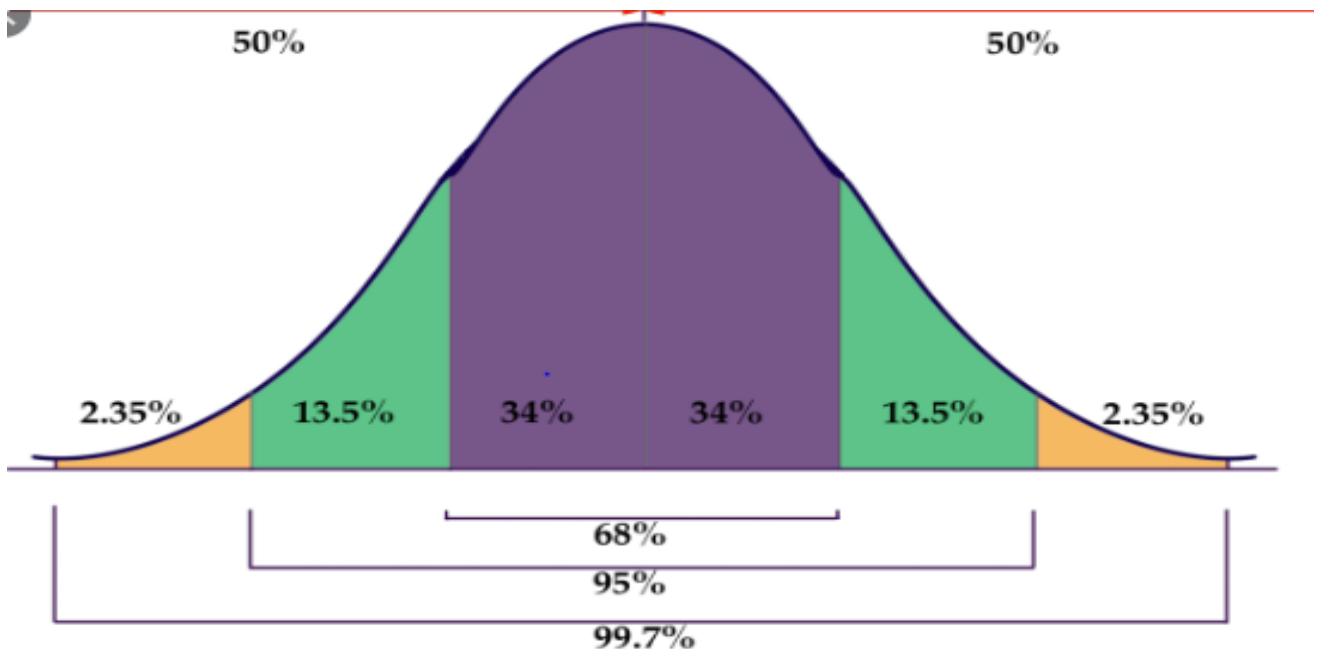
Required:
(i) **Set up a payoff table to help the sales manager decide how many boxes of masks to produce.**
(4 Marks)
(ii) **Assuming that the probability of each event is equal, determine the expected value of perfect information.** (4 Marks)
(Total 20 Marks)

FORMULAE

1. $\beta_1 = \dfrac{n(\varepsilon xy)-(\varepsilon x)(\varepsilon y)}{n(\varepsilon x^2)-(\varepsilon x)^2}$

2. $\beta_0 = \bar{Y} - b\bar{X} = \dfrac{\varepsilon y}{n} - \dfrac{\varepsilon x}{n}$

3. $n_{C_r} = \dfrac{n!}{r!(n-r!)}; (n \geq r)$

4. $Expected\ time = \dfrac{Optimisti\ time + Most\ likely\ time + Pessimistic\ time}{6}$

5. $Standard\ Deviation = \sigma = \dfrac{Pessimistic - Optimistic}{6}$

6. $A^{-1} = \dfrac{1}{|A|} c_{A^T}$; Where A^{-1} stands for matrix inverse; c_{A^T} stands for the transpose of cofactor matrix and $|A|$ stands for determinant of A.

7. $Revenue = price * Output$

8. $Total\ Profit\ (P) = Total\ Revenue - Total\ Cost$

9. Conditions of optimality:

Necessary conditions and Sufficient conditions	Decision
1. $\dfrac{dP}{dx} = 0$ and $\dfrac{d^2P}{dx^2} < 0$	Maximization case
2. $\dfrac{dP}{dx} = 0$ and $\dfrac{d^2P}{dx^2} > 0$	Minimization case

10. $EMV_i = \sum_{i=1}^{k} P_j V_{ij}$; EMV is the expected monetary value.

11. $F_{t+1} = \propto Y_t + (1-\propto)F_t$; Is the exponential smoothing model.

12. $S_p^2 = \dfrac{(n_1-1)S_1^2 + (n_2-1)S_2^2 + \cdots + (n_k-1)S_k^2}{n_1+n_2+\cdots+n_k-k}$

13. $\bar{x} = \dfrac{\sum x_i}{n}$

14. Normal distribution table (see next page)

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