

**EXAMINER'S REPORT****LEVEL I EXAMINATION - JANUARY 2023****(102) BUSINESS MATHEMATICS & STATISTICS**

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This Question paper consists of 3 Sections **A, B** and **C**.

There are 15 compulsory Objective Test Questions (OTQ) in the Section A. There are 10 multiple choice questions from **1.1** to **1.10** carry 30 marks of 3 marks each. The **1.11** carries 4 marks. The short questions **1.12** and **1.13** carry 4 marks of 2 marks each. The questions **1.14** and **1.15** carry 2 marks of 1 mark each. Accordingly, 40 marks were assigned for the Part A.

A few shortcomings generally observed in the answers provided by candidates to part of question 01 are set out below:

**SECTION A****Question No. 01**

The number corresponding to the most correct answer for the 1<sup>st</sup> 10 multiple choice questions; **1.1** to **1.10** is expected to be mentioned in the answer booklet. Generally, candidates answered all 10 multiple choice questions. But there were cases where some candidates did not record an answer. It was seen that if the candidates guessed or jotted down an answer there was a 25% of probability that it will be the correct answer, but they missed that chance. Some candidates had written the correct answer instead of the number corresponding to the correct answer. Some other candidates had marked the correct answer in the question paper and it was attached to the answer sheet.

According to the answers given to the sub-sections of this question, the commonly found weaknesses and observations are listed as follows:

- 1.1** This question expects to find the value of  $x$  through the given simple equation. Majority of candidates had marked the correct answer. There were candidates who had solved the equation correctly and got  $x = 3$ , but marked  $x = 1/3$ . Some other candidates had mentioned the value of  $x$  instead of the number corresponding to the correct answer as well.
- 1.2** This is a compound interest sum under financial mathematics. Majority of the candidates had marked the correct answer using the formula  $S = (1 + r)^n$ . Some candidates had tried to solve the problem by calculating and compounding the interest year by year for 3 years. When substituted into the formula, the amount with interest is obtained and most of the candidates did not deduct the initial amount from that figure. But a significant number of candidates had got the correct answer as  $25,194 - 20,000 = 5,194$ . Another group of candidates had tried to solve the problem using formulas related to simple interest and had marked wrong answers.

- 1.3** It would have been possible to capture the accurate number of people who attended only the English tutoring class by correctly plotting the data in a Venn diagram. Or else, we can get the number of participants only for English through the formula  $n(A \cup B) = n(A) + n(B) - n(A \cap B)$  by taking that other classes are not held for subjects other than these two subjects. However, since this question expects the probability as the answer and as per the conventional definition, the required probability can be obtained by dividing the number of elements in the set from the number of elements in the sample space. But a considerable number of candidates had divided it by 20 instead of 30.

This is because candidates do not clearly understand the basic definitions of mathematics.

- 1.4** This is a question about price indices. Given the prices of 3 commodities A, B and C for 2019 and 2020, the relative price of commodity C for the year 2020 compared to 2019 was asked.

Taking the year 2019 as the base year, the price ratio of commodity C is expected here.

Since many candidates solved this by swapping the numerator and denominator, they got the incorrect answer. Means that they have taken the answer by using  $\frac{1,200}{1,000} \times 100$ , instead of  $\frac{1,000}{1,200} \times 100$ .

Most of the candidates had marked the correct answer for this. But few candidates had tried to find the price ratio for all the 3 goods A, B and C.

- 1.5** Here, the correlation co-efficient between X and Y was asked by given the aggregated data about the advertising cost (x) and the quantity sold (Y) of a particular product for 8 years.

Though the correlation co-efficient between 2 variables should obtain through the formula:

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

The answers were not obtained correctly due to substitution of wrong values into the formula and errors done while solving it. Many candidates had obtained the wrong answer -0.82 through wrong substitution and given (4) as the answer. Around half of the applicants had provided the correct answer.

- 1.6** It is desired to find its mode by a given a frequency distribution. Half of the candidates sought it through the following formula:

$$M_0 = L_1 + \frac{\Delta_1}{\Delta_1 + \Delta_2} \times C$$

Especially when choosing  $L_1$ , the lower limit of median class should be taken correctly, but many candidates had taken 32 as the  $L_2$ .

Since Class boundaries are non-continuous,  $L_2$  should be considered as the class limit.

Since  $\Delta_1 = F - f_1$  and  $D_2 = F - F_1$  were not taken correctly, candidates could not reached the correct answer.

- 1.7** A question associated with discrete random variables. Some applicants failed to identify  $P(X < 3) = P(1) + p(2)$  from a random distribution of a given discrete random variable  $X$  such that  $P(X < 3)$   $X$  is a discrete random variable. Candidates should be able to identify the distribution containing the given discrete random variable.
- 1.8** When interest is calculated semi-annually, the annual effective interest rate is expected to be calculated. Although  $EIR = [(1 + r/M)^M - 1] \times 100$  can be easily done using the formula, some candidates have not taken EIR by correctly substituting  $m=2$ ,  $r = 0.12$ .
- 1.9** A sum related to compound interest under financial mathematics. Though it is possible to obtain maturity value after 2 years through the formula  $A = P(1 + \frac{r}{4})^{4n}$ , candidates had obtained other solutions without considering quarterly basis.  
Candidates should practice identifying the correct modifier by reading the given question clearly.
- 1.10** A sum related to time series. Here, a leading bag sales organization was asked to predict the annual sales amount for the year 2023 by giving the trend equation  $y = 2,439.80 - 145.4x$  related to the average annual sales values of a company, and many applicants had chosen the correct answer. Some other candidates had got wrong answers by substituting other values for  $X$  instead of 7.
- 1.11** In this question, it is expected to select the appropriate explanation of the 4 verses on the right side. Especially many applicants had answered correctly. Mainly words related to time series and quantitative relative have asked through this question.
- 1.12** It is intended to obtain the correct value of the desired sum by using the table showing the given information. Although it was a very easy question, some candidates did not understand it right and struggled.
- 1.13** A problem related to geometric series. This can be answered correctly by applying 'a' as 1<sup>st</sup> term and the common ratio  $y$  to the formula  $T_n = ar^{n-1}$  to find the 12th term, but some candidates did not substitute it correctly,

The two questions 1.14 and 1.15 are expected identify and mentioned as **True** or **False**.

Candidates must study the basic principles about measures of statistical dispersion and correlation coefficients in Statistics.

Overall, mostly 30% of candidates got less than 20 marks out of 40 for the first question of this year's exam. Accordingly, nearly 1/3 of candidates have clearly unsuccessful.

## Section - B

### Question No. **02**

This question consisted of three **parts (a), (b) and (c)** and the total marks awarded were 10. A significant number of candidates gave correct answers to these **parts (a), (b) and (c)** and got the whole marks.

- (a) This subsection is a 2 simultaneous equations sum with 2 variables  $x$  and  $y$ . It was expected to find the values of  $x$  and  $y$  by solving the equation. Most candidates got the maximum score for this section. A few of them had mentioned the correct answer without the pre working.

Some candidates were having wrong understanding about parentheses substitution when subtracting one equation from another. Such candidates seem having no knowledge of what should be done to find one variable by equating the coefficients of the other variable.

Some other candidates tried to solve the problem by multiplying the coefficients of one variable in the 2 equations by using other numbers that are not equal.

Candidates should practice some exercises like this before the exam.

- (b) This is a simple question related to ratio. It should be finding the investment done by each person from the total invested amount and answer the questions asked about it. Many candidates correctly calculated (i) the total amount invested in the business and (ii) the amount invested by A in the business.
- (c) This is a very simple question of percentages, where the answer can be obtain by getting the percentage corresponding to the given value and obtaining the whole element from it, or the value can be found through it in the problem asked. Majority of candidates had secured maximum marks for this question.

### Question No. 03

This question had three **parts (a), (b) and (c)** and the total marks awarded were 10. This is a sum related to Total Revenue (TR) Function that involves Total cost + (TC) Function in financial mathematics.

Given the demand function (P), fixed cost (FC) and variable cost function (VC), (a) identifying the total cost (TC) function (TC) and the total revenue function (TR) and (b) the marginal cost function (MC) of the firm and (c) calculate the break-even quantity were expected.

**Total Cost** = Variable Cost + Fixed Cost

$$TC = VC + FC$$

**Total Revenue Function** = Monthly Demand x Number of Units

$$TR = D \times q$$

Candidates should be aware of such initial combinations. For Marginal cost, the total cost function should be differentiated with respect to  $Q$ .

The number of units for which  $TC = TR$  is the amount of cumulative units.

Most candidates had tried to answer this question, but few of them had given the correct answers to all 3 parts for (a), (b) and (c) and got full marks.

- (a) Given the demand curve ( $p = 39+5q$ ) of a question at a Fixed Cost (FC) = Rs. 90,000 and Variable Cost as  $VC = -5q + 24q$ , the section was asked to identify the Total Revenue Function (TR) and Total Cost Song (TC).

The following deficiencies were found in the evaluation of the answer sheets of the candidates.

- (1) It appears that there is insufficient knowledge with some candidates to identify the total cost function and the total the revenue function as  $TC = FC + VC$  and  $TR = p \times q$
  - (2) Although some candidates correctly wrote  $TC = FC - VC$ , the substitution of values were wrong as  $TC = FC-VC = 90,000-(5q^2+ 24q) = 90,000 - 5q + 24q$ .
  - (3) Some candidates had not recorded the given data correctly in the answer booklet. Eg-  $FC = 9,000$  (instead of  $FC = 90,000$ ) was noted.
  - (4) In finding the total cost function (TC), instead of  $TC = FC+VC$ , the function was considered as  $TC = FC \times VC$  and had given wrong answers.
  - (5) Some other candidates had tried to write answers taking function as  $TC = VC + p$ .
  - (6) Many students had used  $TR = 39 + 5q \times q = 39 +5q$  wrongly instead of  $TR = p \times q = (39+5q) q$  to find the total revenue function (TR).
- (b) A significant number of candidates correctly identified this marginal cost function.
- (c) Here it is desired to find the break-even quantity.
- (1) Some candidates were not having the understanding to take  $TR = TC$  as  $39q + 5q^2 + 24q + 90,000$  and  $15q = 9,000q = 600$  or  $PF = TR - TC = 0$  as  $39q + 5q^2 - (5q + 24q + 90,000) = 0$  ,  $15q - 9,000 = 0$ ,  $q = 6$ ) to find the break-even quantity.
  - (2) Certain other candidates also had tried substituting to following equation to get the answer and got the incorrect answer. It is a waste of time as well.
 
$$q = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
  - (3) Some candidates had tried to find the break-even quantity of production by taking  $MR = MC$  and equalizing marginal revenue with marginal cost.

## Question No. 04

The question itself consisted of two parts (a) and (b) and the total marks awarded were 10. This is a problem related to productivity. This allowed us to identify the least square regression line to predict the proportion of subscribers who opened emails sent to subscribers by a marketing agency. Here is a table containing the number of marketing e-mails sent ('000) as (X) and the rate of e-mails that were opened (Y) was given from the given data.

1<sup>st</sup> find  $\sum x, \sum y, \sum xy, \sum x^2$  from the given data. Then get  $\bar{x}, \bar{y}$ . Later find **b** from  $b = \frac{[n \sum xy - \sum x \sum y]}{[n \sum x^2 - (\sum x)^2]}$

Then expected to get **a** from the equation  $\bar{y} = a + b\bar{x}$ .

A significant set of candidates provided correct answers to both (a) and (b) parts and got full marks.

(a) A majority of candidates got full 7 marks to this segment by highlighting the correct least square regression line through is identified for the segment by using the

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

Reasons for failure to correctly identify the least squares regression line are;

- (1) Though a set of candidates found  $a$  and  $b$  correctly, they seem to have no proper understanding of least square regression line.
- (2) Some candidates lost marks as they used wrong equations.
- (3) Some candidates had mixed up the columns while writing  $xy$  and  $x^2$ .
- (4) Some of the candidates seem to lack the knowledge of sizing.
- (5) Many candidates had use calculators to calculate yield coefficient  $b = \frac{[n \sum xy - \sum x \sum y]}{[n \sum x^2 - (\sum x)^2]}$  and  $\sum x, \sum y, \sum x^2, \sum xy$  which required to find  $b$ , but failed to get correct answers due to lack of knowledge on basic mathematical concepts.
- (6) Though  $b$  was calculated correctly, some candidates substitute  $a = \bar{y} - b\bar{x}$  and fail to find  $a$ .
- (7) Some candidates failed to find  $\bar{x} = \frac{\sum x}{n}$   $\bar{y} = \frac{\sum y}{n}$  correctly.
- (8) Although the value of  $n$  was 8, by substituting 7 and 300, the answer got wrong.
- (9) In finding the value of  $b$ , instead of writing and substituting the formula  $b = \frac{[n \sum xy - \sum x \sum y]}{\sqrt{([n \sum x^2 - (\sum x)^2][n \sum y^2 - (\sum y)^2]}}$  for finding the coefficient, the value of  $b$  was calculated.
- (10) Some candidates had wrongly copied the values given in the paper. Hence, they had got wrong answers for (a) and (b).
- (11) Answers were wrong due to multiplication errors of  $x * y$ . Eg:-  $7 * 0.69 = 48.3$
- (12) Some candidates substitute the values of  $\sum x$  and  $\sum y$ , *instead of  $\bar{x}$  and  $\bar{y}$* .
- (13) Although the values of  $a$  and  $b$  were found correctly, some aspirants lost the marks given for it, because the equation of the derivative line was not written as  $y = a + bx$ .

- (b) This section expected to calculate the proportion of subscribers who have opened 9060 e-mails by using the least square regression line found in subsection (a). A very less number of candidates had secured the full 3 marks for this section.

Although some candidates have taken the equation of the regression line correctly, they have applied the values 900 and 9 instead of 0.9 as the value of  $x(000)$ . Therefore, the answers were wrong.

Some candidates had found  $y$  by substituting the corresponding value of  $y$  for  $x$ . Some other candidates failed to provide correct answers due to trivialization errors and lack of correct understanding of the question.

## Question No. 05

This question had three **parts (a), (b) and (c)** and the total marks awarded were 10.

A table of scores obtained by 160 students who participated in the Aptitude Test has given for the candidates to calculate the (a) the median, (b) the mean, and (c) the standard deviation.

- (a) This section seeks to calculate the average marks obtained by the candidates using the given data.

Most of the candidates haven't got correct values for  $F_c$  and  $F_m$  values for the formula  $M_d = L_1 + \left[ \frac{\frac{\Sigma f}{2} - F_c}{f_m} \right] \times C$  which used to find the median correctly. Some candidates the had substitute wrong values like 59 or 70 for the number of candidates  $L_1$ . Some candidates had taken the value 9 for  $c$  instead of the value 10.

A small number of candidates had provided the correct answer for this question and got all 3 marks for it.

- (b) It is desired to find the mean marks obtained by the candidates who appeared for the aptitude test using the given table using  $\bar{x} = \frac{\Sigma fx}{\Sigma f}$ .

Majority of candidates substituted the correct values for the formula and provided correct answers and obtained all 3 marks for it.

Around 15% candidates failed to calculate the mean marks correctly due to the following errors.

- (1) Failure to correctly calculate the mean of class intervals
- (2) Understanding data values in an interchangeable manner.
- (3) Not getting the  $\Sigma fx$  sum correctly.
- (4) Not copying the values of  $f$  correctly into the answer sheet.
- (5) Though the number of candidates were clearly given as 160 in the question, some candidates had used it as  $\Sigma f - 158$ .

It appears that very few had no knowledge of finding *mean* ( $\bar{x}$ ).

- (c) This is expected to calculate the standard deviation ( $\sigma$ ) of the scores. A significant number of candidates answered this section correctly. Some candidates failed to find the standard deviation correctly due to the following errors.

- (1) Some candidates had used wrong equations  $\sqrt{\frac{\sum f \sum f x^2}{\sum f} - \bar{x}^2}$  or  $\frac{\sum f \sum (\bar{x} - x)^2}{\sum f} - x^2$
- (2) Not copying the correct formula properly  $\sqrt{\frac{\sum f x^2}{\sum f}} \div 2$
- (3) Some candidates have calculated  $\sum f \sum x^2$ ,  $[\sum f \sum x^2]$  instead of  $\sum f x^2$
- (4) Not correctly substituting  $f x$  x  $f x$  and  $f x$  x  $f$  in finding  $x f x^2$
- (5) Some candidates did not have correct understanding about finding standard deviation.
- (6) Some candidates also did not understand about finding the square root

### Section - C

#### Question No. 06

This question consisted of four parts (A), (B), (C) and (D) and the total marks awarded was 20 marks. These parts covered calculating interest, present value and discount factors, probability and probability under periodic cycle were the tested areas of knowledge in candidates.

- (A) (a) This was expected to calculate the value of an annual installment of the loan amount when a loan taken by a person is repaid in equal annual installments in 5 years.  $A = \frac{SR^n (R-1)}{(R^n-1)}$

the value of an installment A was to be calculated using the formula, which was given in the formula sheet. However, most of the candidates failed to get the correct answer due to various shortcomings of not identifying the correct formula, not substituting correct data for the formula and trivialization. Correct answers could not be obtained due to not taking  $R = 1 + r$  from the candidates who identified the correct formula.

- (b) Amortization schedule is asked to be prepared to show re-payment of loan. It appears that most of the candidates have no idea about this.

- (B) This question has 2 sub-parts (a) and (b). The initial investment of 2 companies, the expected cash inflows for the next 3 years and the discount factor of 12% is given.

In this section, knowledge is tested on the calculation of the net present value of projects by using information about project A and B. A significant number of candidates had provided correct answers to this question.



Reasons for not being able to calculate net present value;

- (1) Avoiding + and – signs and errors of calculations
  - (2) In calculating the net present value, the initial investment should be subtracted from the present value. Instead the initial investment had added to the discounted value of the cash flows (using +100,000, instead of -100,000).
  - (3) Use of other discount factors instead of 12% discount factor
  - (4) Not knowing to take the year of initial investment year as 0 and applying discount factor as 1.
  - (5) Some candidates incorrectly multiply the cash flows by the discount factor
- (b) This question seeks to identify with reasons the better investment option by comparing the net present values of projects A and B obtained in part (1) above. Lack of understanding of net present value. Due to this, some students had mentioned that the project with lower NPV value should be selected as the better project. Most of the candidates who answered **part (a)** correctly answered **part (b)**.

(C) This is a conditional probability problem for testing knowledge of probability.

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

Some candidates get the correct solution by Venn drawing. Other applicants tried to solve this problem by drawing sketches. Many candidates could not solve this correctly.

This question tested the knowledge of normal distribution. Normalize the given probabilities  $P(x > a)$  and getting the following value and get the correct probability from standard size table is expected.

$$Z = \frac{P\left(\frac{x - \mu}{\sigma}\right) > \frac{a - \mu}{\sigma}}{\quad}, \quad p(Z > Z_0)$$

Many candidates failed to find the expected probability as the final answer despite obtain  $Z = \frac{x - \mu}{\sigma}$  using the formula .

This section aims to study the height of soldiers in an army regiment and calculate the probability that a randomly selected soldier is taller than 180cm given the standard deviation.

Only 30% candidates answered this question correctly.

(D) Given below are some of the reasons why the candidates did not able to give correct answers to this question;

- (1) Loss of basic knowledge of normal distribution and standard normal distribution.
- (2) Lack of sufficient knowledge to transform the normal distribution into the standard normal distribution.

- (3) Insufficient knowledge of mean ( $\mu = 170$ ) and standard deviation ( $\sigma = 5$ ) to obtain accurate Z through

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

- (4) Obtain wrong value for z by substituting  $x = 170$  instead of correctly using  $\mu$   $Z = \frac{x - \mu}{\sigma}$  170 to
- (5) Lack of awareness of finding the probability related to  $z > 2$  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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