Total Printed Pages : 20

135(E)

(FEB./MARCH-2025)

Total Marks : 100

(મુખ્ય/પૂરક 2025માં લેવાયેલ એચ. એસ. સી. (સામાન્ય પ્રવાહ) પરીક્ષાના પરીક્ષણકાર્ય માટે ગુણપ્રદાન યોજનાનો નમૂનો)

1. Co-ordinators, Moderators and Examiners for Statistics (135) subject are requested to go through this Answer Key carefully before evaluation.

2. Evaluation should be done as per instructions given in Answer Key so that uniformity and consistency in the evaluation work shall be maintained.

3. There are total 61 questions with (General Options) in this question paper. Each question should be corrected according to the instructions given in Answer Key only.

4. Each correct answer should be marked in the decimal fraction method and should be written in left side margin only. Answer should be individually marked and at the end of the each section write the total marks in ∠.

5. If a student gets the correct answer by any correct method other than the method shown in the answer key, is eligible to get full marks.

6. Marks of each section according to the questions should be written orderly in the space [ ] provided on the top of the page. If a question is not answered write [-]

7. In case of general optional questions in Section C, D, E and F check all the answers from each sections and consider the marks whichever is higher and circle on the less marks.

8. Mark × against wrong answers and write = 0 =

9. In case of shuffled answers use CF/BF wherever necessary.

10. This answer key contains total 21 pages.

11. Answers should be checked strictly according to answer key and no injustice should be done to students by over, under or wrong evaluation.

SECTION-A

❖ Choose the correct alternative from the following multiple choice type questions. [20]
(Each questions carries 1mark)

Note:

- For each correct option or correct answer give 1 mark.
- Give full marks if A, B, C, D and answer written, both are correct
- If only option written then give full marks for the right answer
- If only correct answer written then also give full marks.
- If question number of answer is not written by students give marks for correct answer written in order.

1	(D) Retail price
2	(C) 133.33
3	(C) $-1 \leq r \leq 1$
4	(C) 1
5	(A) $(\overline{x},,\overline{y})$
6	(B) Square of correlation coefficient
7	(C) Seasonal
8	(C) t
9	(C) To measurer the life of electric bulb
10	(A) 0
11	(C) Maximum temperature during a day
12	(D) 10
13	(B) Negatively Skewed
14	(A) Mean = 0, Variance = 1
15	(B) 0.5
16	(C) 19
17	(D) $N(5, 0.25)$
18	(C) 19
19	(B) anx^{n-1}
20	(A) $-\frac{p}{x} \cdot \frac{dx}{dp}$

SECTION-B

Answer the following questions in one sentence. *(Each questions carries 1mark)* [10]

Note:

- Even if full sentence not written give full marks.
- If the answer is written half then give half mark for the correct effort/attempt of the students.
- If the sentence covers the content of the answer, give full marks.

21. Rate of inflation $= \dfrac{\left(\begin{array}{c}\text{Wholesale price index}\\ \text{number of current year}\end{array}\right) - \left(\begin{array}{c}\text{Wholesale price index}\\ \text{number of previous year}\end{array}\right)}{\text{Wholesale price index number of previous year}} \times 100$

22. It does not give exact degree of relationship between two variables.

23. Both variables are multiplied by 2. So, regression coefficient will not change.

24. Here, $\hat{y} = 25.1 - 1.5t$

Taking $t = 8$

$\hat{y} = 25.1 - 1.5(8)$

$= 25.1 - 12$

$= 13.1$

25. Suppose A and B are any two events of a finite sample space U. Event A and B do not occur together, which means $A \cap B = \emptyset$

26. For symmetrical binomial distribution $p = \frac{1}{2}$, $q = \frac{1}{2}$

Putting $p = \frac{1}{2}$ in Mean $= np = 9$

$n\left(\frac{1}{2}\right) = 9$

$\therefore n = 9 \times 2$

$\therefore n = 18$

27. "Standard score is independent of unit of measurement." This statement is true.

28. Standard Deviation $= \frac{4}{5} \times \sigma$

$\therefore 12 = \frac{4}{5} \times \sigma$

$\therefore \frac{12 \times 5}{4} = \sigma$

$\therefore \sigma = 15$

29. $\lim\limits_{x \to -1} 4x + k = 6$

$\therefore 4(-1) + k = 6$

$\therefore k = 6 + 4$

$\therefore k = 10$

30. The change in cost due to small change in production is called marginal cost.

SECTION-C

Answer the following questions as directed. Any seven out of nine *(Each questions carries 2 marks)* [14]

31. Real wages $= \frac{\text{Average monthly wage}}{\text{Cost of living index number}} \times 100$

Year	Average monthly wage (Rs.)	Cost of living index number	Real wage
2020	36000	120	$\frac{36000}{120} \times 100 = 30000$ ✓
2021	40000	150	$\frac{40000}{150} \times 100 = 26666.67$ ✓
2022	52000	130	$\frac{52000}{130} \times 100 = 40000$ ✓
2023	56000	160	$\frac{56000}{160} \times 100 = 35000$ ✓

For each correct ✓ give 0.5 marks

32. 1. $r(x, -y) = -r(x, y) = -0.8$ → 1 m
    2. $r(-x, -y) = r(x, y) = 0.8$ → 1 m

33. Here, $\bar{x} = 30, \bar{y} = 20$ and $b = 0.5$ is given.
Intercept of the regression line :
$a = \bar{y} - b\bar{x}$
$= 20 - 0.5(30)$
$= 20 - 15$
$= 5$ → 1 m
Regression line Y on X
$\hat{y} = a + bx$
$= 5 + 0.5x$ → 1 m

34. The components of time series are as follows:
    1. Long term component (Trend)
    2. Seasonal component
    3. Cyclical component
    4. Random (Irregular) component

→ For each component give 0.5 marks

35. $U = \{HH, HT, TH, TT\}$
$n = 4$
(i) A = event of getting one head and one tail
A= $\{HT, TH\}$
$m = 2$
P(A) $= \frac{m}{n} = \frac{2}{4} = \frac{1}{2}$ → 1 m
(ii) B = event of getting at least one head.
B = $\{HT, TH, HH\}$
$m = 3$
P(B) $= \frac{m}{n} = \frac{3}{4}$ → 1 m

36. Properties of Binomial Distribution: (*Give 0.5 for any four correct properties.*)

1. Binomial distribution is a discrete distribution
2. Its parameters are n and p.
3. The mean of the distribution is np.
4. The variance of the distribution is npq and its standard deviation is $\sqrt{npq}$.
5. For binomial distribution, mean is always greater than the variance and $q = \frac{\text{Variance}}{\text{mean}} = probability\ of\ failure$ or $np > npq$
6. If p < ½ then the skewness of the distribution is positive for any value of n
7. If p = ½ then the distribution becomes symmetric that means the skewness of the distribution is zero for any value of n,
8. If p > ½ then the skewness of the distribution is negative for any value of n.

37. N(16,0.5) in interval and modulus form

Comparing N(16,0.5) with $N(a, \delta)$ we get,

$a = 16, \delta = 0.5$

Interval form $= (a - \delta, a + \delta)$

Putting the value $a = 16$ *and* $\delta = 0.5$

$= (16 - 0.5, 16 + 0.5)$

$= (15.5, 16.5)$ ⟶ 1 m

Modulus form $= |x - a| < \delta$

Putting the value $a = 16, \delta = 0.5$

$|x - 16| < 0.5$ ⟶ 1 m

38. $\lim_{x \to -2} \frac{x^7 + 128}{x + 2} = \lim_{x \to -2} \frac{x^7 - (-2)^7}{x - (-2)}$ ⟶ 1 m

$= 7(-2)^{7-1} \quad \left[\because \lim_{x \to a} \frac{x^n - a^n}{x - a} = na^{n-1}\right]$

$= 7(-2)^6$

$= 7(64)$

$= 448$ ⟶ 1 m

39. Here, $y = 12 + 4x - 7x^2$

$\therefore \frac{dy}{dx} = 4 - 14x$ ⟶ 1 m

at $x = 2$

$\frac{dy}{dx} = 4 - 14(2)$

$= 4 - 28$

$= -24 < 0$

∴ Function is decreasing at $x = 2$. ⟶ 1 m

SECTION-D

Answer the following questions as directed. Any Eight out of Twelve *(Each questions carries 3 marks)* [24]

40.

$$\text{Fixed base index number of current year} = \frac{\left(\begin{array}{c}\text{Chain base index number}\\ \text{of the current year}\end{array}\right) \times \left(\begin{array}{c}\text{Fixed base index number of the}\\ \text{preceding year to current year}\end{array}\right)}{100}$$

→ 0.5 m

Year	Index Number of Sale	Fixed base index number
2020	110	110 ✓
2021	112	$= \frac{112 \times 110}{100} = 123.20$ ✓
2022	109	$= \frac{109 \times 123.20}{100} = 134.29$ ✓
2023	108	$= \frac{108 \times 134.29}{100} = 145.03$ ✓
2024	105	$= \frac{105 \times 145.03}{100} = 152.28$ ✓

For each correct✓ give 0.5 marks

41.

Fuel Items	Index Number (I)	Weight (W)	IW
A	100 + 50 = 150	5	750
B	100 + 90 = 190	4	760
C	100 + 110 = 210	3	630
D	100 − 5 = 95	2	190
E	100 − 2 = 98	1	98
Total		15	2428

For correct table give 2 marks

Index Number of fuel prices for the year 2024 $= \frac{\sum IW}{\sum W} = \frac{2428}{15} = 161.87$ → 1 m

42. Here, $n = 10, \sum(x-\bar{x})(y-\bar{y}) = 72$, $S_x = 3$ and $\sum(y-\bar{y})^2 = 360$ is given.

$$S_y = \sqrt{\frac{\sum(y-\bar{y})^2}{n}} = \sqrt{\frac{360}{10}} = 6$$ → 1 m

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{n \times S_x \times S_y}$$ → 1 m

$$= \frac{72}{10 \times 3 \times 6} = \frac{72}{180} = 0.4$$

$\therefore r = 0.4$ → 1 m

43. $\bar{x} = 30$; $\bar{y} = 500$; $S_x^2 = 25$; $S_y^2 = 10000$; $Cov(x, y) = 400$

$$b = \frac{cov(x,y)}{S_x^2}$$

$$= \frac{400}{25}$$

$\therefore b = 16$ → 1 m

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

$= 500 - 16(30)$

$= 500 - 480$

$\therefore a = 20$ → 1 m

$\therefore$ *Regression line of y on x*

$\hat{y} = a + bx$

$= 20 + 16x$ → 0.5 m

Putting $x = 40$,

$\hat{y} = 20 + 16(40)$

$= 20 + 640$

$\hat{y} = 660$ units → 0.5 m

$\therefore$ When the price is Rs. 40 then the supply of ball pen is 660 units

44. $\hat{y} = 11 + 3x$

$\therefore b = 3$ → 0.5 m

Here, $b = 3$ and $S_x : S_y = 3 : 10$

Now, $b = r \times \frac{S_y}{S_x}$ → 0.5 m

$\therefore 3 = r \times \frac{10}{3}$

$\therefore \frac{3 \times 3}{10} = r$

$\therefore r = 0.9$ → 1 m

Coefficient of determination

$R^2 = (r)^2$

$= (0.9)^2$

$= 0.81$ → 1 m

45.

The merits of graphical method are as follow: (Any three) Each carries 1 mark

1. This method is easy to understand and use.
2. The trend can be found without any mathematical formula or calculation.
3. This method can be used even if the trend is not linear.
4. An estimate of the type of curve to be fitted for obtaining trend can be given by this method.

46.

Each carries 1 mark

The following characteristics of the random experiment can be as follow.

1. A random experiment can be independently repeated under objectively almost identical circumstances.
2. All the possible outcomes of a randomized experiment are known, but the exact outcome cannot be predicted before conducting the experiment.
3. The random experiment results into a certain outcome.

47.

Here, $P(B) = \frac{3}{5}$, $P(A' \cap B) = \frac{1}{2}$

$P(A' \cap B) = P(B) - P(A \cap B)$ ⟶ 0.5m

$\therefore \frac{1}{2} = \frac{3}{5} - P(A \cap B)$

$\therefore P(A \cap B) = \frac{3}{5} - \frac{1}{2}$

$\therefore P(A \cap B) = \frac{6-5}{10}$

$\therefore P(A \cap B) = \frac{1}{10}$ ⟶ 0.5m

$$P\left(\frac{A}{B}\right) = \frac{P(A \cap B)}{P(B)}$$

$$= \frac{\frac{1}{10}}{\frac{3}{5}}$$

$$= \frac{1 \times 5}{10 \times 3}$$

$$= \frac{1}{6}$$ ⟶ 1m

$P(A' \cup B') = 1 - P(A \cap B)$

$= 1 - \frac{1}{10} = \frac{10-1}{10}$

$= \frac{9}{10}$ ⟶ 1m

48.

$n = 100$ ⟶ 0.5m

A= Event that the number selected is a single digit number

$A = \{1, 2, 3, \ldots . 9\}$

$m = 9$

$\therefore P(A) = \frac{m}{n} = \frac{9}{100}$ ⟶ 0.5m

B= Event that the number selected is a perfect square

$B = \{1, 4, 9, 16, 25, 36, 49, 64, 81, 100\}$

$m = 10$

$\therefore P(B) = \frac{m}{n} = \frac{10}{100}$ ⟶ 0.5m

$A \cap B$ = Event that the number selected is a single digit number and a perfect square

$A \cap B = \{1, 4, 9\}$

$m = 3$

$P(A \cap B) = \frac{m}{n} = \frac{3}{100}$ ⟶ 0.5m

$A \cup B$ =Event that the number selected is a single digit number or a perfect number

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$= \frac{9}{10} + \frac{10}{100} - \frac{3}{100}$

$= \frac{9 + 10 - 3}{100}$

$= \frac{16}{100}$ *or* $\frac{4}{25}$ *or* 0.16 ⟶ 1m

49.

Mean $= np = 2$, Variance $= npq = \frac{6}{5}$

$npq = \frac{6}{5}$

$\therefore (2)q = \frac{6}{5}$

$\therefore q = \frac{6}{10} = 0.6$ ⟶ 0.5m

$\therefore p = 1 - q = 1 - 0.6$

$= 0.4$ ⟶ 0.5m

Putting p = 0.4 in $np = 2$

$\therefore n(0.4) = 2$

$\therefore n = \frac{2}{0.4} = 5$ ⟶ 0.5m

So, $n = 5, p = 0.4$ and $q = 0.6$

$p(x) = n_{C_x} p^x q^{n-x}$ ⟶ 0.5m

$p(2) = 5_{C_2} (0.4)^2 (0.6)^{5-2}$

$= 10 \times 0.16 \times 0.2$

$= 0.3456$ *or* $\frac{216}{625}$ ⟶ 1m

50.

(1) By the definition of discrete probability distribution , we must have

$$p(0) + p(1) + p(2) + p(3) + p(4) = 1$$

$$\therefore 4K + 15K + 25K + 5K + K = 1$$

$$\therefore 50K = 1$$

$$\therefore K = \frac{1}{50} = 0.02 \longrightarrow 1.5\text{m}$$

(2) Probability of occurrence of one or two accidents

$$= P(X = 1) + P(X = 2)$$

$$= 15K + 25K$$

$$= 40K$$

$$= 40(0.02)$$

$$= 0.80 \longrightarrow 1.5\text{m}$$

51.

$f(x) = (x^2 + 3x + 4)^7$

$\therefore y = (x^2 + 3x + 4)^7$

By using Chain rule ,

Suppose $u = x^2 + 3x + 4$, Thus $y = u^7$ $\longrightarrow$ 0.5m

$\frac{du}{dx} = 2x + 3$ and $\frac{dy}{du} = 7u^6$ $\longrightarrow$ 1m

$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$ $\longrightarrow$ 0.5m

$= 7u^6 \times (2x + 3)$

$= 7(x^2 + 3x + 4)^6(2x + 3)$

Thus $f'(x) = 7(x^2 + 3x + 4)^6(2x + 3)$ $\longrightarrow$ 1m

SECTION-E

Answer the following questions as directed Any Three out of Four (Each question carries 4 marks.) [12]

52. Here, $X = monthly\ expense\ of\ students;\ \mu = Rs.2000, \sigma = Rs.500$

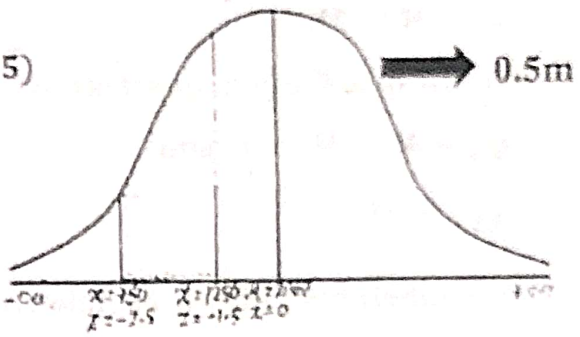
(1) Percentage of students having expense between Rs.750 and Rs. 1250

$= P(750 \leq X \leq 1250)$

$$Z_1 = \frac{750 - 2000}{500} = -2.5$$

$$Z_2 = \frac{1250 - 2000}{500} = -1.5$$

$\therefore P(750 \leq X \leq 1250) = P(-2.5 \leq Z \leq -1.5)$



0.5m

$Now, P(-2.5 \leq Z \leq -1.5)$ ➡ 0.5m

$= P(-2.5 \leq Z \leq 0) - P(-1.5 \leq Z \leq 0)$

From the table of Standard Normal Curve

$= 0.4938 - 0.4332$

$= 0.0606$ ➡ 0.5m

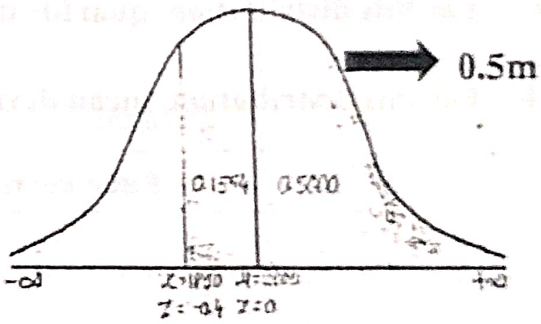
The percentage of students having expenses between Rs.750 and Rs.1250

$= 100 \times 0.0606$

$= 6.06\%$ ➡ 0.5m

(2) Percentage of persons having expense more than Rs. 1800

$= P(X \geq 1800)$



0.5m

$$Z = \frac{1800 - 2000}{500} = -0.4$$

$\therefore P(X \geq 1800) = P(Z \geq -0.4)$ ➡ 0.5m

$Now, P(Z \geq -0.4)$

$= P(-0.4 \leq Z \leq 0) + P(0 \leq Z \leq \infty)$

From the table of Standard Normal Curve

$= 0.1554 + 0.5000$

$= 0.6554$ ➡ 0.5m

The percentage of students having expenses more than Rs. 1800

$= 100 \times 0.6554$

$= 65.54\%$ ➡ 0.5m

The below answer is only for blind students

52. Properties of normal distribution:

1. It is distribution of continuous random variable.
2. The constant μ *and* σ are the parameters of distribution which indicate mean and standard deviation respectively.
3. The distribution is symmetric about μ and its skewness is zero (0).
4. For this distribution, the value of mean, median and mode are same. In notation,

   $\mu = M = M_0$.
5. For this distribution, quartiles are equidistant from median. i.e.

   $Q_3 - M = M - Q_1$ and

   $M = \frac{Q_3 + Q_1}{2}$.
6. The probability curve is completely bell shaped.
7. Normal curve is asymptotic to X-axis. The tails never touch X-axis.
8. The approximate value of quartiles of normal distribution can be obtained from the following formula

   $Q_1 = \mu - 0.675\,\sigma$ *and* $Q_3 = \mu + 0.675\,\sigma$
9. For this distribution, quartile deviation $= \frac{2}{3}\sigma$.
10. For this distribution, mean deviation $= \frac{4}{5}\sigma$.

Each correct properties carries 1 mark

53. Here, $\mu = 52$; $\sigma^2 = 64$ So $\sigma = 8$

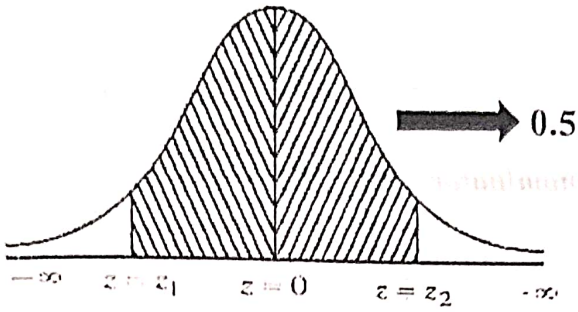
(1) The estimated limits which include exactly middle 60% of the observations.

$\therefore P(x_1 \leq X \leq x_2) = 60\% = \frac{60}{100} = 0.60$ ⟹ 0.5m

Converting to Z

$\therefore P\left(\frac{x_1-52}{8} \leq \frac{X-\mu}{\sigma} \leq \frac{x_2-52}{8}\right) = 0.60$ ⟹ 0.5m

$\therefore P(z_1 \leq Z \leq z_2) = 0.60 \quad \left(\because z_1 = \frac{x_1-52}{8},\ z_2 = \frac{x_2-52}{8}\right)$ ⟹ 0.5m



⟹ 0.5m

From Table	Area	Z-score
Nearest value before 0.3000	0.2995	0.84
Nearest value after 0.3000	0.3023	0.85
Average value	0.3009	0.845

The nearest value of 0.3000 is 0.2995, so $z_1 = -0.84$ and $z_2 = 0.84$

$\therefore P(z_1 \leq Z \leq 0) = 0.30$

z_1 is on the left hand side of $Z = 0$,
So $z_1 = -0.84$

$z_1 = \frac{x_1 - \mu}{\sigma}$

$\therefore -0.84 = \frac{x_1-52}{8}$

$\therefore -0.84 \times 8 = x_1 - 52$

$\therefore -6.72 = x_1 - 52$

$\therefore x_1 = 45.28$ ⟹ 1m

$\therefore P(0 \leq Z \leq z_2) = 0.30$

z_2 is on the right hand side of $Z = 0$,
So $z_2 = 0.84$

$z_2 = \frac{x_2 - \mu}{\sigma}$

$\therefore 0.84 = \frac{x_2-52}{8}$

$\therefore 0.84 \times 8 = x_2 - 52$

$\therefore 6.72 = x_2 - 52$

$\therefore x_2 = 58.72$ ⟹ 1m

∴ The estimated limits which include exactly middle 60% of the observations between 45.28 to 58.72

The below answer is only for blind students

53.

If X is a random normal variable with Mean μ and standard deviation σ then random variable $Z = \frac{x-\mu}{\sigma}$ is called standard normal random variable and its probability function is given below ⟹ 2m

$$f(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}z^2} \quad ; -\infty < z < \infty$$ ⟹ 2m

54.

$\lim_{x\to 2} \frac{f(x)-f(2)}{x-2}$ where $f(x) = x^2 + x$,

Here, $f(x) = x^2 + x$ ⟹ 0.5m

$f(2) = (2)^2 + 2$

$= 4 + 2$

$= 6$ ⟹ 1m

Now, $\lim_{x\to 2} \frac{f(x)-f(2)}{x-2} = \lim_{x\to 2} \frac{(x^2+x)-6}{x-2}$

Numerator $= (x^2 + x) - 6$

$= x^2 + 3x - 2x - 6$

$= x(x + 3) - 2(x + 3)$

$= (x + 3)(x - 2)$

Denominator $= (x - 2)$

So, $= \lim_{x\to 2} \frac{(x^2+x)-6}{x^2-4} = \lim_{x\to 2} \frac{(x+3)(x-2)}{(x-2)}$ ⟹ 1.5m

$= \lim_{x\to 2} (x + 3)$ $(\because x - 2 \neq 0)$

$= 2 + 3 = 5$ ⟹ 1m

55.

Demand function of an item is $\left(P = 30 - \frac{x^2}{10}\right)$

Now, revenue function $R = p.x = \left(30 - \frac{x^2}{10}\right).x$

$\therefore R = 30x - \frac{x^3}{10}$ ⟹ 1m

$\therefore \frac{dR}{dx} = 30 - \frac{3x^2}{10}$ ⟹ 0.5m

Putting $\frac{dR}{dx} = 0$

$\therefore 30 - \frac{3x^2}{10} = 0$

$\therefore 300 - 3x^2 = 0$

$\therefore 3x^2 = 300$

$\therefore x^2 = 100$

$\therefore x = 10$ ⟹ 1m

Now, $\frac{d^2R}{dx^2} = -\frac{6x}{10}$

Here putting x = 10 in

$\frac{d^2R}{dx^2} = -\frac{6(10)}{10} = -6 < 0$ ⟹ 0.5m

Revenue is maximum at x=10

Putting x =10 in demand function $\left(p = 30 - \frac{x^2}{10}\right)$

= price $p = 30 - \frac{(10)^2}{10}$

$= 30 - \frac{100}{10}$

= 30 - 10

$\therefore p = 20$ ⟹ 1m

Revenue maximum at =10 and p = Rs. 20

SECTION-F

Solve the following questions as directed. Any Four out of Six (Each question carries 5 marks.) [20]

56.

Item	Year 2024		Year 2023		p_1q_0	p_0q_0	p_1q_1	p_0q_1
	p_1	q_1	p_0	q_0				
Rice	$\frac{800}{20} = 40$	1.5	$\frac{780}{20} = 39$	1	40	39	60	58.5
Milk	44	10	40	12	528	480	440	400
Bread	50	1.5	45	2	100	90	75	67.5
Banana	36	1.5	30	2	72	60	54	45
Total					740	669	629	571

For correct table = 2m

Laspeyre's Index Number I_L

$$I_L = \frac{\sum p_1q_0}{\sum p_0q_0} \times 100$$

$$= \frac{740}{669} \times 100$$

$$= 110.61$$

$\therefore I_L = 110.61$ ➡ 1m

Paasche's Index Number I_P

$$I_P = \frac{\sum p_1q_1}{\sum p_0q_1} \times 100$$

$$= \frac{629}{571} \times 100$$

$$= 110.16$$

$\therefore I_P = 110.16$ ➡ 1m

Fisher's Index Number $I_F = \sqrt{I_L \times I_P}$

$$= \sqrt{110.61 \times 110.16}$$

$$= 110.38$$

$\therefore I_F = 110.38$ ➡ 1m

57. Here, n =6, X = Advertisement Cost (lakh Rs.); Y = Sales of electric fans (crore Rs.)

Company	x	y	$u = \frac{x-100}{20}$	$v = \frac{x-35}{5}$	uv	u^2	v^2
A	140	35	2	0	0	4	0
B	120	45	1	2	2	1	4
C	80	15	-1	-4	4	1	16
D	100	40	0	1	0	0	1
E	80	20	-1	-3	3	1	9
F	180	50	4	3	12	16	9
Total	700	205	5	-1	21	23	39

For correct table = 2m

$n = 6,$

$$r = \frac{n\sum uv - (\sum u)(\sum v)}{\sqrt{n(\sum u^2) - (\sum u)^2} \times \sqrt{n(\sum v^2) - (\sum v)^2}}$$ → 1m

$$= \frac{6(21) - (5)(-1)}{\sqrt{6(23) - (5)^2} \times \sqrt{6(39) - (-1)^2}}$$

$$= \frac{126 + 5}{\sqrt{138 - 25} \times \sqrt{234 - 1}}$$ → 1m

$$= \frac{131}{\sqrt{113} \times \sqrt{233}}$$

$$= \frac{131}{162.26}$$

$= 0.81$ → 1m

58.

Sales (thousand Units) x	Profit (lakh Rs.) y	R_x	R_y	$d = R_x - R_y$	d^2
25	65	7.5	7	0.5	0.25
58	140	5.5	4	1.5	2.25
215	500	1	1	0	0
72	115	4	5	-1	1
58	65	5.5	7	-1.5	2.25
25	65	7.5	7	0.5	0.25
90	220	3	3	0	0
162	340	2	2	0	0
Total				0	6

For correct table = 2m

The calculation of C.F. is as follows

Repeated Observations	m	$\left(\frac{m^3 - m}{12}\right)$
25	2	$\left(\frac{2^3 - 2}{12}\right) = 0.5$
58	2	$\left(\frac{2^3 - 2}{12}\right) = 0.5$
65	3	$\left(\frac{3^3 - 3}{12}\right) = 2$
-	-	CF = 3

For correct table = 1m

$$r = 1 - \frac{6[\sum d^2 + CF]}{n(n^2 - 1)} \longrightarrow 1m$$

$$= 1 - \frac{6[6 + 3]}{8(64 - 1)}$$

$$= 1 - \frac{6[9]}{8(63)}$$

$$= 1 - \frac{54}{504}$$

$$= 1 - 0.11$$

$$= 0.89 \longrightarrow 1m$$

59. Here, n =6, X = Time of usage of car (years); Y = Average annual maintenance cost (thousand Rs.)

Car	x	y	xy	x^2
1	3	10	30	9
2	1	5	5	1
3	2	8	16	4
4	2	7	14	4
5	5	13	65	25
6	3	8	24	9
Total	16	51	154	52

For correct table = 1.5m

$n = 6,$

$$\bar{x} = \frac{\sum x}{n} = \frac{16}{6} = 2.67$$

$$\bar{y} = \frac{\sum y}{n} = \frac{51}{6} = 8.5 \Rightarrow 0.5\text{m}$$

$$b = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2} \Rightarrow 0.5\text{m}$$

$$= \frac{6(154) - (16)(51)}{6(52) - (16)^2}$$

$$= \frac{924 - 816}{312 - 256}$$

$$= \frac{108}{56}$$

$$b = 1.93 \Rightarrow 0.5\text{m}$$

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

$$= 8.5 - 1.93(2.67)$$

$$= 8.5 - 5.15$$

$$a = 3.35 \Rightarrow 0.5\text{m}$$

So the regression line of Y on X is :

$$\hat{y} = a + bx$$

$$\therefore \hat{y} = 3.35 + 1.93x \Rightarrow 0.5\text{m}$$

Putting X = 5,

$$\hat{y} = 3.35 + 1.93(5)$$

$$\hat{y} = 3.35 + 9.65$$

$\hat{y} = 13$ (thousands Rs.) $\Rightarrow$ 0.5m

➢ Error:

$$e = y - \hat{y}$$

$$= 13 - 13$$

$$= 0 \Rightarrow 0.5\text{m}$$

60. Here, n = 7, t = Time ; y = Birth rate

Year	t	y	ty	t^2
2018	1	22.2	22.2	1
2019	2	21.8	43.6	4
2020	3	21.3	63.9	9
2021	4	20.9	83.6	16
2022	5	20.6	103	25
2023	6	20.2	121.2	36
2024	7	19.9	139.3	49
Total	28	146.9	576.8	140

For correct table = 2m

$n = 7,$

$\bar{t} = \frac{\sum t}{n} = \frac{28}{7} = 4,$

$\bar{y} = \frac{\sum y}{n} = \frac{146.9}{7} = 20.99$ ➡ 0.5m

$b = \frac{n\sum ty - (\sum t)(\sum v)}{n\sum t^2 - (\sum u)^2}$ ➡ 0.5m

$= \frac{7(576.8) - (28)(146.9)}{7(140) - (28)^2}$

$= \frac{4037.6 - 4113.2}{980 - 784}$

$= \frac{-75.6}{196}$

$b = -0.39$ ➡ 0.5m

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

$= 20.99 - (-0.39)4$

$= 20.99 + 1.56$

$a = 22.55$ ➡ 0.5m

Equation for Trend $\hat{y} = a + bt$

$\hat{y} = 22.55 + (-0.39)t$

$\hat{y} = 22.55 - 0.39t$ ➡ 0.5m

➢ To estimate the birth rates in the year 2025, we will take $t = 8$

$\hat{y} = 22.55 - 0.39(8)$

$= 22.55 - 3.12$

$= 19.43$ ➡ 0.5m

Hence, the estimates for the birth rates in the year is 19.43

61. Calculation of four monthly moving averages

Year	time t	Sales (lakh Rs.) y	Four yearly moving total	Pair wise total	Four yearly moving averages
2015	1	5			
2016	2	3			
			5+3+7+6=21 ✓		
2017	3	7		21+20=41 ✓	$\frac{41}{8} = 5.13$ ✓
			21-5+4=20 ✓		
2018	4	6		20+25=45 ✓	$\frac{45}{8} = 5.63$ ✓
			20-3+8=25 ✓		
2019	5	4		25+27=52 ✓	$\frac{52}{8} = 6.5$ ✓
			25-7+9=27 ✓		
2020	6	8		27+31=58 ✓	$\frac{58}{8} = 7.25$ ✓
			27-6+10=31 ✓		
2021	7	9		31+35=66 ✓	$\frac{66}{8} = 8.25$ ✓
			31-4+8=35 ✓		
2022	8	10		35+36=71 ✓	$\frac{71}{8} = 8.88$ ✓
			35-8+9=36 ✓		
2023	9	8			
2024	10	9			