

**SECTION A [30 MARKS]**  
**ANSWER ALL QUESTION**

**Question 1**

**[30]**

**Direction: For each question, there are FOUR responses: A, B, C and D. Choose the corresponding letter of your response and CIRCLE it neatly. NO score will be awarded if you circle more than ONE letter.**

i. The additive inverse of the matrix  $\begin{bmatrix} -3 & 2 \\ 5 & -4 \end{bmatrix}$  is

A  $\begin{bmatrix} -4 & -2 \\ -1 & -3 \end{bmatrix}$ .

B  $\begin{bmatrix} 3 & -2 \\ -5 & 4 \end{bmatrix}$ .

C  $\frac{1}{2} \begin{bmatrix} -4 & 5 \\ 2 & -3 \end{bmatrix}$ .

D  $\frac{1}{2} \begin{bmatrix} -4 & -2 \\ -5 & -3 \end{bmatrix}$ .

ii. Which of the following is the derivative of  $1 + \frac{1}{x}$ ?

A  $x$

B  $x^2$

C  $-\frac{1}{x}$

D  $-\frac{1}{x^2}$

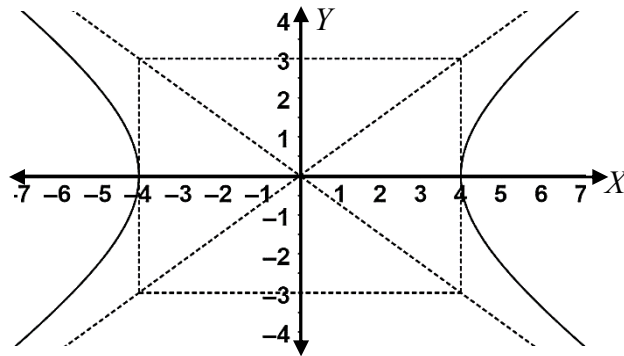
iii. The eccentricity of the given conic section is

A  $\frac{7}{16}$ .

B  $\frac{\sqrt{7}}{4}$ .

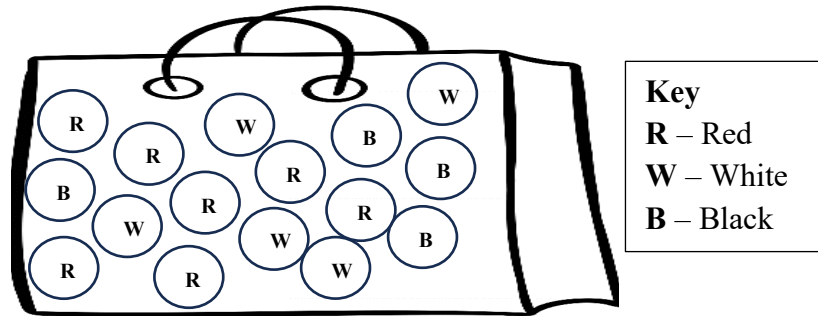
C  $\frac{5}{4}$ .

D  $\frac{25}{16}$ .



- iv. A bag contains identical balls of different colours. When you draw two balls, one after another randomly without replacement, you will win a prize at each draw if the ball drawn is black. What is the probability of winning at least one prize?

- A 0.25  
 B 0.45  
 C 0.67  
 D 0.95



- v. The following table depicts the information related to loan products.

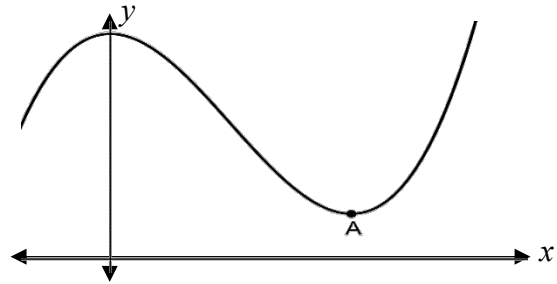
Loan Products	Fixed Rate	Floating Rate	Max tenure (years)
Consumer Loan	11.00%	9.50%	5
Personal Loan	15.00%	13.50%	5
Manufacturing & Industry	12.75%	11.50%	20

An entrepreneur has taken the “Manufacturing & Industry” loan and is paying back Nu 11,538.12 per month. If the loan was availed at the fixed interest rate, what was the sum borrowed?

- A Nu 12,770,242  
 B Nu 12,635,984  
 C Nu 1,085,940  
 D Nu 1,000,000
- vi. A store owner purchased a washing machine for Nu 5,000. In order to attract customers, the owner offered a discount of 20% on the marked price. However, the owner wants to make a profit of 50% on the sale. What price should he mark on the washing machine to achieve this goal?
- A Nu 9,375  
 B Nu 7,500  
 C Nu 6,000  
 D Nu 2,000

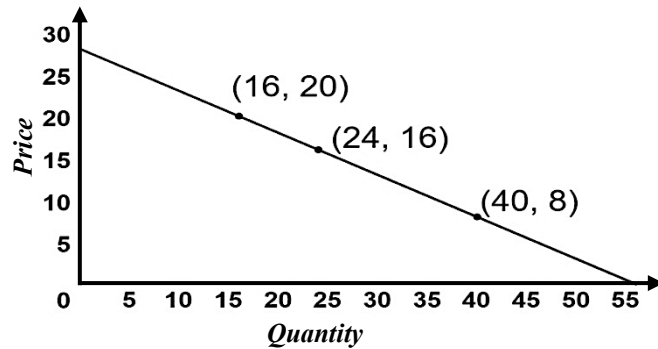
- vii. The equation of the given curve is  $y = x^3 - 3x^2 + 5$ . Find the coordinates of the point A.

- A (2, 1)  
 B (3, 1)  
 C (4, 2)  
 D (5, 2)

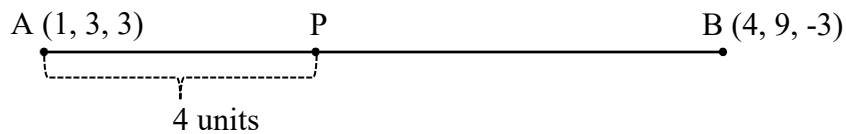


- viii. A manufacturing firm aims to analyse the relationship between the demand for their commodity and its corresponding price. They have access to a demand curve which is provided below. The demand function of the commodity is

- A  $p = 28 - 2x$ .  
 B  $p = -8 - 2x$ .  
 C  $p = 28 - 0.5x$ .  
 D  $p = 8 - 0.5x$ .



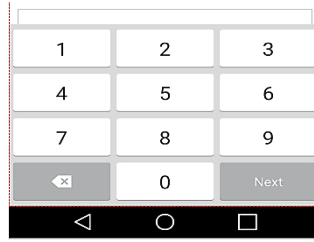
- ix. Find the distance between the points P and B in the following diagram.



- A 9 units  
 B 5 units  
 C 4 units  
 D 2 units
- x. Two regression lines of a certain data were found to be  $7x - 11y + 6 = 0$  and  $2x - 3y + 1 = 0$ . Evaluate the value of  $y$  for  $x = 18$ .
- A 12.5  
 B 12.4  
 C 12.3  
 D 12.0

- xi. From the digits shown in the phone keypad, find the number of four-digit passwords that can be formed without digits being repeated.

- A 5040  
 B 4536  
 C 3024  
 D 2688

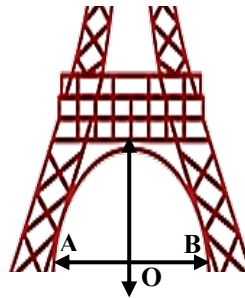


- xii. Find the anti-derivative of  $\sqrt{x} - \frac{1}{\sqrt{2x}}$ .

- A  $\frac{1}{2\sqrt{x}} + \frac{1}{\sqrt{8x^{3/2}}} + c$   
 B  $\frac{3}{2}x^{3/2} - 2\sqrt{x} + c$   
 C  $\frac{2}{3}x^{3/2} - \sqrt{2x} + c$   
 D  $\frac{1}{\sqrt{2x}} + \frac{1}{2\sqrt{2x^{3/2}}} + c$

- xiii. Two engineering students have designed a model of a tower as shown below. The arch of the model was drawn using the equation  $8x^2 + 2y^2 = 800$ . Find the width of the arch from points A to B.

- A 10 units  
 B 20 units  
 C 30 units  
 D 40 units



- xiv. The correlation coefficient between the marks of Accountancy and Business Mathematics is  $\frac{2}{3}$ . If the sum of the squares of the differences in ranks is 55, how many marks of each subject were taken to find the correlation?

- A 12  
 B 11  
 C 10  
 D 9

xv. A company decides to save Nu 200,000 from its profit at the end of each year in a bank which pays compound interest at 6% p.a. The total savings accumulated at the end of 10 years is

A Nu 58,107,290.

B Nu 36,317,050.

C Nu 2,794,330.

D Nu 2,636,160.

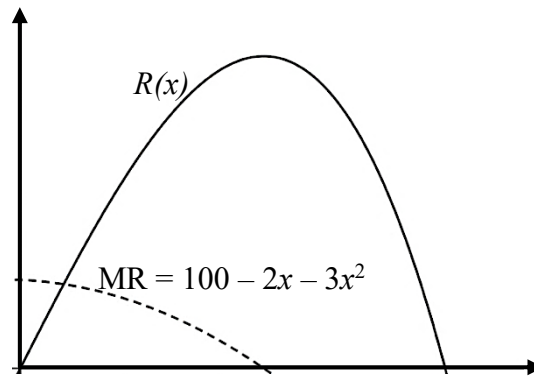
**SECTION B [70 MARKS]**  
**ATTEMPT ANY TEN QUESTIONS**

**Question 2**

a) Find a  $2 \times 2$  matrix  $P$  such that  $P \begin{bmatrix} 3 & -4 \\ 2 & 1 \end{bmatrix} = \begin{bmatrix} 11 & 0 \\ 0 & 11 \end{bmatrix}$ . **[3]**

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- b) In the given graph, the dotted curve represents the marginal revenue function, and the solid curve represents the total revenue function.



- i. Determine the equation of the solid curve.

[2]

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- ii. Determine the demand function and the price when  $x = 5$ .

[2]

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**Question 3**

- a) *As part of the Druk Gyalpo's Relief Kidu to address the challenges posed by the COVID-19 pandemic, loans approved prior to April 2020 were provided with deferred payments and complete interest waiver. Loans approved after April 2020 had the option of deferring payments, but without an interest waiver.*

Dawa obtained a loan on 26<sup>th</sup> May, 2020, at an interest rate of 9% p.a., and decided to defer the loan for one year. The monthly instalment was Nu 5,000.

- i. Find the total amount to be paid at the end of one year to bring the loan up to date.

**[1.5]**

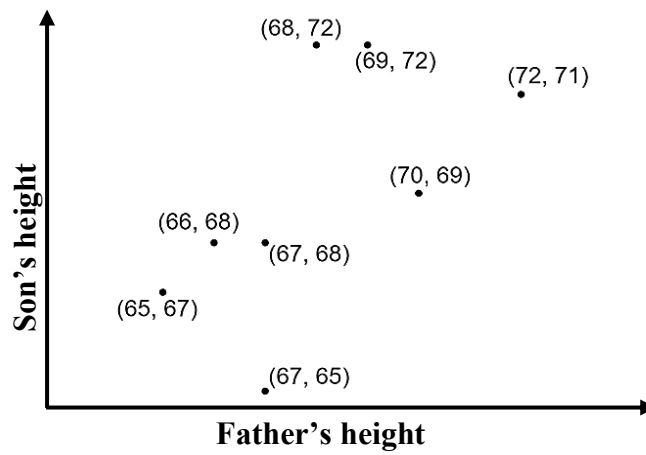
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- ii. If the tenure of the loan was for 5 years, what was the sum of loan sanctioned?

**[1.5]**

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- b) The heights of fathers and their sons were measured in inches, and represented in the scatter plot shown below. Find rank correlation coefficient between the heights of the fathers and sons. [4]

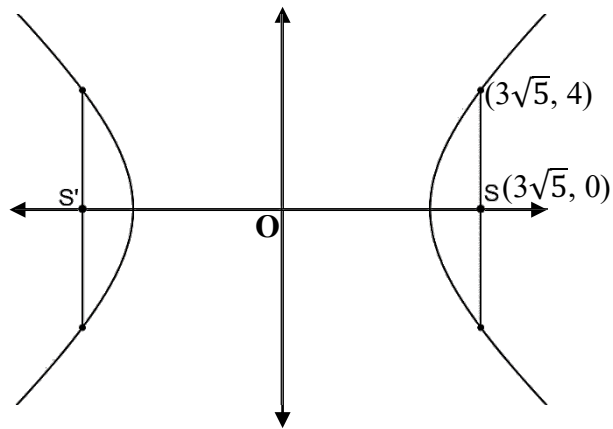


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**Question 4**

a) Find the equation of the conic section given.

**[3]**



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b) Solve the system of equations using matrix method.

[4]

$$x + y + z = 6$$

$$x + 2y + 3z = 14$$

$$x + 4y + 7z = 30$$

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**Question 5**

a) If  $\sqrt{\frac{y}{x}} + \sqrt{\frac{x}{y}} = 4$ , show that  $\frac{dy}{dx} = \frac{7y-x}{y-7x}$ .

**[3]**

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b) *Ema-datshi* is prepared using the following ingredients:



**Datshi**



**Chilies**



**Tomato**



**Oil**



**Coriander**



**Garlic**

While preparing *Ema-datshi*, find the number of ways you can add the ingredients if:

i. coriander has to be always added at the end.

[1]

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ii. coriander is always added after *datshi*.

[1]

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iii. oil, *datshi* and coriander cannot be added at the same time.

[2]

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**Question 6**

a) For a house-warming party, the host who is a male, invited 8 friends, comprising 3 males and 5 females. He arranged a circular table for them to be seated during the party.

i. Find the probability that the host will always be seated with one particular female friend. **[1.5]**

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ii. If two of them are randomly chosen to sing, what is the probability that the singers will be a male and a female? **[1.5]**

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b) Evaluate:  $\int \frac{6x+15}{\sqrt{3x+8}} dx$ .

[4]

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**Question 7**

a) Find  $n$  for each:

i.  ${}^4P_2 = n {}^4C_2$

[1.5]

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ii.  $P(n, 6) = 3P(n, 5)$

[1.5]

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[4]

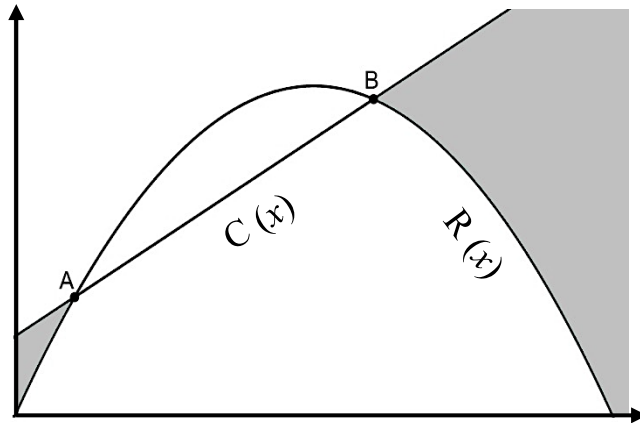
b) Find  $\frac{d^2y}{dx^2}$  of  $y = x\sqrt{x-2}$ .

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**Question 8**

- a) The total cost function and the total revenue function of a certain company are represented in the graph below.

[3]



Fill the table with appropriate terms associated with the graph.

i) Points A and B	.....
ii) The area between the two graphs from points A to B	.....
iii) The shaded areas	.....

- b) Dopphu claims that if we plot the points  $(4, 7, 8)$ ,  $(2, 3, 4)$ ,  $(-1, -2, 1)$  and  $(1, 2, 5)$  in 3-D coordinate system, the joining of the points will form a parallelogram. Verify the claim.

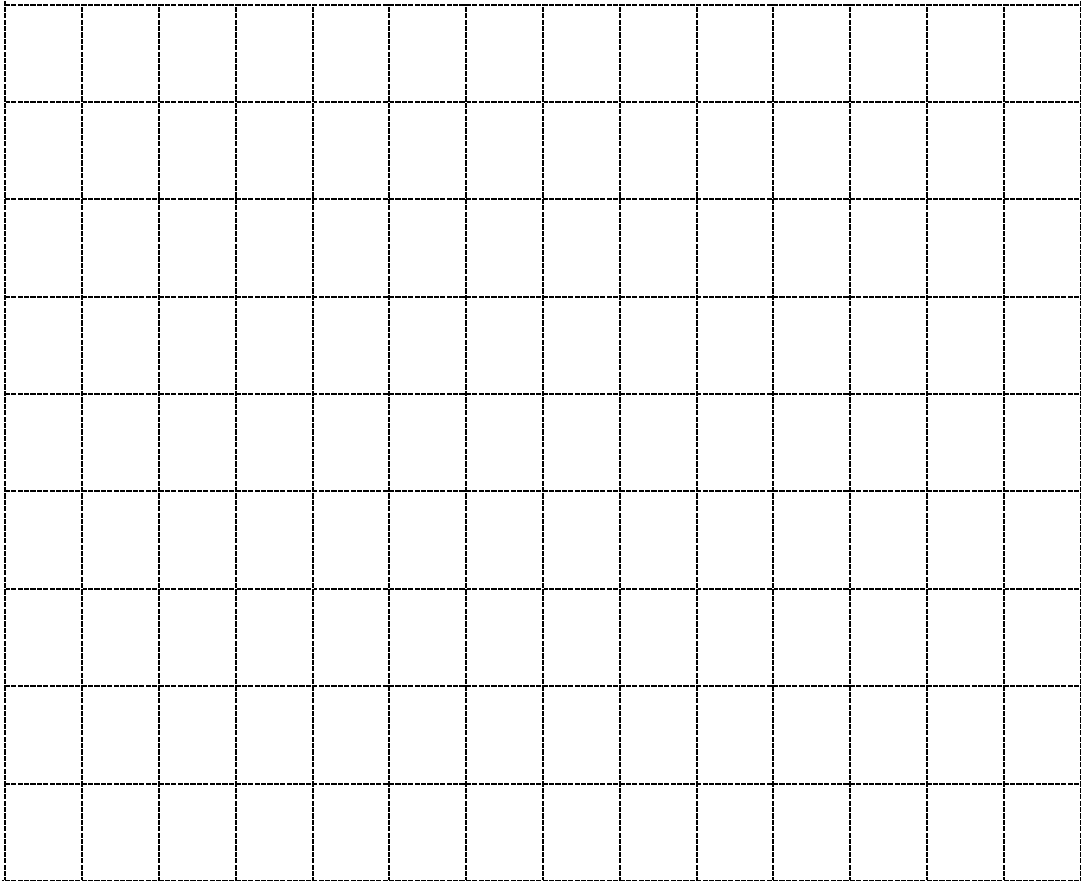
[4]

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**Question 9**

**[3]**

- a) The equation of conic section is  $y^2 + 6x = 0$ . Graph the conic section, and show its focus, directrix and the equation of directrix.



b) The selection process for certain scholarships involves ranking students according to their academic marks and interview scores. The table provided below is the ranking of six students who got selected in the scholarships. Determine the line of regression of  $x$  on  $y$ .

<b>Academic (70%): <math>x</math></b>	57	56	56	54	54	53
<b>Interview (30%): <math>y</math></b>	21	20	22	18	20	19

**Question 10**

- a) The sum of two positive real numbers is 20.5, and the sum of their squares is minimum. Determine the numbers.

**[3]**

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- b) A young entrepreneur who wishes to start a new business venture obtained a loan of Nu 400,950 from a bank under the condition of repaying it with compound interest at 6% p.a. The repayment plan requires making annual instalments of Nu 150,000 each. Determine the number of payments the entrepreneur must make in order to settle the debt.

[4]

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**Question 11**

- a) A businessman accepted a bill of Nu 1,500,000 on November 4, 2023, which was payable after 3 months. The drawer discounted the bill on November 20, 2023 from a bill broker at 6.5% p.a. Compute the amount the drawer got from the bill broker.

**[3]**

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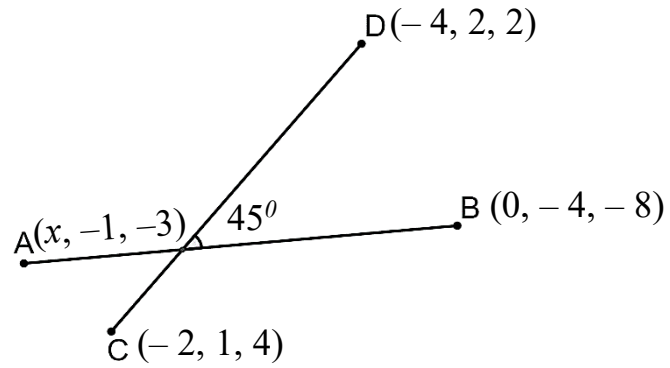
b) Evaluate:  $\int \frac{x-1}{(x+1)(x^2+1)} dx$

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**Question 12**

a) Find the value of  $x$  in the diagram.

**[3]**



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b) In a certain town, it is observed that 85% of the population speaks *Dzongkha*, 40% speaks *Tshangla*, and 20% speaks *Khengkha*. Furthermore, 32% of the population can speak both *Tshangla* and *Dzongkha*, while 13% can speak *Dzongkha* and *Khengkha*, and 10% can speak *Tshangla* and *Khengkha*.

i. If a person is selected randomly from the town, what is the probability of the person speaking all the three languages?

[2.5]

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ii. If a person is randomly selected who speaks *Khengkha*, what is the probability that the person also speaks *Tshangla*?

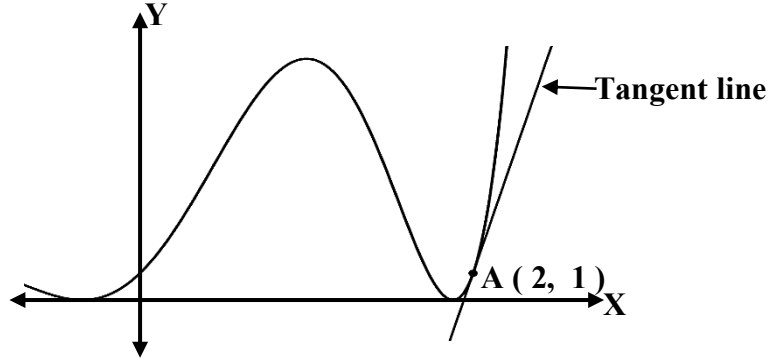
[1.5]

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**Question 13**

- a) Find the slope of the tangent line to the curve at point A if the equation of the curve is  $y = (3x - x^3 + 1)^2$ .

**[3]**



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- b) In BHSEC Mathematics Examination, students must answer 11 out of 13 questions. Find the number of choices a student has if:

- i. the first question is compulsory.

**[1]**

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ii. they have to answer at least five questions from the first six questions.

[1.5]

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iii. they have to answer exactly two questions from the last three questions.

[1.5]

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## Formulae

### Strand A: Numbers and Operations

$${}^n P_r = \frac{n!}{(n-r)!}$$

$${}^n C_r = \frac{n!}{r!(n-r)!}$$

$$C_{ij} = (-1)^{i+j} M_{ij}$$

$$A A^{-1} = A^{-1} A = I$$

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

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

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

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

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

$$\text{Present worth}(P) = \frac{A}{1+ni}$$

$$\text{True Discount}(D) = A - P = \frac{Ani}{1+ni}$$

$$\text{Banker's Discount}(B.D.) = Ani$$

$$\text{Banker's Gain}(B.G.) = B.D. - T.D$$

$$= \frac{A(ni)^2}{1+ni}$$

$$\text{D.V. of the bill} = B.V. - B.D.$$

### Strand B: Patterns and Algebra

$$a^2 - b^2 = (a+b)(a-b)$$

$$(a \pm b)^2 = a^2 \pm 2ab + b^2$$

In the quadratic equation  $ax^2 + bx + c = 0$ ,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$y = x^n, y' = nx^{n-1}$$

$$\text{If } y = u \pm v, \text{ then } \frac{dy}{dx} = \frac{du}{dx} \pm \frac{dv}{dx}$$

$$\text{If } y = uv, \text{ then } \frac{dy}{dx} = u \frac{dv}{dx} + v \frac{du}{dx}$$

$$\text{If } y = \frac{u}{v}, \text{ then } \frac{dy}{dx} = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$$

$$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$$

$$\int x^n dx = \frac{x^{n+1}}{n+1} + c$$

$$C(x) = F + V(x), A(x) = \frac{C(x)}{x}$$

$$R(x) = p \cdot x, P(x) = R(x) - C(x)$$

$$MC = \frac{d}{dx}(C(x)), MR = \frac{d}{dx}(R(x))$$

$$C = C(x) = \int MC dx + k$$

$$R = R(x) = \int MR dx + k$$

**Strand C: Measurement  
&  
Strand D: Geometry**

$$SP = ePM$$

$$\Rightarrow \sqrt{(x-\alpha)^2 + (y-\beta)^2} = \left| \frac{ax+by+c}{\sqrt{a^2+b^2}} \right|$$

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

$$(x, y, z) = \left( \frac{m_1x_2 + m_2x_1}{m_1 + m_2}, \frac{m_1y_2 + m_2y_1}{m_1 + m_2}, \frac{m_1z_2 + m_2z_1}{m_1 + m_2} \right)$$

$$a_1x + b_1y + c_1z = 0 \text{ and } a_2x + b_2y + c_2z = 0$$

$$\frac{x}{b_1c_2 - b_2c_1} = \frac{y}{c_1a_2 - c_2a_1} = \frac{z}{a_1b_2 - a_2b_1}$$

Conditions of perpendicularity and parallelism:

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}, \frac{l_1}{l_2} = \frac{m_1}{m_2} = \frac{n_1}{n_2}$$

$$a_1a_2 + b_1b_2 + c_1c_2 = 0, \quad l_1l_2 + m_1m_2 + n_1n_2 = 0$$

$$l = \frac{a}{\sqrt{a^2 + b^2 + c^2}}$$

$$m = \frac{b}{\sqrt{a^2 + b^2 + c^2}}$$

$$n = \frac{c}{\sqrt{a^2 + b^2 + c^2}}$$

Angles between two lines:

$$\cos \theta = \pm \frac{a_1a_2 + b_1b_2 + c_1c_2}{\sqrt{a_1^2 + b_1^2 + c_1^2} \sqrt{a_2^2 + b_2^2 + c_2^2}}$$

$$\cos \theta = l_1l_2 + m_1m_2 + n_1n_2$$

**Strand E: Data Management &  
Probability**

$$\bar{X} = \frac{\sum fx}{\sum f} \text{ or } \bar{X} = \frac{\sum x}{n}$$

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{n\sum x^2 - (\sum x)^2} \sqrt{n\sum y^2 - (\sum y)^2}}$$

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{n\sigma_x \sigma_y}$$

$$r = 1 - \frac{6\sum D^2}{n(n^2 - 1)}$$

$$\text{Correction factor} = \frac{1}{12}(m^3 - m)$$

$$r = \pm \sqrt{b_{xy} \cdot b_{yx}}$$

$$b_{yx} = r \frac{\sigma_y}{\sigma_x} = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$$

$$b_{xy} = r \frac{\sigma_x}{\sigma_y} = \frac{n\sum xy - \sum x \sum y}{n\sum y^2 - (\sum y)^2}$$

$$y - \bar{y} = \frac{\text{cov}(x, y)}{\sigma_x^2} (x - \bar{x}) = r \frac{\sigma_y}{\sigma_x} (x - \bar{x})$$

$$x - \bar{x} = \frac{\text{cov}(x, y)}{\sigma_y^2} (y - \bar{y}) = r \frac{\sigma_x}{\sigma_y} (y - \bar{y})$$

$$b_{xy} = r \frac{\sigma_x}{\sigma_y}, \quad b_{yx} = r \frac{\sigma_y}{\sigma_x}$$

$$y - \bar{y} = b_{yx} (x - \bar{x})$$

$$x - \bar{x} = b_{xy} (y - \bar{y})$$

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

$$P(A) + P(\bar{A}) = 1$$

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

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

## Rough Work

## Rough Work