# EXAMINER'S REPORT

## LEVEL I EXAMINATION - JANUARY 2024

# (102) BUSINESS MATHEMATICS & STATISTICS

## SECTION A

### Question No. 01

It was expected to select the correct answer and write the relevant number in the answer booklet for the questions **1.1** to **1.10**. Almost all the candidates had attempted all 10 MCQs. Some candidates had obtained the correct answer instead of correct number.

The following are some of the common errors / weaknesses of the answers given by the candidates for each sub section:

**1.1** The objective of this question is to find the factors of the following quadratic expression.

$9x^2 - 25$ Majority of applicants had marked the correct answer. A limited number of candidates had marked the answer (3x +5)(3x+5) instead of the correct answer No. (4).

**1.2** This is a compound interest question. Majority of the applicants had marked the correct answer using the formula $S = X(1+r)^n$. Another group of candidates had solved the sum by calculating the interest year by year and calculating the total interest for the four years. Another set of candidates calculated the total amount(S) using the correct formula but did not calculate the interest. Very few applicants have tried to solve the sum using the simple interest formula S=x(1+rn).

**1.3** This is a sum related to probability. Majority of the candidates had calculated the probability of $P(x \cap y)$ using the following correct formula.

$P(x \cup y) = P(x) + P(y) - P(x \cap y)$ A very limited number of candidates have used erroneous formulas such as the following:

$p(x \cup y) = P(x) + P(x \cap y)$ $\qquad$ $p(x \cup y) = P(x) + P(y) + P(x \cap y)$

**1.4** This is a sum related to Index numbers. Here, considering 2012 as the base year, it is indicated to calculate the quantity Index for S rice type.

Majority of the candidates had marked the correct answer. Very few applicants have calculated using $\frac{q_0}{q_1} \times 100$ instead of $\frac{q_1}{q_0} \times 100$. They got as 80% which is a wrong answer.

**1.5** Given numerical data for both variables **X** and **Y** and asked to find the correlation coefficient between **X** and **Y**. Majority of the candidates had solved the correlation coefficient between the two variables X and Y calculated the correlation coefficient using the formula. Formula is, $r = \frac{n\sum xy - \sum x \sum y}{\sqrt{\{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]\}}}$

Correct answer is -0.7759. But very few candidates have marked -0.7795 as answer.

**1.6** The objective of this question is to find the median of a frequency distribution. Majority of the candidates got the correct answer using formula $M_d = L_1 + \left[\frac{\frac{n}{2}-F_c}{Fm}\right] XC$

Some other group of candidates have used 35-39 instead of the median class 30 - 34. Due to this mistake the values of fm=20 and fc=10 have been obtained and arrived at the wrong answer 37.

**1.7** Here, given the probability distribution of the random variable x, it is desired to calculate the probability of "a". But it was observed that most of the candidates did not have a correct understanding of the question. The sum of all the probabilities in the probability distribution should be equal to 1 and thus the value of "a" should be calculated. However, only half of the candidates got the correct answer of 0.25.

**1.8** This is a question on finding the effective interest rate(EAR). A very small number of candidates had obtained the correct answer of 16.98% using the formula $\boldsymbol{EAR = \{(1+r)^n - 1\} \times 100\%}$. Some candidates had got the wrong answer of 16.64%.

**1.9** It is expected to calculate the value of annual installment of an annuity that comes under the financial mathematics. It is required to find the installment to be paid for a loan amount of Rs.2,000,000/- taken from a bank to be paid in five annual installments at an interest rate of 12% to start a business. Few candidates had solved using the formula $A = \frac{pr(1+r)^n}{(1+r)^n-1}$ and got the correct answer of (2) Rs.554,785/-.

**1.10** This is a question that comes under time series. It has given the quarterly seasonal indices and the trend value of the 4th quarter for the quarterly sales values of tea factory and it was asked to forecast sales value for the fourth quarter using the given information. Majority of the candidates had given the correct answer by multiplying the trend value and seasonal index for the fourth quarter.

**1.11** Average number of candidates had selected and noted the appropriate explanations on the right hand side in relation to the letters **A, B, C, D** given on the left hand side. Most of the candidates had correctly selected the answers related to questions **B** and **C**. But the answers to questions **A** and **D** were mixed up.

**1.12** Majority of the candidates correctly identified the bar chart and correctly states the total number of minutes watched the TV on Tuesday and Thursday. Some candidates had separately mentioned the number of hours watched.

**1.13** This is a question on arithmetic series. Majority of the candidates had marked the correct answers by finding the 10th term using the formula $T_n = a + (n-1)d$ taking the first term as 0 and the common difference as 1/4 . Some candidates gave incorrect answers taking -1/4 as the common difference and others as 1/4 as the first term.

**1.14** It was stated that increasing X by one unit in the regression model Y =3-2x increases Y by 2 units and asked about its true or false. But, according to this regression model, it is clear that if X increases by one unit, Y decreases by 2 units. Accordingly, this statement is false. A majority of candidates have stated that this statement is false.

**1.15** When the value of the correlation coefficient between two variables is close to -1, there is a strong negative relationship between the two variables. It appears that the majority of candidates were not aware of this relationship. Therefore, a majority of candidates had stated that this statement was false.

## Section - B

### Question No. 02

This question consisted of three parts **(a), (b)** and **(c)** and the total marks given was 10. This question tests the knowledge in Arithmetic Ability, Solving Simultaneous Equations and Simple Tax Calculations, etc. A significant number of candidates answered all three parts **(a), (b)** and **(c)** and scored full marks.

**(a)** Profit of a company increases every year by 15% than previous year's profit. When the company earned a profit of Rs.500,000/- in first year, it was expected to calculate the profit of the 4th year.

Majority of the candidates had calculated the correct answer using the formula S=X$(1+r)^n$ used to calculate compound interest. A few others had mistakenly understood Rs.500,000/- as the investment amount and calculated the profit as the answer. Another group of candidates did not calculate the interest at the end of the 4th year.

**(b)** It was have given the number of shares purchased in two companies **A** and **B** by **Anura** and **Vasana** and the amount spent on them. In this section it is expected to calculate the cost per share of each company.

To solve this problem, we need to construct two simultaneous equations with two variables, **x** and **y**, for the share prices of companies **A** and **B**. This is expected to find the values related to those two variables.

Solving these equations is very easy since the coefficient of one variable is the same in both equations. Majority of the candidates has earned maximum marks. A few candidates had written down the answer without previous work. Another group of candidates had constructed incorrect equations and provided incorrect answers.

**(c)** It was expected to calculate the total amount payable by **Nuwan** when he was planning to buy a phone charger for Rs.840/- and charge a VAT at 15%. Majority of candidates had answered correctly for this part.

## Question No. 03

This question consists of three parts **(a), (b)** and **(c)** and the total marks given was 10.

Given the total cost function and demand function of a firm for a month, **(a)** Also identify the total revenue function(TR) and marginal revenue function(MR), **(b)** Also calculate the firm's marginal cost (MC)of producing 50 units and **(c)** It is also expected to calculate the break-even quantity. Majority of candidates have attempted this question. But only a few of them have answered all the three sections correctly and got full marks.

**(a)** This section asked us to identify the total revenue (TR) and marginal cost functions(MC) given the demand function of a product p=13q-20, total cost function (TC) = $13q^2$ +5q-1000.

Average number of candidates had correctly identified the total revenue function as TR = pxq. Thus the total revenue function was obtained as $13q^2 - 20q$.

It appears that some applicants do not have sufficient knowledge to calculate the marginal cost function as (MC ) =$\frac{d(TC)}{dq} = \frac{d(13q2\ +5q-1000)}{dq}$

Some candidates had not correctly written the data given in the question correctly in the answer sheet.

**(b)** Using the marginal cost function MC = 26q + 5 from **part (a)** above, the firm wishes to find marginal cost when it produces 50 units. Candidates who identified MC correctly answered this section satisfactorly.

**(c)** It is expected to find the break-even quantity. A considerable number of candidates solved this and correctly calculated the break-even quantity.

(1) Some of the applicants calculated the correct answer as follows:

$$\begin{aligned} TR &= TC \\ 13q^2 +5q-1000 &= 13q^2 -20q, \\ 25q &= 1{,}000 \\ q &= 40 \text{ units} \end{aligned}$$

**OR**

$$\begin{aligned} PF &= TR - TC = 0 \\ 13q^2 -20q -(13q^2+5q-1000) &= 0 \\ 25q &= 1{,}000 \\ q &= 40 \text{ units} \end{aligned}$$

(2) Some candidates have taken TR = TC, but due to calculation errors, it is not possible to take the break-even quantity correctly.

(3) Also, another group of applicants had wasted their time due to substitution of values in the equation $q = \frac{-b \mp \sqrt{b^2-4ac}}{2a}$ and due to calculation errors.

(4) Some other group of candidates had tried to find break even quantity by equating marginal revenue and the marginal cost (MR = MC). It was noted that some candidates have do not aware how to find the breake even quantity.

## Question No. 04

This question consisted of two **parts (a)** and **(b)** and the total marks given was 10.

This is a question related to Regression Analysis. The owner of a restaurant wanted to expand its dishes offered to customers. Therefore, he varied the number of dishes on the menu in each week and asked his customers to rate their satisfaction. This data was collected over a period of 8 weeks. Each week he noted the number of dishes offered, (x), and the average customer satisfaction(y) rating on a scale of 1 to 10, where 10 means excellent.

A small number of candidates provided correct answers to both **(a)** and **(b) parts** and secured full marks.

**(a)** This section asked to identify the least squares line given by y = a + bx for the relationship between number of recipes and customer satisfaction.

A small number of candidates have correctly calculated **(a)** and **(b)** using the following formulas.

$$b = \frac{[n\sum xy - \sum x \sum y]}{[n\sum x^2 - (\sum x)^2]} \quad \text{and} \quad a = \bar{y} - b\bar{x}$$

By calculating **a** and **b** using above formula and finding the correct least squares regression line, the full marks for this section were obtained.

Some of the candidates could not identify the least square regression line correctly due to the reasons given below:

(1) It seems that some candidates correctly found “a” and “b” but did not idea about the line of least squares regression.

(2) Entire marks were forfeited for using incorrect formulas.

(3) In finding XY and $X^2$ values, those values were swapped.

(4) It appears that knowledge about simplification is lacking.

(5) Calculators were used to calculate coefficient of regression b= $\frac{[n\sum xy - \sum x \sum y]}{[n\sum x^2 - (\sum x)^2]}$ and find the required $\sum x, \sum y, \sum x^2, \sum xy$ but due to lack of knowledge of basic mathematical concepts they failed to obtain the correct answer.

(6) Some of the candidates who calculated **b** correctly failed to calculate $a = \bar{y} - b\,\bar{x}$.

(7) Some candidates failed to find $\bar{x}=\frac{\sum x}{n}$ and $\bar{y}=\frac{\sum y}{n}$.

(8) Some candidates have calculated r = $\frac{[n\sum xy - \sum x \sum y}{\sqrt{\{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]\}}}$ instead of **b**.

(9) Errors in copying the given values resulted in wrong answers for **a** and **b**.

(10) The answer was wrong due to errors in multiplying x and y.

(11) Instead of $\sum x$ and $\sum y$, $\bar{x}$ and $\bar{y}$ were substituted.

(12) **a** and **b** are calculated correctly but the regression equation is not written.

**(b)** This section was expected to calculate the expected rating of customer satisfaction when he offered 19 dishes in a particular week

Most of the candidates correctly answered y = 16.486-0.438*19 = 8.164, but only a few wrote 8 as the answer.

## Question No. 05

This question consisted of three **parts (a), (b)** and **(c)** and the total marks given was 10.

The given frequency table shows the rainfall (in mm) in November 2023. You should calculate the **(a)** mode **(b)** mean and **(c)** standard deviation, using the above distribution.

Majority of candidates had attempted to answer this question.

**(a)** This section expects to calculate the mode value of rainfall in a day using the given data.

Avearge number of candidates used the formula $M_0 = L_1 + \frac{\Delta_1}{\Delta_1+\Delta_2} xC$ to find the Mode and provided correct answers.

Some applicants used the correct formula but did not correctly substitute the values of $L_1$, $\Delta_1$, $\Delta_2$ and **C** so could not calculate the mode correctly.

Since the class boundaries of a given grouped frequency distribution are discontinuous, first the class boundaries of the class containing the mode of the given data table must be found. Accordingly, the lower and upper boundaries of the class containing the mode are 79.5-89.5

$L_1$ = 79.5 $C$=89.5-79.5=10

$\Delta_1$= Frequency difference between Modal class and the pre modal class.

$\Delta_2$= Frequency difference between Modal class and the post modal class.

Very few candidates had tried to find the "mode" using the formula $M_d = L_1 + \left[\frac{\frac{n}{2}-F_c}{f_m}\right] XC$ used to find the median.

Due to calculation errors, some candidates could not get the correct answer.

**(b)** It is expected to find the mean rainfall for a day using the rainfall values received during the 30 days of November.

A majority of candidates scored all 3 marks by providing the correct answer using the formula $\bar{x} = \frac{\Sigma f_i x_i}{\Sigma f}$.

Another group of candidates have miscalculated the midpoints of the class intervals.That is, 79.5, 94.5, 109.5, 124.5, 139.5, 154,5. Using this data gives incorrect results as shown below:

$\Sigma f_i x_i = 3{,}735$ $\bar{x} = \frac{\Sigma f_i x_i}{\Sigma f}$=3735/30=124.5

A small number of candidates could not correctly calculate the Mean due to the following errors:

(1) Not calculating the midpoints of the class intervals correctly.

(2) Not correctly identifying midpoints and frequencies of class intervals.

(3) Not getting the sum of $\sum fx$ correctly.

(4) Not copying the frequency values correctly to the answer sheet.

A very small number of candidates appeared to have no understanding about the mean$(\bar{x})$.

**(c)** Expected to calculate the standard deviation ^σ& of rainfall received in 30 days of November using the given table.

Candidates have correctly calculated the standard deviation using the following formulas:

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

There were also candidates who failed to find the standard deviation correctly due to the following errors.

(1) Not copying the formula correctly. $\sqrt{\frac{\Sigma fx^2}{\Sigma f} - \bar{x}^2}$

(2) Not using correct formulas. Eg: $\sqrt{\frac{\Sigma f \Sigma fx^2}{\Sigma f} - \bar{x}^2}$, $\frac{\Sigma f \Sigma(x-\bar{x})^2}{\Sigma f} - \bar{x}^2$

(3) Some candidates have calculated the following sums instead of $\sum fx^2$.

$\Sigma f \Sigma x^2$ , $[\Sigma fx]^2$, $\Sigma f^2 x^2$

(4) Incorrect applications used in calculating $fx^2$ Eg. fx x fx and fx x f

(5) Lack of accurate knowledge of standard deviation.

(6) Lack of understanding on finding the square root.

## Section - C

**Question No. 06**

This question has four parts **(A), (B), (C)** and **(D)** and the total marks given is 20. In this question candidates' knowledge was tested on the areas of interest calculations, present value, discount factors, Probability and Probability under Normal curve.

**(A)** **(a)** **Manoj** received a loan had to pay in five equal annual installments of Rs.65,848/- each. The bank charges an interest rate of 12% per annum. This section aims to calculate the value of the loan obtained.

"S" which is the value of the loan amount was to be calculated using formula $A = \frac{SR^n(R-1)}{(R^n-1)}$ given in the formula sheet. Majority of the applicants were not able to give correct answers.

Some of the reasons for that are given below:

(1) Not recognizing the correct formula.

(2) Not using R=1+r even though the correct formula is identified.

(3) Not substituting correct data for formula.

(4) Various errors of solving the sum.

**(b)** This section called for the preparation of the loan amortization schedule to show the repayment of the loan obtained in **part (a)**. It appears that majority of applicants have no knowledge about this.

**(B)** This question has 2 sub-**parts (a)** and **(b)**. This will check the knowledge about net present value calculation to choose the right investment plan. A significant number of applicants answered this question correctly.

**(a)** **Mallika** wants to choose one investment plan from the two options **A** and **B** while investing in a business. For that, the net cash receipts for the next three years along with the initial investment cost of each option and the annual cost of capital was given as 10%. It was asked to calculate the net present values for options **A** and **B** of the investment plan using the given information.

Reasons for impossibility to calculate Net Present Value accurately:

(1) Errors of ignoring and trivialization + and - signs.

(2) In calculating the net present value, the initial investment should be subtracted from the present value, but instead the initial investment is added to the discounted value of the cash flows.

(3) Use of other discount factors instead of 10% discount factor.

(4) Not knowing that the discount factor applicable to the beginning of the first year is 1.

(5) Not multiplying cash flows by a discount factor.

**(b)** This section aims to identify the better investment option with reasons by comparing the net present values calculated for options **A** and **B** obtained in **part (a)** above.

The majority of candidates who answered **part (a)** correctly had correctly identified **A** as a net present value comparison investment.

**(C)** In this section tests knowledge about the conditional probability.

This consists of 2 **parts (a)** and **(b)**. Given information on how to dispose of bottles made from 3 types of plastic, **part (a)** asked the probability that a bottle was made of plastic type A and **(b)** the probability that it was a wrongly disposed bottle given that it was made of plastic type B.

Most applicants answered this part correctly.

**(D)** This question tested the knowledge about Normal distribution. Given the mean and standard deviation of overtime claims of 2,000 minor employees in a company in a week, it was asked to calculate the number of minor employees receiving more than Rs.7,200/- as overtime.

Only a very few candidates answered this question correctly.

Many students have obtained z =2 using the formula $z = \frac{x-\mu}{\sigma}$. But finding probabilities using the standard normal curve, has failed to find the relevant number of minor employees.

Below are some of the reasons that contributed to not being able to answer this question correctly:

(1) Lack of basic knowledge about normal distribution and standard normal distribution.

(2) Lack of sufficient knowledge to transform the normal distribution into the standard normal distribution.

(3) Not knowing enough to correctly substitute the mean ($\mu = 7{,}020$) and standard deviation ($\sigma = 90$) for $z = \frac{x-\mu}{\sigma}$ to get the correct Z values.

(4) In substituting the values for $z = \frac{x-\mu}{\sigma}$, instead of $\mu = 7{,}020$, the values are shifted and substituted as X =7020. Hence the wrong value for Z is obtained.

(5) Lack of awareness of finding the probability of z >2 with the help of standard table.

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**General matters for attention to improve performance level of candidates:**

**(1)** Study the full contents of the syllabus completely paying more attention to any newly introduced subject matter.

**(2)** Workings should be clearly shown along with answers where applicable.

**(3)** It is required to correctly apply the basic mathematical rules and simplifications in copying formulae and in substitutions. Use the most convenient formula when several formulae could be applied to answer certain questions. Further, when formulae are copied, it should be done without changing "+" and "-" signs.

**(4)** Some candidates may obtain final answer using calculators. However, it is appropriate to present the final answer showing the steps correctly, writing the formula and substituting the values in it. In doing so, there is a possibility of scoring the marks for steps even when the final answer may not be correct.

**(5)** It should be noted to correctly apply the mathematical principles in solving equations and calculus of functions.

**(6)** Handwriting should be legible and the numbers of questions should be correctly and clearly written.

**(7)** Follow the instructions given in the question paper'

**(8)** Perusal of past question papers and suggested answers would help sharpening knowledge and experience.

**(9)** Proper management of time is important.

**(10)** Re-check the question numbers before handing over the answer scripts.

**(11)** There were instances when answers to new questions had been started in a small space at the end of the previous answer without starting the next answer on a new page. Each answer should be started on a new page at all times for easy reference'

**(12)** Appear for the examination with a firm determination of passing the examination with due preparation.

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