Mock Exam

Terminology. Please answer within 20 words.

a. State one advantage of using primary data over secondary data.

b. Explain what it means if a dataset has standard deviation close to zero.

c. State why decision variables are restricted to be non-negative in many linear programming problems.

d. Define the complement of an event A using a Venn diagram interpretation.

e. What is Calculus?

f. Explain the difference between discrete quantitative data and continuous quantitative data.

g. What is the difference between real and nominal interest rate?

h. Compare additive and comparative models in time-series forecasting.

i.What is the objective function in a linear programming problem?

j. What are mutually exclusive events?

k. Describe the data distribution shape when the mean is greater than the median.

l. State one key limitation of using a simple price index to measure cost-of-living changes.

m. Explain what the feasible region represents in a linear programming problem.

n. Explain what distinguishes a combination from a permutation.

o. Define an identity and zero matrices.

Question 1.

A nationwide electronics distributor collected monthly revenue data (in thousand dollars) from a sample of 120 stores. Because the data set was large, the revenue information was grouped into class intervals as shown below. Table 1. Monthly Revenue Distribution:

Revenue ($ thousands)	**f**	**Mid-point**	**f*Mid-point**
[30 ; 70)	18	50	900
[70 ; **c**)	22	95	2090
[**c** ; 150)	**d**	130	1950
[150 ; 250)	30	**e**	**f**
[250 ; 450)	20	350	7000
[450 ; 650)	**g**	**h**	8250

Required:

(a) Find the missing values c, d, e, f, g, and h.

(b) Compute the mean monthly revenue (correct to 4 decimal places).

(c) Compute the median monthly revenue using the grouped-data median formula.

(d). Calculate the variance for given data.

Question 2.

A logistics company monitors monthly fuel consumption (in thousand litres) for its fleet of heavy trucks. To analyse fuel efficiency and plan next year's fuel budget, analysts summarised data from 165 trucks into the grouped frequency table below. Due to a data-entry problem, some values are missing.

Table 2. Monthly Fuel Consumption per Truck:

Fuel (in thousand L)	**Number of trucks**	**Mid-point**	**Total Fuel**
[20 ; 60)	16	40	**i**
[60 ; **a**)	**b**	80	2800
[**a** ; 140)	30	**f**	**j**
[140 ; 200)	**c**	170	3400
[200 ; 260)	24	**g**	**k**
[260 ; 360)	**d**	**h**	9300
[360 ; **b**)	**e**	420	**l**

Total number of trucks: 165

(a) Calculate the missing values. Show all working.

Using the completed table, calculate the following (correct to 4 decimal places where appropriate):

(b) The mean monthly fuel consumption per truck.

(c) The median monthly fuel consumption per truck, using the grouped-data median formula.

(d) The mode of monthly fuel consumption, using the grouped-data mode formula.

(e) The lower quartile Q1 and upper quartile Q3.

(f) Calculate the variance of monthly fuel consumption for the trucks.

Question 3.

A national statistics agency has published the **Laspeyres and Paasche Price Index** numbers for **three household essentials—flour, sugar, and milk**—consumed by suburban households for the years **2019 and 2023**. The following information is provided:

- The **total expenditure** on all three items in **2019** was **$8,400**.
- The **price of flour** increased by **20%** from 2019 to 2023.
- The **2019 sugar quantity** and **2019 sugar price** were **70%** and **60%** of the 2023 sugar quantity and price, respectively.
- The **price of milk** in 2023 was **40% higher** than in 2019.

The partially completed dataset is shown below in Table 3:

Items	**2019**		**2023**	
	Price ($)	**Quantity**	**Price ($)**	**Quantity**
Flour	15	200	**(a)**	180
Sugar	**(b)**	**(c)**	30	220
Milk	**(d)**	150	**(e)**	130

Additional information: The agency's published index numbers are **Laspeyres = 141.66 and Paasche = 145.77.**

a. Calculate the missing price and quantity values. Show full steps and equations.

b. Explain why the Paasche index is slightly higher than the Laspeyres index in this scenario, referring to consumption behavior shown in your table.

Question 4.

A consumer survey organization has compiled price index numbers for four essential food items **(wheat, milk, chicken and vegetables)** consumed by urban households, comparing the years **2021 (base year) and 2025 (current year)**. Due to confidentiality rules, several values in their internal database were removed.

Information provided by the organization:

- Total expenditure on all four items **in 2021 was $8,450.**
- The price of wheat increased by **35% from 2021 to 2025**.
- For milk, **the 2021 quantity and price were 75% and 65% of their 2025 quantity and price, respectively**.
- Chicken was **40% more expensive in 2025 than in 2021**; however, **households purchased 20% less chicken in 2025.**
- Vegetable **prices remained unchanged between 2021 and 2025**, but **quantity consumed increased by 60% in 2025.**

Your task is to reconstruct the missing price and quantity data in the table below and use them to **compute the required price indices.**

Table 4. Prices and Quantities of Food Items in 2021 and 2025

Items	**2021**		**2025**	
	Price ($)	**Quantity**	**Price ($)**	**Quantity**
Wheat	18	160	**(a)**	140
Milk	**(b)**	**(c)**	22	320
Chicken	**(d)**	110	14	**(e)**
Vegetables	4	**(f)**	**(g)**	480

a. Calculate the missing values. Show complete working.

b. Using your completed table, calculate the Laspeyres and Paasche price indices for 2025 (base 2021). Express each index correct to two decimal places. Show your full calculations.

c. Compute the Fisher Ideal price index for 2025. Give your answer to two decimal places.

d. Using changes in quantities from 2021 to 2025, explain why the Laspeyres index differs from the Paasche index. Refer to substitution effects and expenditure patterns.

Question 5.

QuantumApps, a cloud-based software company, is analyzing how subscription quantity affects monthly revenue. The analytics team models the total monthly revenue R(Q) as a function of subscriptions sold, Q (in thousands). The revenue function is:

$$\mathbf{R(Q)=(600-Q^2)(2Q-5)}$$

Where:

- Q = quantity of subscriptions sold (in thousands)
- R(Q) = total monthly revenue (in thousands of dollars)

a. Compute the first-order derivative $R'(Q)$ using the product rule and determine all stationary points.

b. Compute the second-order derivative $R''(Q)$ using the **limit definition** of the derivative.

c. Using the stationary points from part (a), evaluate $R''(Q)$ at each point and classify them as maxima or minima.

d. Identify the subscription quantity that maximizes or minimizes the revenue and compute the revenue value.

Question 6.

Net profit $\pi(q)$ (in thousands of US Dollars) for a Tech startup is modelled as:

$$\pi(q) = (q - 9)^2 (q + 9)$$

where q is quantity (in thousands of units).

a. Differentiate the function. Use chain rule for $(q - 9)^2$ term.

b. Find the stationary points by solving $\pi'(q) = 0$.

c. Compute the second-order derivative $\pi''(q)$ using the limit approach.

d. Using the stationary points obtained in part (b), evaluate $\pi''(q)$ at each point and classify each as a local minimum, local maximum, or saddle point. Consider the concept of domain.

e. Prove that the minimum profit is at break-even, meaning no-loss business.

Question 7.

A company manufactures **mugs** and **plates**, selling each for **$12**.
The cost to produce a mug is **$4**, while a plate costs **$2 more** than a mug. Shaping is done by a machine with **24 hours available**. A mug requires **3 minutes** of shaping. A plate requires **5 minutes** of shaping. Finishing is done manually, with **30 hours available**. A mug requires **4 minutes** of finishing. A plate requires **6 minutes** of finishing. The company must produce **at least 80 mugs**, and may produce **no more than 100 plates**. How many mugs and plates should be produced to **maximize profit**?

a. Define your decision variables.

b. Formulate your objective function.

c. List all constraints (all inequalities must include equality).

d. Graphically represent all constraints on a Cartesian plane and identify the feasible region.

e. Solve the intersection point(s) between shaping and finishing constraints using Matrix Methods (Cramer or Inverse).

Question 8.

The WIUT Robotics Club has been informed that five students will be selected to represent the university at an international robotics championship in Tokyo. There are 15 shortlisted candidates, including Sara. Among these 15 candidates, Sara has six close teammates in her robotics project group.

Answer the following:

a. How many total ways are there to select 5 students from the 15 shortlisted candidates?

b. How many ways can Sara be selected together with exactly 3 of her 6 close teammates?

c. What is the probability that Sara is selected and exactly three of her six close teammates are also selected to represent WIUT at the competition?

Question 9.

The following table shows daily smartphone sales (in thousands**)** in Saudi Arabia during the first three working weeks of 2026. Some Sales values and some 5-point Moving Averages are missing. Use the information provided to fill in all missing values**.**

Days	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri	Mon	Tue	Wed	Thu	Fri
Sales	58	67	42	(a)	55	78	92	(b)	73	65	93	82	(c)	88	95
5-point MA			53	(d)	62	63	69	71	(e)	72	77	(f)	86		

Table 1. Smartphone Sales and 5-Point Moving Average

Days	Monday	Tuesday	Wednesday	Thursday	Friday
Average Deviation	14.00	-16.00	21.00	-9.00	-8.5
Adjustment	2.40				
Seasonal Variation	x	y	z	w	t

Table 2. Seasonal Variation Components

a. Using Table 1, calculate all missing Sales values.

b. Compute the missing 5-point moving averages.

c. The forecasted trend value for next Wednesday is 78.50. Forecast next Wednesday's sales using your Wednesday seasonal variation.