# SECOND REVISION TEST - 2025

## Standard XI

Reg.No. | | | | | | |

## BUSINESS MATHEMATICS AND STATISTICS

*Time : 3.00 hrs* **Part - I** *Marks : 90*

**I. Choose the correct answer:** 20 x 1 = 20

1. The number of Hawkin's Simmon conditions for the viability of an input-output analysis is
   a) 4 b) 1 c) 2 d) 3
2. If any three rows of a determinant are identical then the value of the determinant is
   a) 1 b) 0 c) 3 d) 2
3. The number of ways in selecting 4 players out of 5 is
   a) 25 b) 4 ! c) 5 d) 20
4. The sum of the binomial coefficient is
   a) 2n b) $2^n$ c) n + 17 d) $n^2$
5. The equation of directrix of the parabola $y^2 = x$ is
   a) $x - 4 = 0$ b) $4x + 1 = 0$ c) $x + 4 = 0$ d) $4x - 1 = 0$
6. The angle between the pair of straight lines $x^2 - 7xy + 4y^2 = 0$
   a) $\tan^{-1}\left(\frac{\sqrt{33}}{5}\right)$ b) $\tan^{-1}\left(\frac{1}{3}\right)$ c) $\tan^{-1}\left(\frac{5}{\sqrt{33}}\right)$ d) $\tan^{-1}\left(\frac{1}{2}\right)$
7. The value of sin 15° cos 15° is
   a) $\sqrt{3}/2$ b) 1 c) $1/4$ d) $1/2$
8. If P sec 50° = tan 50°, then the value of P is
   a) tan 50° b) cos 50° c) sec 50° d) sin 50°
9. The graph of $y = 2x^2$ is passing through the point
   a) (2,0) b) (0,0) c) (0,2) d) (2,1)
10. If $f(x) = x^2 - x + 1$ then f(x + 1) is
    a) 1 b) $x^2$ c) $x^2 + x + 1$ d) x
11. If $u = e^{x^2}$ then $\frac{\partial u}{\partial x}$ =
    a) $2xe^{x^2}$ b) 0 c) $e^{x^2}$ d) $2e^{x^2}$
12. The calculation of dividend is based on
    a) market value b) capital c) face value d) none of these
13. Example of contigent annuity is
    a) An endowment fund to give scholarship the students
    b) Personal loan from a bank
    c) Instalment of payment for a plot of land
    d) All the above
14. Which of the following represents median?
    a) $Q_3$ b) $Q_1$ c) $D_2$ d) $Q_2$
15. The maximum value of f(x) = sin x is
    a) $1/\sqrt{2}$ b) 1 c) $-1/\sqrt{2}$ d) $\sqrt{3}/2$

16. The probability of drawing a spade from a pack of cards is
    a) $4/13$ b) $1/52$ c) $1/4$ d) $1/13$
17. If X and Y are two variables, then there can be atmost
    a) Three regression lines b) One regression lines
    c) More regression lines d) Two regression lines
18. If the value of the two variables move in same direction, then the correlation is said to be
    a) Perfect positive b) Negative c) No correlation d) Positive
19. The objective of network analysis is to
    a) Minimize the total project duration
    b) Minimize the production delays, interruption and conflicts
    c) Minimize the total project cost d) All the above
20. The maximum value of the objective function $z = 3x + 5y$ subject to the constraints $2x + 5y \leq 10$, $x \geq 0$, $y \geq 0$ is
    a) 25 b) 6 c) 31 d) 15

## Part - II

**II. Answer any 7 questions. (Q.No.30 is compulsory)** 7 x 2 = 14

21. Evaluate : $\begin{vmatrix} x & x+1 \\ x-1 & x \end{vmatrix}$
22. In how many ways 7 pictures can be hung from 5 pictures nails on a wall?
23. Find the focus and Vertex of the parabola $y^2 = 20x$
24. Evaluate : $\lim_{x \to \infty} \frac{2x+5}{x^2+3x+9}$
25. The total cost C in Rupees of making x units of a product is $C(x) = 50 + 4x + 3\sqrt{x}$. Find the marginal cost of the product at 9 units of output.
26. Find the market value of 325 shares of face value ₹100 at a premium of ₹18.
27. An aeroplane flies along the four sides of a square of 100, 200, 300 and 400 kilometres per hour respectively. Find the average speed of the plane in its flight around the square.
28. Calculate the correlation co-efficient from the following data.
    $N = 9$, $\Sigma X = 45$, $\Sigma Y = 108$, $\Sigma X^2 = 285$, $\Sigma Y^2 = 1356$, $\Sigma XY = 597$
29. Develop a network based on the following information.

| Activity | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| Immediate predecessor | – | – | A | B | C,D | C,D | E | F |

30. Find the value of $\tan 150^\circ$

## Part - III

**III. Answer any 7 questions. (Q.No.40 is compulsory)** 7 x 3 = 21

31. Find $\lambda$, if the matrix $\begin{bmatrix} 1 & 1 & 3 \\ 2 & \lambda & 4 \\ 9 & 7 & 11 \end{bmatrix}$ has no inverse.

32. Find the rank of the word 'CHAT' in dictionary.
33. For what value of a and b does the equation $(a-2)x^2 + by^2 + (b-2)xy + 4x + 4y - 1 = 0$ represents a circle? Write down the resulting equation of the circle.
34. Show that $\tan^{-1}\left(\frac{1}{2}\right) + \tan^{-1}\left(\frac{2}{11}\right) = \tan^{-1}\left(\frac{3}{4}\right)$
35. The total cost function y for x units is given by $y = 3x\left(\frac{x+7}{x+5}\right) + 5$. Show that the marginal cost (MC) decreases continuously as the output x increases.
36. Which is better investment, 20% stock at ₹140 or 10% stock at ₹70?
37. compute $Q_1$, $D_2$ and $P_{90}$ from the following data.

| Marks | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| No.of students | 4 | 7 | 15 | 8 | 7 | 2 |

38. The following are ranks obtained by 10 students in Commerce and Accountancy

| Commerce | 6 | 4 | 3 | 1 | 2 | 7 | 9 | 8 | 10 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| Accountancy | 4 | 1 | 6 | 7 | 5 | 8 | 10 | 9 | 3 | 2 |

Find the Rank correlation co-efficient.

39. A furniture dealer deals only in two items viz., tables and chairs. He has to invest ₹10,000 and a space to store atmost 60 pieces. The cost of a table is ₹500 and the cost of a chair is ₹200. He can sell all the items that he buys. He is getting a profit of ₹50 per table and ₹15 per chair. Formulate this problem as an LPP so as to maximize the profit
40. Find $\frac{dy}{dx}$, if $x = a\sec^3\theta$, $y = b\tan^3\theta$

## Part - IV

**IV. Answer all the questions.** 7 x 5 = 35

41. a) Show that the matrices $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$, and $B = \begin{bmatrix} 4/5 & -2/5 & -1/5 \\ -1/5 & 3/5 & -1/5 \\ -1/5 & -2/5 & 4/5 \end{bmatrix}$ are inverse of each other. *(OR)*

b) If $\tan\alpha = 1/3$ and $\tan\beta = 1/7$, then prove that $\tan(2\alpha + \beta) = \pi/4$

42. a) Find the term independent of x in the expansion of $\left(2x^2 + 1/x\right)^{12}$ *(OR)*

b) If the demand for a commodity x is $q = 5 - 2p_1 + p_2 - p_1^2 p_2$, find the partial elasticities $\frac{Eq}{Ep_1}$ and $\frac{Eq}{Ep_2}$ when $p_1 = 3$ and $p_2 = 7$

43. a) By the Mathematical Induction, prove that $1 + 2 + 3 + \ldots\ldots + n = \frac{n(n+1)}{2}$ for all $n \in N$

*(OR)*

b) Verify by continuity of the defined function f(x) is given by $f(x) = \begin{cases} 2-x & ; x<2 \\ 2+x & ; x \geq 2 \end{cases}$ at $x = 2$

44. a) A project has the following time schedule.

| Activity | 1-2 | 1-6 | 2-3 | 2-4 | 3-5 | 4-5 | 6-7 | 5-8 | 7-8 |
|---|---|---|---|---|---|---|---|---|---|
| Duration (in days) | 7 | 6 | 14 | 5 | 11 | 7 | 11 | 4 | 18 |

Construct the network and calculate EST, EFT, LST and LFT and determine the critical path of the project and duration to complete the project.

*(OR)*

b) Differentiate with respect to x : $\sqrt{\frac{(x-1)(x-2)}{(x-3)(x^2+x+1)}}$

45. a) Calculate the coefficient of correlation for the ages of husbands and their respective wives.

| Age of husbands | 23 | 27 | 28 | 29 | 30 | 31 | 33 | 35 | 36 | 39 |
|---|---|---|---|---|---|---|---|---|---|---|
| Age of wives | 18 | 22 | 23 | 24 | 25 | 26 | 28 | 29 | 30 | 32 |

*(OR)*

b) The annual demand for an item A is 800 units and unit price is ₹0.02 if ordering cost is ₹5 per order and annual holding cost is 10% of unit price, then determine the following (i) EOQ in units (ii) Minimum inventory cost (iii) EOQ in Rupees (iv) EOQ in years of supply (v) Number of orders per year

46. a) A company has three machines A,B,C which produces 25%, 30% and 50% of the product respectively. Their respective defective percentages are 5, 4 and 2. From these products one is chosen and inspected. If it is defective, what is probability that it has been made by the machine B.

*(OR)*

b) Find the equation of the circle on the line joining the points (1,0), (0,1) and having its centre on the line x + y = 1

47. a) If the payment of ₹2,000 is made at the end of every quarter for 10 years at the rate of 8% per year, then find the amount of annuity. $[(1.02)^{40} + 2.2080]$

*(OR)*

b) The total cost of 4 kg onion, 3 kg wheat and 2 kg rice is ₹320, the total cost of 2 kg onion, 4 kg wheat and 6 kg rice is ₹560. The total cost of 6 kg onion, 2 kg wheat and 3 kg rice is ₹380. Find the cost of each item per kg by matrix conversion method.

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SECOND REVISION TEST - 2025



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STD: XI THIRUVALLUR DISTRICT

SUBJECT: BUSINESS MATHEMATICS AND STATISTICS

I

part-I

1. c) 2
2. b) 0
3. c) 5
4. b) $2^n$
5. b) $4x+1=0$
6. a) $\tan^{-1}\left(\frac{\sqrt{33}}{5}\right)$
7. c) $\frac{1}{4}$
8. d) $\sin 50^\circ$
9. b) (0,0)
10. c) $x^2+x+1$
11. a) $2xe^{x^2}$
12. c) face value
13. a) An endowment fund to give scholarship the students
14. d) $Q_2$
15. b) 1
16. d) $\frac{1}{13}$
17. d) Two regression lines
18. d) positive
19. a) Minimize the total project duration
20. d) 15

21.) $\begin{vmatrix} x & x+1 \\ x-1 & x \end{vmatrix} = x^2-(x-1)(x+1) = x^2-(x^2-1^2) = x^2-x^2+1 = 1$

22.) ${}^7P_5 = 7\times6\times5\times4\times3 = 210\times12 = 2520$

23.) $y^2 = 20x$

$y^2 = 4ax$

$4a = 20$

$a = 5$

Vertex V(0,0)

Focus F(a,0) = F(5,0)

24.) $\lim_{x\to\infty} \frac{2x+5}{x^2+3x+9} = \lim_{x\to\infty} \frac{x\cdot(2+\frac{5}{x})}{x^2(1+\frac{3}{x}+\frac{9}{x^2})} = \lim_{x\to\infty} \frac{\frac{1}{x}\cdot(2+\frac{5}{x})}{1+\frac{3}{x}+\frac{9}{x^2}}$

$= \frac{\frac{1}{\infty}\cdot(2+\frac{5}{\infty})}{1+\frac{3}{\infty}+\frac{9}{\infty^2}} = \frac{0\cdot(2+0)}{1+0+0} = \frac{0}{1} = 0$

25.) $C(x) = 50+4x+3\sqrt{x}$

Marginal cost $(M.C) = \frac{d}{dx}(C(x)) = \frac{d}{dx}(50+4x+3x^{1/2})$

$M.C = 0+4(1)+3\left(\frac{1}{2}x^{-1/2}\right) = 4+\frac{3}{2\sqrt{x}}$

Given output $x = 9$ units

$M.C = 4+\frac{3}{2\sqrt{9}} = 4+\frac{3}{2(3)} = 4+0.5$

$M.C = ₹\ 4.50$

26.) Given F.V = ₹100

premium = ₹18

M.V. of 1 share = F.V + premium = 100 + 18 = ₹118

M.V. of 325 shares = $325 \times$ ₹118 = ₹

27.) Given $n = 4$

Let $a = 100$, $b = 200$, $c = 300$, $d = 400$

Average speed $H.M = \dfrac{n}{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}} = \dfrac{4}{\frac{1}{100}+\frac{1}{200}+\frac{1}{300}+\frac{1}{400}}$

$= \dfrac{4}{\frac{12+6+4+3}{1200}} = \dfrac{4 \times 1200}{25} = \dfrac{48}{25}$

Average speed = $19\frac{1}{2}$ km/hr

28.) Given $N = 9$, $\Sigma X = 45$, $\Sigma Y = 108$, $\Sigma X^2 = 285$, $\Sigma Y^2 = 1356$, $\Sigma XY = 597$

Correlation co-efficient $r(x,y) = \dfrac{N\Sigma XY - \Sigma X \Sigma Y}{\sqrt{N\Sigma X^2 - (\Sigma X)^2}\sqrt{N\Sigma Y^2 - (\Sigma Y)^2}}$

$r(x,y) = \dfrac{9(597) - (45)(108)}{\sqrt{9(285) - (45)^2}\sqrt{9(1356) - (108)^2}}$

$= \dfrac{5373 - 4860}{\sqrt{2565 - 2025}\sqrt{12204 - 11664}}$

$= \dfrac{513}{\sqrt{540}\sqrt{540}}$

$= \dfrac{513}{540}$

$r(x,y) = 0.95$

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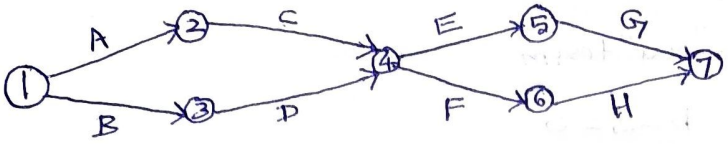
29.)




30.) $\tan 150^\circ = \tan(90^\circ + 60^\circ) = -\cot 60^\circ = -\frac{1}{\sqrt{3}}$

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Part-III

31.) Let $A = \begin{bmatrix} 1 & 1 & 3 \\ 2 & \lambda & 4 \\ 9 & 7 & 11 \end{bmatrix}$

Given no inverse $|A| = 0$

$$\begin{vmatrix} 1 & 1 & 3 \\ 2 & \lambda & 4 \\ 9 & 7 & 11 \end{vmatrix} = 0$$

Expand $R_1$

$$1(11\lambda - 28) - 1(22 - 36) + 3(14 - 9\lambda) = 0$$

$$11\lambda - 28 - 1(-14) + 42 - 27\lambda = 0$$

$$-28 + 14 + 42 - 16\lambda = 0$$

$$28 = 16\lambda$$

$$\frac{28}{16} = \lambda$$

$$\boxed{\frac{7}{4} = \lambda}$$

32.)

| | C | H | A | T |
|---|---|---|---|---|
| → | 2 | 3 | 1 | 4 |
| | 3! | 2! | 1! | 0! |
| | 1 | 1 | 0 | 0 |

RANK of the word 'CHAT' $= (3! \times 1) + (2! \times 1) + (1! \times 0) + (0! \times 0) + 1$

$= 6 + 2 + 0 + 0 + 1$

$= 9$ //

33.) Given $(a-2)x^2 + by^2 + (b-2)xy + 4x + 4y - 1 = 0$

Circle (i) No "xy" term

ie., $b - 2 = 0$

$$\boxed{b = 2}$$

(ii) coeff. of $x^2$ = coeff. of $y^2$

$$a - 2 = b$$

$$a - 2 = 2$$

$$a = 2 + 2$$

$$\boxed{a = 4}$$

∴ The resulting Eqn. of circle

$$\boxed{2x^2 + 2y^2 + 4x + 4y - 1 = 0}$$

34.) L.H.S $= \tan^{-1}\left(\frac{1}{2}\right) + \tan^{-1}\left(\frac{2}{11}\right)$

WKT $\tan^{-1}A + \tan^{-1}B = \tan^{-1}\left[\frac{A+B}{1-AB}\right]$

$$= \tan^{-1}\left[\frac{\frac{1}{2} + \frac{2}{11}}{1 - \left(\frac{1}{2}\right)\left(\frac{2}{11}\right)}\right]$$

$$= \tan^{-1}\left[\frac{\frac{11+4}{22}}{\frac{22-2}{22}}\right]$$

$$= \tan^{-1}\left[\frac{\frac{3}{15}}{\frac{20}{4}}\right]$$

$$= \tan^{-1}\left[\frac{3}{4}\right]$$

LHS = RHS Hence proved.

35.) T.C $y = 3x\left(\frac{x+7}{x+5}\right)+5$

$$y = \frac{3x^2+21x}{x+5}+5$$

Marginal cost (M.C), $\frac{dy}{dx} = \frac{(x+5)(6x+21)-(3x^2+21x)(1+0)}{(x+5)^2}+0$

$$\frac{dy}{dx} = \frac{6x^2+21x+30x+105-3x^2-21x}{(x+5)^2}$$

$$= \frac{3x^2+30x+105}{(x+5)^2}$$

$$= \frac{3(x^2+10x+35)}{(x+5)^2}$$

$$= \frac{3\cdot(x^2+2\cdot x\cdot 5+5^2+10)}{(x+5)^2}$$

$$= \frac{3(x+5)^2}{(x+5)^2}+\frac{30}{(x+5)^2}$$

$$\frac{dy}{dx} = 3\left[1+\frac{10}{(x+5)^2}\right]$$ .. This shows

Hence $x$ increases M.C decreases continuously

Hence proved.

36.)

Investment in each case ₹(140 X 70)

Income of 20% stock at ₹140 $= \frac{20}{140} \times (140 \times 70)$

$= ₹1400$

Income of 10% stock at ₹70 $= \frac{10}{70} \times (140 \times 70)$

$= ₹1400$

Both investment fecthes same income

∴ They are equivalent shares.

37.)

| Marks $x$ | No. of students $f$ | c.f |
|---|---|---|
| 10 | 4 | 4 |
| (20) | 7 | (11) |
| 30 | 15 | 26 |
| 40 | 8 | 34 |
| (50) | 7 | (41) |
| 60 | 2 | N = 43 |

$\therefore Q_1 =$ size of $\left(\frac{N+1}{4}\right)^{th}$ value

$=$ size of $\left(\frac{43+1}{4}\right)^{th}$ value

$=$ size of $\left(\frac{44}{4}\right)^{th}$ value,

$=$ size of $11^{th}$ value,

$Q_1 = 20$

$D_2 =$ Size of $2\left(\frac{N+1}{10}\right)^{th}$ value

$=$ size of $2\left(\frac{43+1}{10}\right)^{th}$ value

$=$ size of $2(4.4)^{th}$ value

$=$ size of $(8.8)^{th}$ value

$D_2 = 20$ (Just greater than 8.8 in c.f is 11) corresponding value of $x$

$P_{90} =$ size of $90\left(\frac{N+1}{100}\right)^{th}$ value,

$=$ size of $90\left(\frac{43+1}{100}\right)^{th}$ value

$=$ size of $90(0.44)^{th}$ value

$=$ size of $(39.60)^{th}$ value

$P_{90} = 50$ (Just greater 39.60 in c.f is 41) corresponding value of $x$

38.)

| Commerce $R_A$ | Accountancy $R_B$ | $d = R_A - R_B$ | $d^2$ |
|---|---|---|---|
| 6 | 4 | 2 | 4 |
| 4 | 1 | 3 | 9 |
| 3 | 6 | -3 | 9 |
| 1 | 7 | -6 | 36 |
| 2 | 5 | -3 | 9 |
| 7 | 8 | -1 | 1 |
| 9 | 10 | -1 | 1 |
| 8 | 9 | -1 | 1 |
| 10 | 3 | 7 | 49 |
| 5 | 2 | 3 | 9 |
| | | | $\Sigma d^2 = 128$ |

$N = 10$

Rank correlation coefficient $r = 1 - \frac{6\Sigma d^2}{N(N^2-1)}$

$= 1 - \frac{6(128)}{10(10^2-1)} = 1 - \frac{768}{10(100-1)}$

$= 1 - \frac{\cancel{256}\ 128}{\cancel{10}\ 5\ (99)\ 33} = 1 - \frac{128}{165} = 1 - 0.775$

$= 0.2242$

39.) (i) Variables:

Let $x_1$ & $x_2$ denote the number of tables & chairs

(ii) Objective function:

Profit on $x_1$ tables $= 50x_1$

Profit on $x_2$ chairs $= 15x_2$

Total Profit $= 50x_1 + 15x_2$

Let $z = 50x_1 + 15x_2$ Maximize

(iii) Constraints:

Space to store atmost 60 pieces

ie, $x_1 + x_2 \leq 60$

The cost of $x_1$ tables $= 500x_1$

The cost of $x_2$ chairs $= 200x_2$

Total cost cannot more than 10000

ie., $500x_1 + 200x_2 \leq 10000$

ie., $5x_1 + 2x_2 \leq 100$

(iv) Non-negative restrictions.

Since number of chairs & table cannot be negative

ie., $x_1 \geq 0$, $x_2 \geq 0$

L.P.P is

Maximize $z = 50x_1 + 15x_2$

Subject to constraints

$x_1 + x_2 \leq 60$

$5x_1 + 2x_2 \leq 100$

$x_1, x_2 \geq 0$

40.) If $x = a\sec^3\theta$ ; $y = b\tan^3\theta$

$\frac{dx}{d\theta} = a(3\sec^2\theta \cdot \sec\theta \cdot \tan\theta)$ ; $\frac{dy}{d\theta} = b(3\tan^2\theta \cdot \sec^2\theta)$

$$\frac{dy}{dx} = \frac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}} = \frac{b(3\tan^2\theta \cdot \sec^2\theta)}{a(3\sec^3\theta \cdot \tan\theta)} = \frac{b\tan\theta}{a\sec\theta}$$

$$= \frac{b\frac{\sin\theta}{\cos\theta}}{a\frac{1}{\cos\theta}}$$

$$\boxed{\frac{dy}{dx} = \frac{b}{a}\sin\theta}$$

## part - IV

41.) a) $$AB = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix} \frac{1}{5} \begin{bmatrix} 4 & -2 & -1 \\ -1 & 3 & -1 \\ -1 & -2 & 4 \end{bmatrix}$$

$$AB = \frac{1}{5}\begin{bmatrix} 8-2-2 & -4+6-2 & -2-2+4 \\ 4-3-1 & -2+9-2 & -1-3+4 \\ 4-2-2 & -2+6-4 & -1-2+8 \end{bmatrix}$$

$$AB = \frac{1}{5}\begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = I_3$$

$$BA = \frac{1}{5}\begin{bmatrix} 4 & -2 & -1 \\ -1 & 3 & -1 \\ -1 & -2 & 4 \end{bmatrix}\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$$

$$BA = \frac{1}{5}\begin{bmatrix} 8-2-1 & 8-6-2 & 4-2-2 \\ -2+3-1 & -2+9-2 & -1+3-2 \\ -2-2+4 & -2-6+8 & -1-2+8 \end{bmatrix}$$

$$BA = \frac{1}{5}\begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = I_3$$

$\therefore AB = BA = I_3$

$\therefore$ A & B are inverse of each other

Hence proved.

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b) If $\tan\alpha = \frac{1}{3}$, $\tan\beta = \frac{1}{7}$

Now $\tan 2\alpha = \frac{2\tan\alpha}{1-\tan^2\alpha} = \frac{2\left(\frac{1}{3}\right)}{1-\left(\frac{1}{3}\right)^2} = \frac{2/3}{1-\frac{1}{9}} = \frac{2/3}{\frac{9-1}{9}} = \frac{2\times 3}{8} = \frac{3}{4}$

$$\tan 2\alpha = \frac{3}{4}$$

Consider $\tan(2\alpha+\beta) = \frac{\tan 2\alpha + \tan\beta}{1-\tan 2\alpha \cdot \tan\beta} = \frac{\frac{3}{4}+\frac{1}{7}}{1-\left(\frac{3}{4}\right)\left(\frac{1}{7}\right)}$

$$\tan(2\alpha+\beta) = \frac{\frac{21+4}{28}}{\frac{28-3}{28}}$$

$$\tan(2\alpha+\beta) = \frac{25}{25}$$

$$\tan(2\alpha+\beta) = 1$$

$$2\alpha+\beta = \tan^{-1}(1)$$

$$2\alpha+\beta = \pi/4$$ Hence proved.

42) a) $\left(2x^2 + \frac{1}{x}\right)^{12}$

General term

$$T_{r+1} = {}^{n}C_{r}\, x^{n-r} \cdot a^{r}$$

here $x = 2x^2$, $a = \frac{1}{x}$, $n = 12$

$$T_{r+1} = {}^{12}C_{r}\, (2x^2)^{12-r} \cdot \left(\frac{1}{x}\right)^{r}$$

$$T_{r+1} = {}^{12}C_{r}\, 2^{12-r} \cdot x^{24-3r}$$

term Independent

i.e., $24 - 3r = 0$

$24 = 3r$

$\boxed{8 = r}$

$$T_{8+1} = {}^{12}C_{8}\, 2^{12-8} \cdot x^{0}$$

$$T_9 = \frac{12 \cdot 11 \cdot 10 \cdot 9}{4 \cdot 3 \cdot 2 \cdot 1} \times 2^4 \times 1$$

$$T_9 = 55 \times 9 \times 8 = 55 \times 72$$

$$\begin{array}{r} 110 \\ 385 \\ \hline 3960 \end{array}$$

independent term $\boxed{T_9 = 3960}$

---

b) $q = 5 - 2P_1 + P_2 - P_1^2 P_2$

$$\frac{\partial q}{\partial P_1} = -2 - 2P_1 P_2$$

$$\frac{\partial q}{\partial P_2} = 1 - P_1^2$$

$$\frac{Eq}{EP_1} = -\frac{P_1}{q}\frac{\partial q}{\partial P_1}$$

$$= \frac{-P_1}{5 - 2P_1 + P_2 - P_1^2 P_2} \cdot (-2 - 2P_1 P_2)$$

$$\boxed{\frac{Eq}{EP_1} = \frac{2P_1 + 2P_1^2 P_2}{5 - 2P_1 + P_2 - P_1^2 P_2}}$$

Given $P_1 = P_2 = P_2 = 7$

$$\frac{Eq}{EP_1} = \frac{6 + 2(9)(7)}{5 - 6 + 7 - 9(7)} = \frac{6 + 126}{-57} = -\frac{132}{57}$$

$$\frac{Eq}{EP_2} = -\frac{P_2}{q}\frac{\partial q}{\partial P_2}$$

$$= \frac{-P_2}{5 - 2P_1 + P_2 - P_1^2 P_2} \cdot (1 - P_1^2)$$

$$\boxed{\frac{Eq}{EP_2} = \frac{-P_2 + P_1^2 P_2}{5 - 2P_1 + P_2 - P_1^2 P_2}}$$

Given $P_1 = 3$, $P_2 = 7$

$$\frac{Eq}{EP_2} = \frac{-7 + 9(7)}{5 - 6 + 7 - 9(7)}$$

$$= \frac{-7 + 63}{-57}$$

$$\boxed{\frac{Eq}{EP_2} = -\frac{56}{57}}$$

43) a)

**Step:1**

Let $P(n): 1+2+3+\cdots+n = \frac{n(n+1)}{2}$, $\forall n \in N$

Put $n=1 \Rightarrow$ LHS $= 1$

RHS $= \frac{1\cdot(1+1)}{2} = 1$

LHS = RHS

$\therefore$ P(1) is true

**Step:2** Let us assume that P(k) is also true, for some $n=k$

$P(k): 1+2+3+\cdots+k = \frac{k(k+1)}{2}$, $\forall k \in N$

**Step:3** To prove: P(k+1) is also true.

$$P(k+1) = P(k) + t_{k+1}$$

$$= \frac{k(k+1)}{2} + (k+1)$$

$$= (k+1)\left[\frac{k}{2}+1\right]$$

$$= (k+1)\left[\frac{k+2}{2}\right]$$

$$\boxed{P(k+1) = \frac{(k+1)\cdot(k+2)}{2}}$$

$\therefore$ P(k+1) is also true

By principle Mathematical induction P(n) is true $\forall n \in N$.

b)

$$f(x) = \begin{cases} 2-x & ; x<2 \\ 2+x & ; x \geq 2 \end{cases} \quad \text{at } x=2$$

| f(x) = 2−x | f(x) = 2+x |
|---|---|
| 2⁻ | 2⁺ |

$$L[f(x)]_{at\ x=2} = \lim_{x\to 2^-} f(x) = \lim_{x\to 2^-} (2-x)$$

$(x = 2-h,\ x\to 2^-,\ h\to 0)$

$$= \lim_{h\to 0} 2-(2-h) = \lim_{h\to 0} 2-2+h = 0$$

$$R[f(x)]_{at\ x=2} = \lim_{x\to 2^+} f(x) = \lim_{x\to 2^+} 2+x$$

$(x = 2+h,\ x\to 2^+,\ h\to 0)$

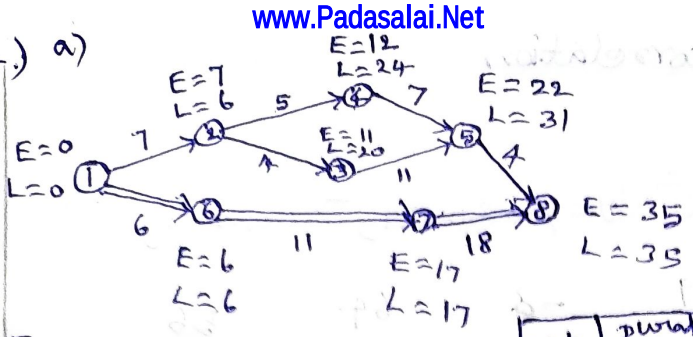
$$= \lim_{h\to 0} 2+2+h = \lim_{h\to 0} 4+h = 4+0 = 4$$

$f(2) = 2+2 = 4$

$\therefore L[f(x)] \neq R[f(x)] = f(2)$

$\therefore f(x)$ is discontinuous at $x=2$

44.) a)




$E_1 = 0$
$E_2 = 7$
$E_3 = 11$
$E_4 = 12$
$E_5 = 22$
$E_6 = 6$
$E_7 = 17$
$E_8 = 35$

$L_8 = 35$
$L_7 = 17$
$L_6 = 6$
$L_5 = 31$
$L_4 = 24$
$L_3 = 20$
$L_2 = 6$
$L_1 = 0$

| Activity | Duration (in days) $t_{ij}$ | E.S.T | E.F.T = E.S.T + $t_{ij}$ | L.S.T = L.F.T − $t_{ij}$ | L.F.T |
|---|---|---|---|---|---|
| 1-2 | 7 | 0 | 7 | | 6 |
| 1-6 | 6 | 0 | (6) | 0 | (6) |
| 2-3 | 14 | 7 | 21 | 6 | 20 |
| 2-4 | 5 | 7 | 12 | 19 | 24 |
| 3-5 | 11 | 11 | 22 | 20 | 31 |
| 4-5 | 7 | 12 | 19 | 24 | 31 |
| 6-7 | 11 | 6 | (17) | 6 | (17) |
| 5-8 | 4 | 22 | 26 | 31 | 35 |
| 7-8 | 18 | 17 | (35) | 17 | (35) |

Critical path 1-6-7-8

project complete duration in 35 days

b) Let $y = \sqrt{\dfrac{(x-1)(x-2)}{(x-3)(x^2+x+1)}}$

take log on ~~both~~ sides

$$\log y = \frac{1}{2}\left[\log(x-1) + \log(x-2) - \log(x-3) - \log(x^2+x+1)\right]$$

diff. 'y' w.r.to x

$$\frac{1}{y}\cdot\frac{dy}{dx} = \frac{1}{2}\left[\frac{1}{x-1} + \frac{1}{x-2} - \frac{1}{x-3} - \frac{1\cdot(2x+1)}{x^2+x+1}\right]$$

$$\frac{dy}{dx} = \frac{y}{2}\left[\frac{1}{x-1} + \frac{1}{x-2} - \frac{1}{x-3} - \frac{(2x+1)}{x^2+x+1}\right]$$

$$\boxed{\frac{dy}{dx} = \frac{1}{2}\sqrt{\frac{(x-1)(x-2)}{(x-3)(x^2+x+1)}}\left[\frac{1}{x-1} + \frac{1}{x-2} - \frac{1}{x-3} - \frac{(2x+1)}{x^2+x+1}\right]}$$

45) a) Coefficient of correlation

| Age of husbands X | Age of wives Y | $dx = X - 30$ | $dx^2$ | $dy = Y - 26$ | $dy^2$ | $dx \cdot dy$ |
|---|---|---|---|---|---|---|
| 23 | 18 | −7 | 49 | −8 | 64 | 56 |
| 27 | 22 | −3 | 9 | −4 | 16 | 12 |
| 28 | 23 | −2 | 4 | −3 | 9 | 6 |
| 29 | 24 | −1 | 1 | −2 | 4 | 2 |
| (30) A | 25 | 0 | 0 | −1 | 1 | 0 |
| 31 | (26) B | 1 | 1 | 0 | 0 | 0 |
| 33 | 28 | 3 | 9 | 2 | 4 | 6 |
| 35 | 29 | 5 | 25 | 3 | 9 | 15 |
| 36 | 30 | 6 | 36 | 4 | 16 | 24 |
| 39 | 32 | 9 | 81 | 6 | 36 | 54 |
| $\Sigma X =$ 311 | $\Sigma Y =$ 257 | $\Sigma dx = 11$ | $\Sigma dx^2 =$ 215 | $\Sigma dy = -3$ | $\Sigma dy^2 =$ 159 | $\Sigma dx\,dy = 175$ |

$N = 10$, $\bar{X} = \frac{\Sigma X}{N} = \frac{311}{10} = 31.1$, $\bar{Y} = \frac{\Sigma Y}{N} = \frac{257}{10} = 25.7$

Assumed Mean Method

Coefficient of correlation

$$r(x,y) = \frac{N\Sigma dx\,dy - \Sigma dx \cdot \Sigma dy}{\sqrt{N\Sigma dx^2 - (\Sigma dx)^2}\sqrt{N\Sigma dy^2 - (\Sigma dy)^2}}$$

$$= \frac{10(175) - (11)(-3)}{\sqrt{10(215) - (11)^2}\sqrt{10(159) - (-3)^2}}$$

$$= \frac{1750 + 33}{\sqrt{2150 - 121}\sqrt{1590 - 9}}$$

$$= \frac{1783}{\sqrt{1029}\sqrt{1581}}$$

$$= \frac{1783}{(\quad)(\quad)}$$

$$= \frac{1783}{1790.8}$$

$$\boxed{r(x,y) = 0.996}$$

X and Y are highly positively correlated.

The ages of their husband and wives have a high degree of correlation.

45) b) Given Item A

Requirement (Annual demand) $R = 800$ units

ordering cost $C_3 = ₹5$

holding cost $C_1 = 10\%$ of unit price

$= 10\%$ of $₹0.02$

$= \frac{10}{100} \times 0.02$

$C_1 = 0.002$

(i) E.O.Q, $q_0 = \sqrt{\frac{2C_3R}{C_1}}$

$= \sqrt{\frac{2(5)(800)}{0.002}}$

$= \sqrt{\frac{2(5)(800)(1000)}{2}} = \sqrt{4000000}$

$q_0 = 2000$ units

(ii) Minimum inventory cost $= \sqrt{2C_3C_1R}$

$= \sqrt{2(5)(0.002)(800)}$

$= \sqrt{16000}$

$= \sqrt{16}$

$= ₹4$

(iii) E.O.Q in Rupees $= q_0 \times$ unit price

$= 2000 \times 0.02 = 2000 \times \frac{2}{100}$

$= ₹40$

(iv) E.O.Q in year of supply $= \frac{q_0}{R} = \frac{2000}{800} = \frac{5}{2} = 2.5$

(v) Number of order per year $= \frac{R}{q_0} = \frac{800}{2000} = \frac{2}{5} = 0.4$

45) a) Coefficient of correlation

46) a) Let $E_1$ = Machine A produces the product

$E_2$ = Machine B produces the product

$E_3$ = Machine C produces the product

D = defective percentage

Given $P(E_1) = 25\% = \frac{25}{100}$ | $P(D/E_1) = \frac{5}{100}$

$P(E_2) = 30\% = \frac{30}{100}$ | $P(D/E_2) = \frac{4}{100}$

$P(E_3) = 50\% = \frac{50}{100}$ | $P(D/E_3) = \frac{2}{100}$

Using Bay's theorem

$$P(E_2/D) = \frac{P(E_2) \cdot P(D/E_2)}{P(E_1) \cdot P(D/E_1) + P(E_2) \cdot P(D/E_2) + P(E_3) \cdot P(D/E_3)}$$

$$= \frac{\left(\frac{30}{100}\right)\left(\frac{4}{100}\right)}{\left(\frac{25}{100}\right)\left(\frac{5}{100}\right) + \left(\frac{30}{100}\right)\left(\frac{4}{100}\right) + \left(\frac{50}{100}\right)\left(\frac{2}{100}\right)}$$

$$= \frac{\frac{120}{100 \times 100}}{\frac{125 + 120 + 100}{100 \times 100}}$$

$$= \frac{120}{345}$$

$$= \frac{8}{23}$$

$$\boxed{P(E_2/D) = \frac{8}{23}}$$

A

46) b)

Required equation of circle

$$\boxed{x^2+y^2+2gx+2fy+c=0} \rightarrow (1)$$

$(1, 0)$

$$1+0+2g+0+c=0$$

$$\boxed{2g+c=-1} \rightarrow (2)$$

$(0, 1)$

$$0+1+0+2f+c=0$$

$$\boxed{2f+c=-1} \rightarrow (3)$$

Centre $C(-g, -f)$ lies on the line $x+y=1$

$$\boxed{-g-f=1} \rightarrow (4)$$

Solve (2) & (3)

$$2g+c=-1$$
$$2f+c=-1$$
$$(-)\quad(-)\quad(+)$$

$$2g-2f=0$$

$\div$ by 2

$$\boxed{g-f=0} \rightarrow (5)$$

Solve (4) & (5)

$$-g-f=1$$
$$g-f=0$$

$$-2f=1$$

$$\boxed{f=-\frac{1}{2}}$$ sub (5)

$$g-\left(\frac{-1}{2}\right)=0$$

$$g+\frac{1}{2}=0$$

$$\boxed{g=-\frac{1}{2}}$$ sub (2)

$$2\left(\frac{-1}{2}\right)+c=-1$$

$$c=-1+1$$

$$\boxed{c=0}$$

All values sub eqn (1)

Required eqn. of circle

$$x^2+y^2+2\left(\frac{-1}{2}\right)x+2\left(\frac{-1}{2}\right)y+0=0$$

$$\therefore \boxed{x^2+y^2-x-y=0}$$

47.) a)

Given payment $a = ₹\ 2000$ (end of every quarter)

number of years $n = 10$ years

$n = 10 \times 4$ quarter

$\boxed{n = 40}$ quarter

$i = 8\%$ per year $= \frac{8^2}{100} \times \frac{1}{4}$ per quarter

$\boxed{i = 0.02}$

Amount of annuity

$$A = \frac{a}{i}\left[(1+i)^n - 1\right]$$

$$= \frac{2000}{0.02}\left[(1+0.02)^{40} - 1\right]$$

$$= 100000\left[(1.02)^{40} - 1\right]$$

$$= 100000\left[2.2080 - 1\right]$$

$$= 100000\left[1.2080\right]$$

$$= 120800.0000$$

$$\boxed{A = ₹\ 1,20,800}$$

47.)

b) Let $x, y$ & $z$ be a cost of per kg of onion, wheat and rice respectively.

Given $4x+3y+2z = 320 \rightarrow (1)$

$2x+4y+6z = 560 \rightarrow (2)$

$6x+2y+3z = 380 \rightarrow (3)$

$$AX = B$$

$$\begin{bmatrix} 4 & 3 & 2 \\ 2 & 4 & 6 \\ 6 & 2 & 3 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 320 \\ 560 \\ 380 \end{bmatrix}$$

$$\boxed{X = A^{-1}B}$$

Inversion Method

$$A^{-1} = \frac{1}{|A|} \cdot \text{adj}\, A$$

$$|A| = \begin{vmatrix} 4 & 3 & 2 \\ 2 & 4 & 6 \\ 6 & 2 & 3 \end{vmatrix} = 4(12-12) - 3(6-36) + 2(4-24)$$

$$= 4(0) - 3(-30) + 2(-20)$$

$$= 0 + 90 - 40$$

$$\boxed{|A| = 50} \neq 0$$

$A$ is non-singular matrix

$A^{-1}$ exist.

$$\text{adj}\, A = \begin{bmatrix} +(12-12) & -(6-36) & +(4-24) \\ -(9-4) & +(12-12) & -(8-18) \\ +(18-8) & -(24-4) & +(16-6) \end{bmatrix}^T$$

$$= \begin{bmatrix} 0 & 30 & -20 \\ -5 & 0 & 10 \\ 10 & -20 & 10 \end{bmatrix}^T$$

$$\text{adj}A = \begin{bmatrix} 0 & -5 & 10 \\ 30 & 0 & -20 \\ -20 & 10 & 10 \end{bmatrix}$$

$$A^{-1} = \frac{1}{50}\begin{bmatrix} 0 & -5 & 10 \\ 30 & 0 & -20 \\ -20 & 10 & 10 \end{bmatrix}$$

$$X = \frac{1}{50}\begin{bmatrix} 0 & -5 & 10 \\ 30 & 0 & -20 \\ -20 & 10 & 10 \end{bmatrix}\begin{bmatrix} 320 \\ 560 \\ 380 \end{bmatrix}$$

$$= \frac{1}{5}\begin{bmatrix} 0 & -5 & 10 \\ 30 & 0 & -20 \\ -20 & 10 & 10 \end{bmatrix}\begin{bmatrix} 32 \\ 56 \\ 38 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & -1 & 2 \\ 6 & 0 & -4 \\ -4 & 2 & 2 \end{bmatrix}\begin{bmatrix} 32 \\ 56 \\ 38 \end{bmatrix}$$

$$= \begin{bmatrix} 0-56+76 \\ 192+0-152 \\ -128+112+76 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 20 \\ 40 \\ 60 \end{bmatrix}$$

$$\begin{array}{r} 188 \\ -128 \\ \hline 60 \end{array}$$

∴ Cost of 1kg onion is ₹20
Cost of 1kg wheat is ₹40.
Cost of 1kg Rice is ₹60

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