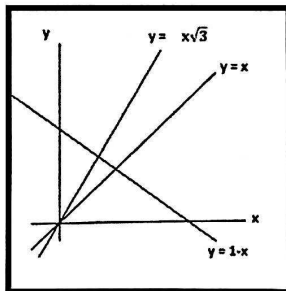




- (7) A player rolls a fair six-sided die. If the die shows a number greater than 4, the player wins twice the value that appears on the die. If the die shows a number less than or equal to 4, the player loses the value that appears on the die. What is the expected gain of the player? 1
- a) 2 b) 3 c) 6 d) None of these
- (8) The original cost of a car is ₹ 8,00,000 and its scrap value after a useful life of 5 years is ₹ 1,00,000. Assuming straight-line depreciation, what will be the book value of the car at the end of 3 years? 1
- a) ₹ 3,80,000 b) ₹ 2,80,000 c) ₹ 1,20,000 d) ₹ 2,20,000
- (9) A ball is thrown upward from the ground, and its height above the ground follows the parabolic path given by the equation,  $y = 4x - x^2$ , where  $y$  is the height of the ball and  $x$  is the horizontal distance from the point where the ball was thrown. The ball reaches its maximum height at the point (2,4). Find the slope of the path of the ball at the maximum height. 1
- a) 0 b) 1 c) -1 d) None of these
- (10) In a large consignment of toys, 8% of the toys are found to be defective. A random sample of 100 toys is taken for inspection with replacement. What is the variance of the number of defective toys in the sample? 1
- a) 7.46 b) 7.36 c) 2.26 d) 8.36
- (11) If it is currently 9:00 AM on a 12-hour clock, what will be the time after 510 hours? 1
- a) 3 p.m. b) 2 p.m. c) 3 a.m. d) 4 p.m.
- (12) If  $\frac{x+1}{x+2} \geq 1$ , then in which interval does  $x$  belong? 1
- a)  $x \in (-\infty, 2]$  b)  $x \in (-\infty, -2)$  c)  $x \in (-\infty, 2)$  d)  $x \in (-\infty, 1]$
- (13) The supply of finished goods was delayed for a month due to landslide in hilly terrain. Under which trend oscillation does this situation fall? 1
- a) Seasonal Trend b) Cyclical Trend c) Long Term Trend d) Irregular Trend
- (14) At what rate of interest will the present value of a perpetuity of ₹ 300 payable at the end of each quarter be ₹ 24000? 1
- a) 6% b) 5% c) 5.5% d) 7%
- (15) For a  $3 \times 3$  matrix  $B$ , if  $\text{adj } B = 3B^{-1}$ , then find  $|2BB^T|$ . 1
- a) 70 b) 72 c) 65 d) 80
- (16) Find the differential equation of the family of straight lines given below: 1



- a)  $\frac{d^2y}{dx^2} = 0$  b)  $\frac{d^2y}{dx^2} = -4$  c)  $\frac{d^2y}{dx^2} = \frac{dy}{dx}$  d)  $\frac{dy}{dx} = -2$
- (17) For two matrices  $A = \begin{bmatrix} -1 & 2 \\ 32 & 4 \\ 5 & -2 \end{bmatrix}$  and  $B^T = \begin{bmatrix} 1 & 3 & 5 \\ 4 & 2 & 6 \end{bmatrix}$ , find the matrix  $A - B$ . 1
- a)  $\begin{bmatrix} -2 & -2 \\ 29 & 2 \\ 0 & -8 \end{bmatrix}$  b)  $\begin{bmatrix} 2 & 2 \\ -29 & -2 \\ 0 & 8 \end{bmatrix}$  c)  $\begin{bmatrix} -2 & -2 \\ 29 & 20 \\ 0 & -8 \end{bmatrix}$  d)  $\begin{bmatrix} -2 & 29 & 0 \\ -2 & 2 & -8 \end{bmatrix}$

- (18) The order and degree (if defined) of the differential equation  $\frac{d^2y}{dx^2} + x\left(\frac{dy}{dx}\right)^2 = 2x^2 \log\left(\frac{d^2y}{dx^2}\right)$  are 1
- a) Order = 2, Degree = 2  
 b) Order = 2, Degree = 1  
 c) Order = 2, Degree = Not defined  
 d) Order = 1, Degree = 1

For questions 19 and 20, two statements are given – one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below:

- (i) Both A and R are true and R is the correct explanation of the assertion  
 (ii) Both A and R are true but R is not the correct explanation of the assertion  
 (iii) A is true, but R is false  
 (iv) A is false, but R is true
- (19) Assertion (A): When a nominal interest rate of 5% is compounded continuously, the effective interest rate is given by  $e^{0.05} - 1$ , which is approximately 5.13%. 1

Reason (R): The effective interest rate can be calculated using the formula  $r_{\text{eff}} = e^r - 1$ , where r is the nominal interest rate expressed as a decimal.

- a) (i)                                      b) (ii)                                      c) (iii)                                      d) (iv)
- (20) Assertion (A): The product of two matrices A and B is commutative, i.e.,  $AB=BA$ , if both matrices are square matrices of the same order. 1

Reason (R): The order of multiplication in matrix operations does affect the outcome for square matrices.

- a) (i)                                      b) (ii)                                      c) (iii)                                      d) (iv)

### SECTION B

(All questions are compulsory. In case of internal choice, attempt any one question only)

- (21) (a) How many kg of sugar costing ₹ 45 per kg must be mixed with 30 kg of sugar costing ₹ 35 per kg so that there may be a gain of 12 % by selling the mixture at ₹ 47.04 per kg? 2

OR

- (21) (b) Two pipes A and B can fill a tank in 24 minutes and 32 minutes respectively. If both the pipes are opened simultaneously, after how much time B should be closed so that the tank is full in 18 minutes? 2
- (22) In a 100 m race, A runs at 8 km/hour. If A gives B a start of 4 m and still beats him by 15 seconds, what is the speed of B? 2
- (23) Find the ratio of swimming speed of Raj in still water to speed of river, if ratio of time taken to go 10 km upstream to the time taken to go 10 km downstream is 11: 5. 2

- (24) (a) The marks obtained in a certain exam follow normal distribution with mean 45 and standard deviation 10. If 1300 students appeared at the examination, calculate the number of students scoring

- (i) less than 35 marks  
 (ii) more than 65 marks 2

OR

- (b) A die is thrown 6 times. If “getting an odd number” is a “success”, what is the probability of  
 (i) 5 successes  
 (ii) at most 5 successes. 2

- (25) If  $A = \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$  and  $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ , find k so that  $A^2 = 5A + kI$ . 2

### SECTION C

(All questions are compulsory. In case of internal choice, attempt any one question only)

- (26) Find the remainder when  $2^{20} + 3^{30} + 4^{40} + 5^{50} + 11^7$  is divided by 7. 3
- (27) (a) Find the students' - t for the following variable values in a sample of eight: -4, -2, -2, 0, 2, 2, 3, 3 taking the mean of the universe to be zero. 3

OR

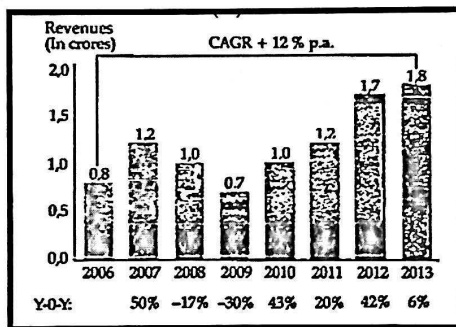
(27) (b) In a rat feeding experiment, the following results were obtained:

Diet	High Protein	Low Protein
Gain in weight (in gm)	13	7
	14	11
	10	10
	11	8
	12	10
	16	13
	10	9
	8	
	11	
	12	
	9	
	12	

Investigate if there is any evidence of superiority of one diet over the other. The value of  $t$  for 17 degrees of freedom at 5 % level of significance is 2.11. 3

(28) In the proportion of defective in a bulk is 4 %. Find the probability of not more than 2 defective in a sample of 10. It is known that  $e^{-0.4} = 0.6703$ . 3

(29) An interviewer gives the following graph on a client's sales in the last 7 years to candidate and said to find the CAGR. Given that  $(\frac{9}{4})^{\frac{1}{2}} = 1.1228$ . 3



(30) A company manufactures two types of products A and B. Each unit of A requires 3 gm of nickel and 1 gm of chromium, while each unit of B requires 1 gram of nickel and 2 gram of chromium. The firm can produce 9 gram of nickel and 8 grams of chromium. The profit is ₹ 40 on each unit of product of type A and ₹ 50 on each unite of type B. How many units of each type should the company manufactures so as to earn maximum profit? Use linear programming to find the solution. 3

(31) (a) Five cards are drawn one by one, with replacement from a well- shuffled deck of 52 cards. Find the probability that

- (i) all the five cards are diamonds 1
- (ii) only 3 cards are diamonds 1
- (iii) none of the card is diamond. 1

OR

(31)(b) A random variable X has the following probability distribution: 3

$X_i$	-2	-1	0	1	2	3
$P_i$	0.1	k	0.2	2k	0.3	k

(i) Find the value of k.

- Calculate the mean of X.  
 (iii) Calculate the variance of X.

### SECTION D

(All questions are compulsory. In case of internal choice, attempt any one question only)  
 (32) (a) Fit a straight-line trend by using the method of least squares for the following data and calculate the trend values. 5

Year	2017	2018	2019	2020	2021
Sale of sugar (in 1000 kg)	80	90	92	83	94

OR

(b) Calculate the four – yearly moving averages of number of students studying in a higher secondary school in a particular city from the following data. 5

Year	No. of students
2011	124
2012	120
2013	135
2014	140
2015	145
2016	158
2017	162
2018	170
2019	175

(33) (a) Prove that  $\begin{vmatrix} yz - x^2 & zx - y^2 & xy - z^2 \\ zx - y^2 & xy - z^2 & yz - x^2 \\ xy - z^2 & yz - x^2 & zx - y^2 \end{vmatrix}$  is divisible by  $(x + y + z)$  and hence find the quotient. 5

OR

(33) (b) Reena owns a small café that serves three different types of coffee drinks: Latte, Cappuccino, and Espresso. She needs to determine how many of each type to prepare based on ingredient costs and preparation time. **Modified Data Collected:**

- A Latte costs ₹ 3 in milk, ₹ 2 in coffee beans, and takes 1 minute to prepare.
- A Cappuccino costs ₹ 4 in milk, ₹ 3 in coffee beans, and takes 2 minutes to prepare.
- An Espresso costs ₹ 2 in milk, ₹ 1 in coffee beans, and takes 1 minute to prepare.

Reena wants to prepare these drinks such that:

1. The total cost of milk for all three types adds up to ₹ 26.
2. The total cost of coffee beans for all three types adds up to ₹ 18.
3. The total preparation time for all three types adds up to 12 minutes.

Using this information, help Reena determine the number of each type of coffee she should prepare to meet these conditions using Cramer's Rule. 5

(34) Suppose the demand for the certain product is given by  $p = -0.01x^2 - 0.1x + 6$ , where p is the unit price given in rupees and x is the quantity demanded per month given in the units of 1000. The unit market price for the product is ₹ 4 per unit. Evaluate the following:

- (a) Find the quantity demanded at the given price. 2
- (b) Find the consumer's surplus if the market price for the product is ₹ 4 per unit. 3
- (35) The cost of a TV depreciates by ₹ 800 during the second year and by ₹ 700 during the third year. Calculate: (i) the rate of depreciation per annum. 1
- (ii) the original cost of the machine. 2
- (iii) the value of the TV at the end of the third year. 2

## SECTION E

(All questions are compulsory. In case of internal choice, attempt any one question only)

### 36. CASE STUDY – I:

Student Arav is running on a playground along the curve given by  $2y = 3x + 6$ . Another student, Nisha, is standing at the point (2, 5) on the playground and wants to hit Arav with a paper ball when he is nearest to her.

Based on the above information, answer the following questions:

- (i) Let at any instant while running along the curve  $2y = 3x + 6$ . Arav's position be  $(x, y)$ . Find the expression for the distance D between Arav and Nisha in terms of x. 1
  - (ii) Find the critical point(s) of the distance function. 1
  - (iii) What is the distance between Arav and Nisha when they are at least distance from each other? 2
- OR
- (iv) Find the position of Arav when he is closest to Nisha. 2

### 37. CASE STUDY – II:

Equated Monthly Installments (EMI) consists of two key elements:

1. The interest charged on the outstanding loan amount
2. The portion of the principal being repaid

Calculation Methods for EMI:

1. Flat Rate Method: The interest is calculated on the original loan amount throughout the tenure.
2. Reducing Balance Method: The interest is calculated on the outstanding balance, which decreases as the loan is repaid.

Riya has taken a loan of ₹1,800,000 to purchase a car. She made an initial down payment of ₹300,000, which leaves her with a balance of ₹1,500,000 to be financed. Riya plans to repay this amount over a period of 5 years through monthly installments. The loan has an annual interest rate of 10%, compounded monthly. You are provided with the value  $(1.00833)^{-60} \approx 0.5506$ . Based on the above information, answer the following questions:

- (i) Calculate the total number of monthly payments Riya will make and find the effective monthly interest rate. 1
  - (ii) Using the reducing balance method, determine the amount of each monthly installment. 2
- OR
- (iii) Using the flat rate method, calculate the monthly installment amount. 2
  - (iv) Based on the method selected in part (37(ii)), compute the total interest paid over the life of the loan. 1

### (38) CASE STUDY – III:

There are two factories located one at P and the other at place Q. From these locations, a certain commodity is to be delivered to each of the three depots situated at A, B and C. The weekly requirements of the depots are respectively 5, 5 and 4 units of the commodity while the production capacity of the factories at P and Q are respectively 8 and 6 units. The cost of transportation per unit is given below:

From \ To	Cost (in ₹)		
	A	B	C
P	160	100	150
Q	100	120	100

Based on the above information, answer the following questions:

- (i) Formulate the objective function and the constraints for this Linear Programming problem. 2
- (ii) How many units should be transported from each factory to each depot in order that the transportation cost is minimum. What will be the minimum transportation cost? 2

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