CERTIFIED PUBLIC ACCOUNTANT

FOUNDATION LEVEL 1 EXAMINATIONS

F1.1: BUSINESS MATHEMATICS AND QUANTITATIVE METHODS

DATE: THURSDAY 28, AUGUST 2025

INSTRUCTIONS:

1. Time allowed: **3 hours and 15 minutes**. (15 minutes reading and 3 hours writing).
2. This paper has **seven questions** and only **five questions** are to be attempted.
3. Marks allocated to each question are shown at the end of the question.
4. Show all your workings and formulas, where applicable.
5. The question paper should not be taken out of the examination room.

QUESTION ONE

Ituze Manufacturers Ltd. is a company operating in Kigali specializing in the manufacture of domestic furniture. The company manufacture chairs, tables and cupboards since 2010. A chair requires 2 hours of labour time and 1 hour of machine time; a table requires 3 hours of labour time and 1 hour of machine time; and a cupboard requires 2 hours of labour time and 2 hours of machine time. The company has up to 1,000 labour hours and 800 machine hours each week. The expected profit on each product is FRW 7, FRW 8, and FRW 10 for a chair, a table and a cupboard respectively.

Required:

a) Using simplex model method, **develop a linear programming model and advise the Ituze Manufacturers Ltd on the product to produce so as to maximize profits.** (16 Marks)

b) Explain four limitations of linear programming. (4 Marks)

(Total: 20 Marks)

QUESTION TWO

a) Gasabo Ltd (GL) is a specialized manufacturer of juices. The production manager of GL has estimated that the fixed cost for operation is FRW 120,000 per week. The cost of producing one bottle of juice (x) is FRW 6,000. The selling price of the bottle of juice is FRW 7,000.

Required:

i) Derive the weekly total cost, total revenue and profit functions for GL from the information above. (3 Marks)

ii) Calculate the weekly total profit from producing 2,500 bottles of juice. (1 Mark)

iii) Compute the number of bottles of juices GL should produce weekly to break even and find the breakeven in sales revenue. (2 Marks)

b) Maniraguha company manufactures and sells leather bags. After a careful study of the market, the company concluded that demand is sensitive to price and production costs change based on the scale of production. The selling price per bag (in FRW) is $p(x) = 100 – 2x$ and the cost of producing x bags (000) is $C(x) = 20x + 0.5x^2 + 500$. Due to material discounts and labour patterns, the total cost of producing a bag behaves quadratically.

Required:

i) Find the profit function, marginal profit function and output that maximizes profit. (7 Marks)

ii) Compute the maximum profit for Maniraguha company. (1 Mark)

iii) Derive marginal cost and marginal revenue functions for Maniraguha company. (2 Marks)

iv) Plot the graph of the total cost function for all value ranging from 1 to 4 bags.

(4 Marks)

(Total: 20 Marks)

QUESTION THREE

a) Terimbere Mart, a retail chain supplier of domestic products in Kigali City, is analysing how consumer prices have shifted in the past two years (2023 – 2024). The management has selected five commonly consumed products for analysis.

2023 prices and quantities:

- 100 litres of milk at FRW 700 each
- 120 kilograms of maize flour at FRW 900 each
- 220 litres of cooking oil at FRW 1,500 each
- 170 kilograms of salt at FRW 500 each

2024 prices and quantities:

- 110 litres of milk at FRW 900 each
- 140 kilograms of maize flour at FRW 950 each
- 200 litres of cooking oil at FRW 1,550 each
- 180 kilograms of salt at FRW 600 each

You have been approached by the Management of the Mart to analyse the price changes using prices indices.

Required:

Taking 2023 as the base year, **compute Laspeyres' and Paasche's price indices for the above provided data and interpret your results for both indices.** (12 Marks)

b) Terimbere Mart hired a private company to plan the launch of a new juice product known as "Buryohe Juice". The table below lists the necessary activities and their durations in weeks.

Activity	Description	Predecessors	Duration (weeks)
A	Finalise package design	-	3
B	Set up packaging equipment and purchase materials	A	4
C	Produce a protype	A	6
D	Test the protype	B	3
E	Set up the sales office	C	2
F	Recruit a sales team	A	1
G	Train a sales team	D, F	2
H	Select retailers	G	2

I	Sell to retailers	G	3
J	Dispatch to retailers	E, H, I	2
K	Select advertising agencies	J	1
L	Plan advertisement campaign	I	2
M	Release pre – launch advertisement	J	3
N	Conduct advertisement campaign	K, L	2

Required:

Draw the network diagram for the project and find the critical path along with the project duration. (8 Marks)

(Total: 20 Marks)

QUESTION FOUR

a) IMENA Ltd, is a company located in Kimoronko, specializing in the manufacture of custom wooden furniture: chairs, tables and cabinets. The company has recently won a bid to produce the same products within three days' time. It plans to use 23 kgs of wood, 47 hours of labour time and 26 hours of machine time for this order to be successful.

- Each chair requires 1 kg of wood, 3 hours of machine and 6 hours of labour.
- Each table requires 2 kg of wood, 1 hour of machine and 1 hour of labour.
- Each cabinet requires 5 kgs of wood, 4 hours of machine and 7 hours of labour.

Required:

Find the number of units required to be produced for each product to meet the order within the three days' time by the client. (15 Marks)

b) IMENA Ltd. is considering investing in two projects X and Y whose initial investment is FRW 5,000,000 each. The expected cash flows of the two projects for 3 years are provided below in the table:

Year	Cash flows for Project X (FRW)	Cash flows for Project Y (FRW)
1	1,000,000	1,500,000
2	2,500,000	2,000,000
3	3,000,000	2,940,000

Required:

Advise the management of IMENA Ltd on the project to undertake using the Net Present Value (NPV) method of investment appraisal at a discount rate of 12%. (5 Marks)

(Total: 20 Marks)

QUESTION FIVE

a) Mugisha Ltd. is analysing customer preference of its three recently launched products at the market; Boneza, Kinigi and Ndama.
A survey was conducted last year and 950 customers were interviewed. Out of 950 customers interviewed, 70 responded that they preferred Boneza and Kinigi only, 30 preferred Kinigi and Ndama only and 80 preferred all the three products. The number of customers who preferred Boneza only was the same as the number of customers who preferred Boneza and Ndama only. 470 customers preferred Boneza and 300 customers preferred Kinigi.

Required:

i) Represent the above information on a Venn Diagram. (8 Marks)
ii) Calculate the number of customers who preferred at least two products. (2 Marks)

b) The table below shows the sales (FRW) of Mugisha Ltd. for years 2018 to 2024:

Year	**Sales ("Millions") FRW**
2018	65
2019	88
2020	132
2021	190
2022	275
2023	300
2024	320

Required:

i) **Find the linear equation that describes the trend in sales made by the company from 2018 to 2024 using least square method.**
(Take 2 decimals places for the solutions). (8 Marks)
ii) **Forecast the sales of the company for the year 2026.** (2 Marks)

(Total: 20 Marks)

QUESTION SIX

Karungi Ltd., a producer of Murage Juice in the Western Province of Rwanda, claims that its new machine produces an average of 300 bottles per day of Murage Juice. A survey was conducted for 7 days to verify this claim. The data about the bottles of juice produced per day is given below:

Day	**Bottles**
Monday	310
Tuesday	298
Wednesday	295
Thursday	303
Friday	292
Saturday	288
Sunday	300

Required:

a) **Conduct a hypothesis test to either support the claim that 300 bottles of Murage Juice are produced per day or not at 5 % level of significance**. *All values should be done in 2 decimal places.* (8 Marks)

b) **Distinguish between simple random sampling and stratified sampling techniques and state two advantages of simple random sampling techniques.** (4 Marks)

c) **Explain four methods of data presentation that could be used by Karungi Ltd to present its data from a survey.** (4 Marks)

d) **State four characteristics of measures of dispersion used in statistics.** (4 Marks)

(Total: 20 Marks)

QUESTION SEVEN

a) Neema Limited is a company operating in Eastern Province. The company is planning to launch three of its products in the market to be able to compete with other companies producing similar products. The company has to decide in which market to launch the product first. The market analyst has identified three potential products to decide on: Product A, Product B, and Product C.

The products are expected to be launched in under four states of nature which are very high demand, high demand, moderate demand and low demand. The market research has assigned the following probabilities under the four states of nature and economic forecasts:

State of nature	**Description**
Very High Demand	0.20
High Demand	0.35
Moderate Demand	0.30
Low Demand	0.15

Below is a payoff table showing the expected profits in Rwandan Francs for the products under the four states of nature:

	Very High Demand	**High Demand**	**Moderate Demand**	**Low Demand**
Product A	500,000	400,000	300,000	150,000
Product B	400,000	420,000	350,000	200,000
Product C	300,000	350,000	400,000	250,000

Required:

i) **Determine the Expected Value under uncertainty and Expected Value of perfect information using expected monetary values and interpret your results.** (4 Marks)

ii) **Determine the appropriate decision for Neema Limited under Maximax, Maximin and Hurwitz criteria** (coefficient of realism, $\alpha = 0.80$). (6 Marks)

b) IGIRE Ltd. is a company that manufactures batteries for mobile phones in Kigali City. The company maintains a strict quality control of its products. A survey was conducted to check the performance of the batteries in the market. A sample of 25 batteries was randomly selected from the a few mobile phone shops in Kicukiro District. 5 % of the batteries tested were found to be defective. The quality control team wants to use a binomial probability to evaluate the effectiveness of their sampling procedures.

Required:

i) Find the probability that exactly 4 batteries were defective. (2 Marks)
Round off to 3 decimal places

ii) Find the probability that at most 2 batteries were defective. (4 Marks)
Round off to 3 decimal places

c) Uncertainty plays an important role in our daily lives and activities as well as in business and probabilities have proven vital in many ways to both business and the social sciences based on uncertainties.

Required:

Explain with examples four properties of probability. (4 Marks)

(Total: 20 Marks)

End of Question Paper

t – distribution table is required here

		Significance level					
Degrees of	***Two-tailed test*:**	**10%**	**5%**	**2%**	**1%**	**0.2%**	**0.1%**
freedom	***One-tailed test*:**	**5%**	**2.5%**	**1%**	**0.5%**	**0.1%**	**0.05%**
1		6.314	12.706	31.821	63.657	318.309	636.619
2		2.920	4.303	6.965	9.925	22.327	31.599
3		2.353	3.182	4.541	5.841	10.215	12.924
4		2.132	2.776	3.747	4.604	7.173	8.610
5		2.015	2.571	3.365	4.032	5.893	6.869
6		1.943	2.447	3.143	3.707	5.208	5.959
7		1.894	2.365	2.998	3.499	4.785	5.408
8		1.860	2.306	2.896	3.355	4.501	5.041
9		1.833	2.262	2.821	3.250	4.297	4.781
10		1.812	2.228	2.764	3.169	4.144	4.587
11		1.796	2.201	2.718	3.106	4.025	4.437
12		1.782	2.179	2.681	3.055	3.930	4.318
13		1.771	2.160	2.650	3.012	3.852	4.221
14		1.761	2.145	2.624	2.977	3.787	4.140
15		1.753	2.131	2.602	2.947	3.733	4.073
16		1.746	2.120	2.583	2.921	3.686	4.015
17		1.740	2.110	2.567	2.898	3.646	3.965
18		1.734	2.101	2.552	2.878	3.610	3.922
19		1.729	2.093	2.539	2.861	3.579	3.883
20		1.725	2.086	2.528	2.845	3.552	3.850
21		1.721	2.080	2.518	2.831	3.527	3.819
22		1.717	2.074	2.508	2.819	3.505	3.792
23		1.714	2.069	2.500	2.807	3.485	3.768
24		1.711	2.064	2.492	2.797	3.467	3.745
25		1.708	2.060	2.485	2.787	3.450	3.725
26		1.706	2.056	2.479	2.779	3.435	3.707
27		1.703	2.052	2.473	2.771	3.421	3.690
28		1.701	2.048	2.467	2.763	3.408	3.674
29		1.699	2.045	2.462	2.756	3.396	3.659
30		1.697	2.042	2.457	2.750	3.385	3.646
32		1.694	2.037	2.449	2.738	3.365	3.622
34		1.691	2.032	2.441	2.728	3.348	3.601
36		1.688	2.028	2.434	2.719	3.333	3.582
38		1.686	2.024	2.429	2.712	3.319	3.566
40		1.684	2.021	2.423	2.704	3.307	3.551
42		1.682	2.018	2.418	2.698	3.296	3.538
44		1.680	2.015	2.414	2.692	3.286	3.526
46		1.679	2.013	2.410	2.687	3.277	3.515
48		1.677	2.011	2.407	2.682	3.269	3.505
50		1.676	2.009	2.403	2.678	3.261	3.496
60		1.671	2.000	2.390	2.660	3.232	3.460
70		1.667	1.994	2.381	2.648	3.211	3.435
80		1.664	1.990	2.374	2.639	3.195	3.416
90		1.662	1.987	2.368	2.632	3.183	3.402
100		1.660	1.984	2.364	2.626	3.174	3.390
120		1.658	1.980	2.358	2.617	3.160	3.373
150		1.655	1.976	2.351	2.609	3.145	3.357
200		1.653	1.972	2.345	2.601	3.131	3.340
300		1.650	1.968	2.339	2.592	3.118	3.323
400		1.649	1.966	2.336	2.588	3.111	3.315
500		1.648	1.965	2.334	2.586	3.107	3.310
600		1.647	1.964	2.333	2.584	3.104	3.307
∞		1.645	1.960	2.326	2.576	3.090	3.291

Present value interest factor of Frw1 per period at i% for n periods, PVIF(i,n).

Period	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.847	0.840	0.833
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797	0.783	0.769	0.756	0.743	0.731	0.718	0.706	0.694
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712	0.693	0.675	0.658	0.641	0.624	0.609	0.593	0.579
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683	0.659	0.636	0.613	0.592	0.572	0.552	0.534	0.516	0.499	0.482
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567	0.543	0.519	0.497	0.476	0.456	0.437	0.419	0.402
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.535	0.507	0.480	0.456	0.432	0.410	0.390	0.370	0.352	0.335
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	0.482	0.452	0.425	0.400	0.376	0.354	0.333	0.314	0.296	0.279
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	0.434	0.404	0.376	0.351	0.327	0.305	0.285	0.266	0.249	0.233
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424	0.391	0.361	0.333	0.308	0.284	0.263	0.243	0.225	0.209	0.194
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322	0.295	0.270	0.247	0.227	0.208	0.191	0.176	0.162
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.350	0.317	0.287	0.261	0.237	0.215	0.195	0.178	0.162	0.148	0.135
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319	0.286	0.257	0.231	0.208	0.187	0.168	0.152	0.137	0.124	0.112
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290	0.258	0.229	0.204	0.182	0.163	0.145	0.130	0.116	0.104	0.093
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263	0.232	0.205	0.181	0.160	0.141	0.125	0.111	0.099	0.088	0.078
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239	0.209	0.183	0.160	0.140	0.123	0.108	0.095	0.084	0.074	0.065
16	0.853	0.728	0.623	0.534	0.458	0.394	0.339	0.292	0.252	0.218	0.188	0.163	0.141	0.123	0.107	0.093	0.081	0.071	0.062	0.054
17	0.844	0.714	0.605	0.513	0.436	0.371	0.317	0.270	0.231	0.198	0.170	0.146	0.125	0.108	0.093	0.080	0.069	0.060	0.052	0.045
18	0.836	0.700	0.587	0.494	0.416	0.350	0.296	0.250	0.212	0.180	0.153	0.130	0.111	0.095	0.081	0.069	0.059	0.051	0.044	0.038
19	0.828	0.686	0.570	0.475	0.396	0.331	0.277	0.232	0.194	0.164	0.138	0.116	0.098	0.083	0.070	0.060	0.051	0.043	0.037	0.031
20	0.820	0.673	0.554	0.456	0.377	0.312	0.258	0.215	0.178	0.149	0.124	0.104	0.087	0.073	0.061	0.051	0.043	0.037	0.031	0.026
25	0.780	0.610	0.478	0.375	0.295	0.233	0.184	0.146	0.116	0.092	0.074	0.059	0.047	0.038	0.030	0.024	0.020	0.016	0.013	0.010
30	0.742	0.552	0.412	0.308	0.231	0.174	0.131	0.099	0.075	0.057	0.044	0.033	0.026	0.020	0.015	0.012	0.009	0.007	0.005	0.004
35	0.706	0.500	0.355	0.253	0.181	0.130	0.094	0.068	0.049	0.036	0.026	0.019	0.014	0.010	0.008	0.006	0.004	0.003	0.002	0.002
40	0.672	0.453	0.307	0.208	0.142	0.097	0.067	0.046	0.032	0.022	0.015	0.011	0.008	0.005	0.004	0.003	0.002	0.001	0.001	0.001
50	0.608	0.372	0.228	0.141	0.087	0.054	0.034	0.021	0.013	0.009	0.005	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000

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