SECTION A [30 MARKS]

ANSWER **ALL** QUESTIONS

Question 1 **[30]**

For each question, there are four alternatives: A, B, C and D. Choose the correct alternative and circle it. Do not circle more than ONE alternative. If there are more than ONE choice circled, NO score will be awarded.

i) If the present value of an annual perpetuity of Nu 30,000 is Nu 150,000, the rate of interest is

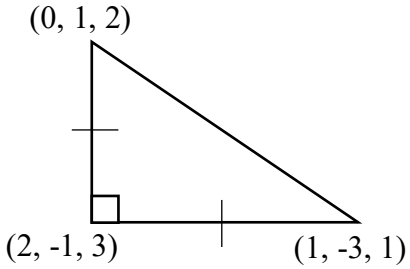
A 2%.
B 5%.
C 20%.
D 500%.

ii) The missing gradient of the function at the point indicated in the given table is

f(*x*)	Coordinate	Gradient
x^3+2x-1	(0, 0)	2
$5x^4+3x^2-2x+1$	(0, 0)	–2
$x(x-1)$	(0, 0)	?

A –2.
B –1.
C 1.
D 2.

iii) Find the area of the given triangle.

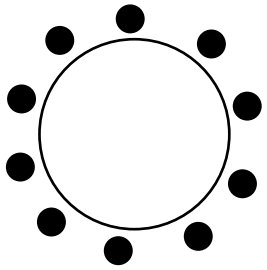


A 3.0 sq. units
B 3.5 sq. units
C 4.0 sq. units
D 4.5 sq. units

iv) The line of regression of English marks (x) and Mathematics marks (y) of a class is found to be $25x - 22y - 4 = 0$. The regression coefficient of Mathematics marks on English marks is

A $\frac{25}{22}$.
B $\frac{22}{25}$.
C $-\frac{22}{25}$.
D $-\frac{25}{22}$.

v) In a school, there are 8 house leaders and 2 school leaders. The sitting arrangement for a meeting is as shown in the diagram. In how many ways can they be seated if the school leaders are always together?



A $10! \times 2!$

B $9! \times 2!$

C $8! \times 2!$

D $7! \times 2!$

vi) If the annual average revenue of a firm from selling x units of a commodity is Nu $\left(36+3x+\frac{5}{x}\right)$, find the total revenue generated from selling 10 units.

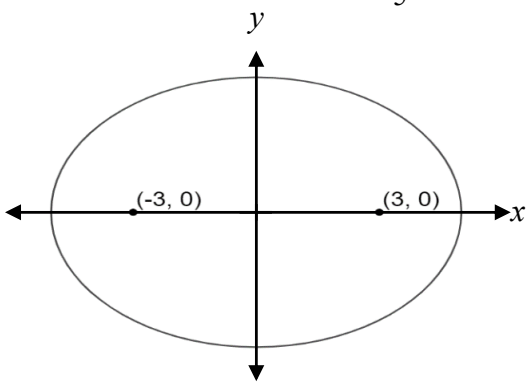
A Nu 660

B Nu 665

C Nu 670

D Nu 675

vii) The equation of the conic section given below with eccentricity $\frac{3}{5}$ is



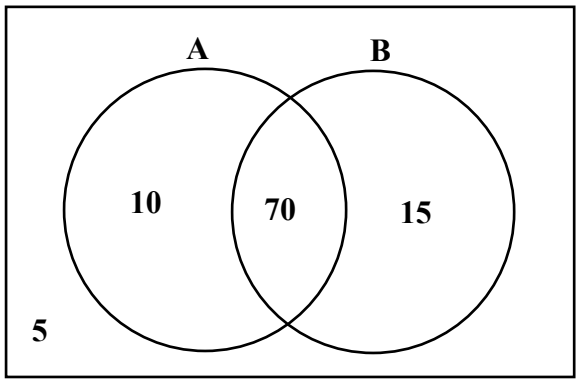
A $\frac{x^2}{25}+\frac{y^2}{16}=1.$

B $\frac{x^2}{25}-\frac{y^2}{16}=1.$

C $\frac{x^2}{16}+\frac{y^2}{25}=1.$

D $\frac{x^2}{16}-\frac{y^2}{25}=1.$

viii) From the given Venn diagram, find $\mathrm{P}(\mathrm{A}/\mathrm{B})$.



A $\frac{1}{8}$

B $\frac{7}{8}$

C $\frac{17}{20}$

D $\frac{14}{17}$

ix) Find the product of $\begin{bmatrix} 2 & 3 \\ -1 & 4 \end{bmatrix}$ and its additive inverse.

A $\begin{bmatrix} 1 & 18 \\ 6 & 13 \end{bmatrix}$

B $\begin{bmatrix} 1 & 18 \\ -6 & 13 \end{bmatrix}$

C $\begin{bmatrix} -1 & -18 \\ 6 & -13 \end{bmatrix}$

D $\begin{bmatrix} -1 & -18 \\ -6 & -13 \end{bmatrix}$

x) Tashi cell company sells voucher at Nu 50 each. The fixed cost for the company is Nu 75,000 and variable costs are estimated to be 25% of the total revenue. Determine the quantity that the company must sell to cover the fixed cost.

A 1000
B 1500
C 2000
D 2500

xi) Calculate the angle between the lines whose direction ratios are 1, 1, 0 and 2, -2, 1.

A 30°
B 45°
C 60°
D 90°

xii) Following are the ranks obtained by 8 students in Accountancy and Commerce subjects. The correction factor for Accountancy subject is

Rank of Accountancy	7	5.5	8	5.5	1.5	1.5	4	3
Rank of Commerce	8	7	5.5	5.5	4	3	2	1

A 0.5.
B 1.0.
C 1.5.
D 2.0.

xiii) Determine the anti-derivative of the function $\sqrt{ax+b}$.

A $\frac{2}{3a}(ax+b)^{\frac{3}{2}}+c$

B $\frac{2}{3a}(ax+b)^{\frac{2}{3}}+c$

C $\frac{2}{3}(ax+b)^{\frac{3}{2}}+c$

D $\frac{2}{3}(ax+b)^{\frac{2}{3}}+c$

xiv) What is the true present worth and the true discount of Nu 1065 due in 21 months at $6\frac{1}{4}$% p.a.?

A Nu 1397; Nu 332

B Nu 909; Nu 116

C Nu 960; Nu 105

D Nu 605; Nu 460

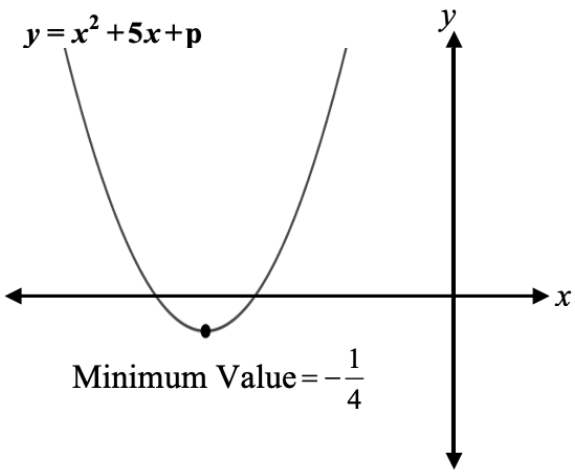
xv) Find the value of p from the given graph.

A 1

B 3

C 4

D 6



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

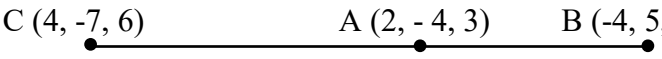
Question 2

a) Solve the system of equations; $2x + y = 1$ and $x - 2y = 8$ using Martin's rule. **[3]**

b) Differentiate $\frac{\sqrt{x^4+1}+\sqrt{x^4-1}}{\sqrt{x^4+1}-\sqrt{x^4-1}}$ w.r.t. x. **[4]**

Question 3

a) Find the ratio in which the point C divides the line segment AB. **[3]**



b) The data given in the table shows the number of Covid-19 cases detected in Phuntsholing daily for 6 days from the community and contacts.

Date	**15/07/21**	**16/07/21**	**17/07/21**	**18/07/21**	**19/07/21**	**20/07/21**
Community	1	0	2	0	2	14
Contacts	30	4	3	5	2	9

i) Find the equation of the line of best fit. **[3.5]**

ii) What would be the probable contact cases if there are 7 community cases? **[0.5]**

Question 4

a) Aum Dema wants to open a simple recurring deposit account in the Bank of Bhutan Limited. The terms and its corresponding interest rate offered by the bank are shown in the table. If she deposits Nu 50,000 yearly, find the balance in her account after 5 years. **[3]**

Term	RD Plus rates	Flexi RD Rates	Simple RD rates
91 days to less than 1 year	4.75%	4.75%	5.00%
1 year to less than 2 years	6.75%	6.75%	7.00%
2 years and above	7.25%	7.25%	7.25%

b) Show that the points (3, -1, 2), (1, 2, -4), (-1, 1, 2) and (1, -2, 8) are the vertices of a parallelogram. **[4]**

Question 5

a) After completing class XII, Yangzom and Yonten are competing for a scholarship. The probability of Yangzom's selection is $\frac{2}{5}$ and that of Yonten's is $\frac{1}{4}$. Find the probability that

i) none of them will be selected. **[1.5]**

ii) at least one of them will be selected. **[1.5]**

b) Decompose $\frac{x}{(x+1)^2(x-1)}$ into partial fraction and integrate. **[4]**

Question 6

a) Calculate Karl Pearson's coefficient of correlation between the values of x and y for the following data. **[3]**

$n=10,\ \sum x=55,\ \sum y=40,\ \sum x^2=385,\ \sum y^2=192$ and $\sum(x+y)^2=947.$

b) On a shelf of a book store, there are 3 books on English, 4 books on Economics and 5 books on Business Mathematics. How many collections can be made, if each collection consists of

i) at least one book on each subject? **[2]**

ii) at most 3 books on each subject? **[2]**

Question 7

a) The equation of a conic section is $2x^2 - 3y^2 = 15$. Find its eccentricity and the equation of transverse axis. **[3]**

b) Passang divided Nu 64 between two grandchildren such that the sum of the squares of their amount is minimum. Find the amount each grandchild received. **[4]**

Question 8

a) Find the length of the medians of the triangle whose vertices are A (2, -3, 1), B (-6, 5, 3), and C (8, 7, -7). **[3]**

b) Pema wants to start a business. He approached a wholesaler and drew a bill of Nu 200,000 on 5th May, 2021 for 4 months. On 20th June, 2021, the wholesaler discounted the bill from Tashi Bank to purchase the shares announced by Royal Securities Exchange of Bhutan (RSEB). Find the banker's discount, true discount and the amount the wholesaler received from the bank if the rate of interest is 10% p.a. **[4]**

Question 9

a) The correlation coefficient between x and y is 0.60. If the variance of $x = 225$, the variance of $y = 400$, mean of $x = 10$ and mean of $y = 20$, find the equation of the regression lines of y on x and x on y. **[3]**

b) Dodo shoe manufacturer has determined that the marginal cost function of manufacturing x number of shoes as $6+10x-6x^2$. The cost of producing a pair of shoes is Nu 100. Find the total cost and average cost function. **[4]**

Question 10

a) The coefficient of rank correlation of marks obtained by the top 10 contestants of Voice of Bhutan in Boedra and Zhungdra was found to be 0.65. It was later discovered that the difference in ranks in Boedra and Zhungdra obtained by one of the contestants was wrongly taken as 4 instead of 8. Find the correct coefficient of rank correlation. **[3]**

b) Dawa Tashi, a civil servant, retires at the age of 58 years. The National Pension and Provident Fund (NPPF) gives him a pension of Nu 14,000 monthly for the rest of his life. Instead of receiving his pension on a monthly basis, he wants to claim his pension in a single sum. Reckoning his expected age to be 75 years and the rate of interest at 9% p.a. payable monthly, determine the single sum received by him. **[4]**

Question 11

a) Find the direction ratios of the line which is perpendicular to the lines with direction cosines proportional to 1, -2, -2; 0, 2, 1. **[3]**

b) If $x\sqrt{1+y}+y\sqrt{1+x}=0$, prove that $\frac{dy}{dx}=-\frac{1}{(x+1)^2}$. **[4]**

Question 12

a) Your school library received 10 different books from one of the book stores. In how many ways can the school librarian arrange these books on a shelf such that

i) two books are always together? **[1.5]**

ii) two books are always separated? **[1.5]**

b) A tailoring firm wants to start producing face masks. The firm observes that it needs to invest Nu 75,000 for training the tailors. The cost of setting up machines is Nu 125,000 and the cost of producing one face mask is Nu 20. If the firm can sell each item at Nu 60, find

i) the total cost of producing x number of face masks. **[2]**

ii) the break-even point. **[2]**

Question 13

a) Evaluate: $\int \frac{x^2}{\sqrt{x+1}}\, dx$ **[3]**

b) For the matrix $A = \begin{bmatrix} -8 & 5 \\ 2 & 4 \end{bmatrix}$, find x and y so that $A^2 + xI = yA$. Hence obtain A^{-1}. **[4]**

FORMULAE

Strand A: Numbers and Operations

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 $ax^{2} + bx + c = 0$,

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

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

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

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

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

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

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

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

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

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

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

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

Strand C: Measurement & Strand D: Geometry

$$|SP| = e|PM|$$

$$\Rightarrow \sqrt{(x-x_1)^2+(y-y_2)^2} = \left|\frac{ax+by+c}{\sqrt{a^2+b^2}}\right|$$

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

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

If $a_1x+b_1y+c_1z=0$ and $a_2x+b_2y+c_2z=0$, then

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

Conditions of perpendicularity and parallelism:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Rough Work

Rough Work