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SRI LANKA

ASSOCIATION OF ACCOUNTING TECHNICIANS OF SRI LANKA

LEVEL I   EXAMINATION - JANUARY 2023

(102) BUSINESS MATHEMATICS AND STATISTICS

05-03-2023
Morning
[09.00 – 12.00]

No. of Pages   : 10
No. of Questions : 06

- **Instructions to candidates** (Please Read Carefully)**:**

  (1) **Time:** *03 hours.*

  (2) **All questions should be answered.**

  (3) **Answers** *should be in* **one language***, in the* **medium** *applied for, in the* **booklets** *provided.*

  (4) *Submit all workings and calculations. State clearly assumptions made by you, if any.*

  (5) *Use of Non-programmable calculators is* **only** *permitted.*

  (6) **Mathematical Tables** *will be provided.*

  (7) **Action Verb Check List** *with definitions is attached. Each question will begin with an* **action verb** *excluding OTQ's. Candidates should answer the questions based on the* **definition** *of the verb given in the Action Verb Check List.*

  (8) **Formulae Sheets** *are attached.*

  (9) *100 Marks.*

SECTION A

Objective Test Questions (OTQs)

(Total 40 marks)

Question 01

Select the most correct answer for question No. **1.1** *to* **1.10***. Write the number of the selected answer in your answer booklet with the number assigned to the question.*

1.1 $3 - \frac{2}{3}x = 1$

Find "x".

(1) $x = \frac{1}{3}$ (2) $x = \frac{2}{3}$ (3) $x = 2$ (4) $x = 3$

(03 marks)

1.2 A person invested Rs.20,000/- at a rate of 8% per annum compounded annually. The total interest receivable at the end of 3rd year would be *(to the nearest integer)*:

(1)   Rs.27,210/-   (2)   Rs.25,194/-   (3)   Rs.7,210/-   (4)   Rs.5,194/-

(03 marks)

1.3 Out of 30 students in a class, it was found that 20 attend English tuition classes, 22 attend Science tuition classes and 12 attend both English and Science tuition classes:

If a student is selected at random in the class, the probability that a selected student attend only English tuition classes is:

(1) $\dfrac{8}{20}$ (2) $\dfrac{12}{30}$ (3) $\dfrac{8}{30}$ (4) $\dfrac{20}{30}$

(03 marks)

1.4 The prices of three different commodities in 2019 and 2020 are tabulated below:

Commodity	Price (Rs.) - 2019	Price (Rs.) - 2020
A	800	700
B	1,000	850
C	1,200	1,000

The price relative of commodity **C** *(to the nearest integer)*, using 2019 as the base year is:

(1) 83%   (2) 109%   (3) 117%   (4) 120%

(03 marks)

1.5 The summarized data on advertising cost (x) (Rs.'000) and the number of items sold (y) of a certain product for the last 8 years are as follows:

$$\Sigma x = 44, \quad \Sigma y = 30, \quad \Sigma xy = 160, \quad \Sigma x^2 = 284, \quad \Sigma y^2 = 120$$

Based on the above data, the correlation co-efficient between x and y is:

(1) -0.28   (2) -0.52   (3) -0.72   (4) -0.82

(03 marks)

1.6 You are given the following frequency distribution:

x	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60
f	5	8	25	32	30	20

The mode of the above frequency distribution is *(approximately)*:

(1) 32.7   (2) 38.3   (3) 30.5   (4) 31.5

(03 marks)

1.7 Consider the following probability distribution of the discrete random variable **X**:

X	1	2	3	4
Probability P(x)	0.35	0.30	0.20	0.15

The probability that **X** is less than 3 would be:

(1) 0.30   (2) 0.65   (3) 0.80   (4) 0.95

(03 marks)

1.8 **Namal** invested an amount in a bank at an interest rate of 12% per annum. If the interest is compounded semi-annually, the effective annual interest rate would be:

(1) 6.18%   (2) 12.36%   (3) 13.42%   (4) 25.42%

(03 marks)

1.9 **Sarath** invested Rs.100,000/- in a fixed deposit of a bank for 2 years at the annual interest rate of 16% compounded quarterly. The maturity value of the fixed deposit at the end of the 2nd year would be *(to the nearest integer)*:

(1) Rs.132,000/-   (2) Rs.136,857/-   (3) Rs.134,560/-   (4) Rs.136,049/-

(03 marks)

1.10 The following table provides the average annual sales of bags at a leading retailer over six years from 2017 to 2022:

Year (x)	2017	2018	2019	2020	2021	2022
Sales (y)	2,050	2,200	2,422	2,075	1,920	1,340

The trend equation of sales has been found to be:

$$y = 2,439.80 - 145.4x$$

Where 'y' is the number of bags sold and 'x' is the time.

The predicted annual sales for 2023 (7th year) would be:

(1) 3,458   (2) 2,001   (3) 1,422   (4) 1,567

(03 marks)

*Write the answers for question No. **1.11** to **1.13** in your answer booklet with the number assigned to the question.*

1.11 Relate the terms given on the left hand side of the following table with the number of the appropriate explanation given on the right hand side:

Term	Explanation
(A) Seasonal variation	**(1)** The ratio between two quantities of the same product observed in two periods.
(B) Base period	**(2)** A series of data points indexed in time order.
(C) Time series	**(3)** Short term repetitive movements.
(D) Quantity relative	**(4)** The period against which all other periods are compared.

(01 mark each, 04 marks)

1.12 The following table gives the information on monthly income and vehicle ownership of workers in a company:

	Monthly Income < 50,000	Monthly Income ≥ 50,000
Having an own vehicle	23	27
Not having an own vehicle	30	30

Calculate the number of workers in this company who own a vehicle. (02 marks)

1.13 Find the 12th term of the following geometric series:

3, 6, 12, …………….. (02 marks)

*State whether each of the following statements (**1.14** and **1.15**) is **True** or **False**. Write the answer (True/False) in your answer booklet with the number assigned to the question:*

1.14 The most commonly used measures of dispersion are mean and median. (01 mark)

1.15 If the correlation coefficient is positive, both variables move in the same direction.
(01 mark)
(Total 40 marks)

———————————————— *End of Section A* ————————————————

SECTION B
(Total 40 marks)

Question 02

(a) You are given the following simultaneous equations:
$$2x + 3y = 0$$
$$3x + 4y = 5$$

You are required to:

Calculate the value of 'x' and 'y'. (03 marks)

(b) **A, B** and **C** invested money in a business in the ratio of 4 : 3 : 3 respectively. **C** invested Rs.1,200,000/- to the business.

You are required to:

Calculate the following:

(i) The total investment made to the business. (02 marks)

(ii) The investment made by **A**. (02 marks)

(c) 70% of employees at a manufacturing factory were tested positive for COVID-19. The number of employees tested negative for COVID-19 were 180.

You are required to:

Calculate the number of employees tested positive for COVID-19 at the factory.   (03 marks)

(Total 10 marks)

Question 03

A firm produces **Product A**. Its monthly variable cost function is $5q^2 + 24q$ and it has a fixed cost of Rs.90,000/- per month. The demand function per month is 39 + 5q.

You are required to:

(a) **Identify** the Total Cost (TC) function and Total Revenue (TR) function.   (04 marks)

(b) **Identify** the Marginal Cost (MC) function of the firm.   (02 marks)

(c) **Calculate** the break-even quantity.   (04 marks)

(Total 10 marks)

Question 04

The data in the table below shows the number of online marketing emails sent out per month to the subscribers and the proportion of subscribers who click and open the email:

No. of marketing e-mails (x) (in.'000s)	3	4	1	5	4	7	10	8
Proportion : Click and open (y)	0.41	0.59	0.18	0.65	0.57	0.69	0.84	0.64

Using the above data,

You are required to:

(a) **Identify** the least square regression line given by $y = a + bx$ to predict the proportion of subscribers who click and open the e-mail.   (07 marks)

(b) **Calculate** the expected proportion of subscribers who click and open the email when 900 e-mails are sent out.   (03 marks)

(Total 10 marks)

Question 05

The below table represents marks obtained by 160 students in an aptitude test:

Marks	No. of Students (f)
30 - 39	13
40 - 49	15
50 - 59	22
60 - 69	25
70 - 79	35
80 - 89	28
90 - 99	22

Using the above data,

You are required to:

Calculate the following:

(a)   Median.   (03 marks)

(b)   Mean.   (03 marks)

(c)   Standard Deviation.   (04 marks)
                                                                                                        (Total 10 marks)

——————————— *End of Section B* ———————————

SECTION C

(Total 20 marks)

Question 06

(A) A loan of Rs.700,000/- was obtained by **Amal** for 5 years at the interest rate of 8% per annum and is to be settled in 5 equal annual installments.

You are required to:

(a) **Calculate** the annual installment of the loan. (03 marks)

(b) **Prepare** the amortization schedule to illustrate the re-payment of the loan. (03 marks)

(B) The following table represents net cash flows of two (2) projects (**Project A** and **Project B**):

Project \ Year	0 (Rs.)	1 (Rs.)	2 (Rs.)	3 (Rs.)
A	(100,000)	60,000	45,000	40,000
B	(200,000)	103,000	70,000	50,000

The cost of capital (discounting factor) of the company is 12% per annum.

You are required to:

(a) **Calculate** the Net Present Value (NPV) of each project. (05 marks)

(b) **Identify** the best investment option with reasons based on the NPV. (02 marks)

(C) The probability that a student passes a written exam is $\frac{1}{2}$ and a practical exam is $\frac{1}{3}$. Also a student passes both the written and practical exams has a probability of $\frac{1}{4}$.

You are required to:

Calculate the probability that the student will pass the written exam given that he passed the practical exam if a student is selected at random. (03 marks)

(D) The height of soldiers in a regiment are normally distributed with mean height of 170 cm and a standard deviation of 5 cm.

You are required to:

Calculate the probability that the height of a soldier is more than 180 cm. (04 marks)

(Total 20 marks)

End of Section C

ACTION VERBS CHECK LIST

Level of Competency	Description	Action Verbs	Verb Definitions
Knowledge (1)	Recall Facts and Basic Concepts.	**Draw**	Produce a picture or diagram.
		Relate	Establish logical or causal connections.
		State	Express details definitely or clearly.
		Identify	Recognize, establish or select after consideration.
		List	Write the connected items.

Level of Competency	Description	Action Verbs	Verb Definitions
Comprehension (2)	Explain & Elucidates Ideas and Information.	**Recognize**	Show validity or otherwise, using knowledge or contextual experience.
		Interpret	Translate into understandable or familiar terms.
		Describe	Write and communicate the key features.
		Explain	Make a clear description in detail using relevant facts.
		Define	Give the exact nature, scope or meaning.

Level of Competency	Description	Action Verbs	Verb Definitions
Application (3)	Use and Adapt Knowledge in New Situations.	**Reconcile**	Make consistent / compatible with another.
		Graph	Represent by graphs.
		Assess	Determine the value, nature, ability or quality.
		Solve	Find solutions through calculations and/or explanation.
		Prepare	Make or get ready for a particular purpose.
		Demonstrate	Prove or exhibit with examples.
		Calculate	Ascertain or reckon with mathematical computation.
		Apply	Put to practical use.

Level of Competency	Description	Action Verbs	Verb Definitions
Analysis (4)	Draw Connections Among Ideas and Solve Problems.	**Communicate**	Share or exchange information.
		Outline	Make a summary of significant features.
		Contrast	Examine to show differences.
		Compare	Examine to discover similarities.
		Discuss	Examine in detail by arguments.
		Differentiate	Constitute a difference that distinguishes something.
		Analyze	Examine in details to find the solution or outcome.

FORMULAE SHEETS

Mathematical Fundamentals:

Quadratic equation:
The solutions of a quadratic equation,
$ax^2 + bx + c = 0$ is given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Arithmetic sequence:

Term of an arithmetic sequence:

$T_n = a + (n - 1)\, d$

The sum of first n terms of an AP:
$$S = \frac{n}{2}\{2a + (n-1)d\}$$

Geometric sequence:
The term of a geometric sequence,

$T_n = ar^{n-1}$

The sum of first n terms of a GP:

$$S = a\,\frac{\{r^n - 1\}}{\{r - 1\}} \quad \text{if} \quad r > 1$$

$$S = a\,\frac{\{1 - r^n\}}{\{1 - r\}} \quad \text{if} \quad r < 1$$

$$S = na \quad \text{Otherwise} \quad r = 1$$

Quantitative Finance:

Simple interest:
$S = X(1 + nr)$

Compound Interest:
$S = X\{1 + r\}^n$

Discounting:
Present Value = Future Value $\times \dfrac{1}{(1+r)^n}$

Repayment of mortgage / Loan:
$$A = \frac{SR^n(R - 1)}{\{R^n - 1\}}$$

Effective Interest Rate:
EIR = $\{(1 + r)^n - 1\}\,100\%$

Numerical Descriptive Measures:

Mean $\bar{x}$:
For ungrouped data: $\dfrac{\sum x}{n}$

For grouped data: $\dfrac{\sum fx}{\sum f}$

Median:
For Ungrouped data $M_d = \dfrac{(n + 1)^{th} \text{ term}}{2}$

For Grouped data $M_d = L_1 + \left(\dfrac{\frac{n}{2} - F_c}{f_m}\right) \times C$

Mode:
Grouped data $M_0 = L_1 + \dfrac{\Delta_1}{\Delta_1 + \Delta_2} \times C$

Standard deviation σ:
For ungrouped data:

$$\sqrt{\frac{\sum(x - \bar{x})^2}{n}} \quad \text{or} \quad \sqrt{\frac{\sum x^2}{n} - \bar{x}^2}$$

For grouped data:

$$\sqrt{\frac{\sum f(x - \bar{x})^2}{\sum f}} \quad \text{or} \quad \sqrt{\frac{\sum fx^2}{\sum f} - \bar{x}^2}$$

Coefficient of variation (CV):

$$\frac{Standard\ deviation}{Mean} = \frac{\sigma}{\bar{x}} \times 100$$

Coefficient of skewness $= \dfrac{3(\text{Mean - Median})}{\text{Standard Deviation}}$

Comparing Two Quantitative Variables:

Correlation coefficient (r):

$$\frac{[n\sum xy - \sum x \sum y]}{\sqrt{\{[n\sum x^2 - (\sum x)^2] \times [n\sum y^2 - (\sum y)^2]\}}}$$

Regression line under least square method (a and b):

$b = \dfrac{[n\sum xy - \sum x \sum y]}{[n\sum x^2 - (\sum x)^2]}$

$a = \bar{y} - b\bar{x}$

Comparison over time with Economic variables

Index Numbers:

Price Relative $= \dfrac{p_1}{p_0} \times 100$

Quantity Relative $= \dfrac{q_1}{q_0} \times 100$

Value Relative $V_{1/0} = \dfrac{p_1 q_1}{p_0 q_0} \times 100$

Simple aggregate price index $= \dfrac{\sum p_1}{\sum p_0} \times 100$

Simple aggregate quantity index $= \dfrac{\sum q_1}{\sum q_0} \times 100$

Average price relative $= \dfrac{1}{n} \sum \dfrac{p_1}{p_0} \times 100$

Average quantity relative $= \dfrac{1}{n} \sum \dfrac{q_1}{q_0} \times 100$

Weighted aggregate indices
1) Base-weighted / Laspeyre's:

   Price index $= \dfrac{\sum p_1 q_0}{\sum p_0 q_0} \times 100$

   Quantity index $= \dfrac{\sum q_1 p_0}{\sum q_0 p_0} \times 100$

2) Current-weighted / Paasche's:

   Price index $= \dfrac{\sum p_1 q_1}{\sum p_0 q_1} \times 100$

   Quantity index $= \dfrac{\sum q_1 p_1}{\sum q_0 p_1} \times 100$

3) Using standard weights

   Price index $= \dfrac{\sum p_1 w}{\sum p_0 w} \times 100$

   Quantity index $= \dfrac{\sum q_1 w}{\sum q_0 w} \times 100$

Weighted average of relatives

Price index $= \dfrac{\sum [\, w \times I_p]}{\sum w} \times 100$

Quantity index $= \dfrac{\sum [\, w \times I_q]}{\sum w} \times 100$

Time Series:

Multiplicative Model

$Y = T \times S \times C \times R$

Sets and Probability

$\cup$ - Union; A∪B defines all elements in A plus all elements in B, no element being counted twice.

$\cap$ - Intersection; A∩B defines all elements included in both A and B.

P (A) – Probability of event A
P (A/B) – Probability of event A, given B

General rules:
P (A∪B) = P (A) + P (B) – P (A∩B)

$P\ (A/B) = \dfrac{P(A \cap B)}{P(B)}$

Expectation and Variance of a discrete random variable:

$E(X) = \sum(probability \times pay\ off) = \sum p \times x$

$VAR(X) = \sum px^2 - \left(\sum px\right)^2$

Normal Distribution:

$Z = \dfrac{x - \mu}{\sigma}$