SECTION A [30 MARKS]
ANSWER ALL QUESTIONS

Question 1 **[30]**

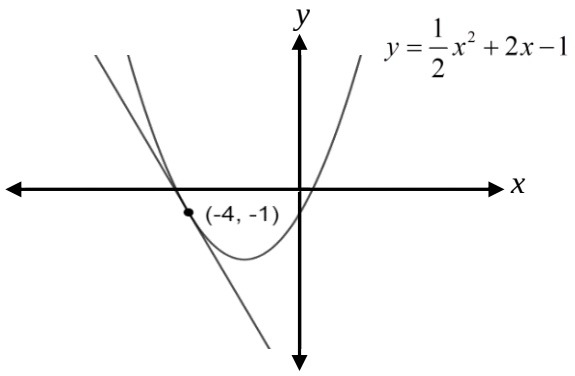
For each question, there are four alternatives: A, B, C and D. Choose the correct alternative and circle it. Do not circle more than ONE alternative. If there is more than ONE choice circled, NO score will be awarded.

i) If $A=\begin{bmatrix} 2 & -3 & -5 \\ -1 & 4 & -1 \\ -3 & -4 & -1 \end{bmatrix}$, then the cofactor of A_{32} is

A $17.$
B $7.$
C $-7.$
D $-17.$

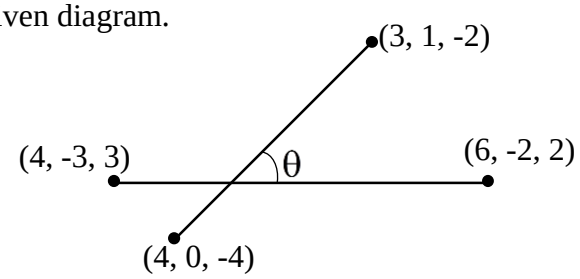
ii) From the given graph find the slope of the tangent line at the point indicated.

A 17
B 1
C –2
D –6



iii) Find the angle θ from the given diagram.

A 15°
B 30°
C 45°
D 60°



iv) Bhutan Lottery Limited has the following number of tickets. If two tickets are drawn simultaneously, what is the probability that both the tickets drawn are prime number?

A $\frac{3}{25}$

B $\frac{3}{20}$

C $\frac{9}{25}$

D $\frac{9}{20}$

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

v) A phone store marked the price of a phone at Nu 95,000 and is available at a discount of 10%. During Thimphu *tshechu*, he offers further discount and sells at Nu 80,000. What is the further discount?

A 5.8%

B 6.4%

C 6.9%

D 10.0%

vi) If $f'(x) = 3x^2 - \frac{2}{x^3}$ and $f(2) = \frac{1}{4}$, find $f(x)$.

A $x^3 - \frac{1}{x^2} + 8$

B $x^3 - \frac{1}{x^2} - 8$

C $x^3 + \frac{1}{x^2} + 8$

D $x^3 + \frac{1}{x^2} - 8$

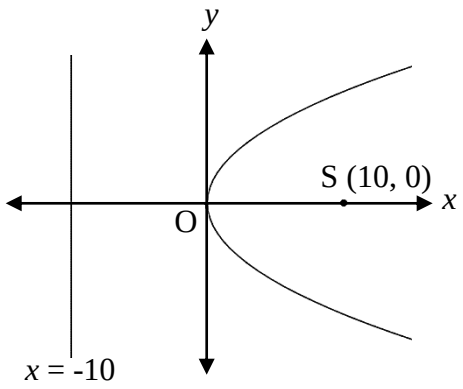
vii) The equation of the given conic section is

A $y^2 = 40x.$

B $x^2 = 40y.$

C $y^2 = -40x.$

D $x^2 = -40y.$



viii) Which is the **TRUE** statement for regression?

A The regression coefficient always lies between 0 and 1.

B The regression coefficient of y on x is b_{xy} and x on y is b_{yx}.

C The point of intersection of two lines of regression is $(\bar{x}, \bar{y})$.

D The correlation coefficient and the two-regression coefficient have different signs.

ix) In how many ways can the letters of the word **CORONA** be arranged such that two O's do not occur together?

A 240 ways

B 300 ways

C 600 ways

D 720 ways

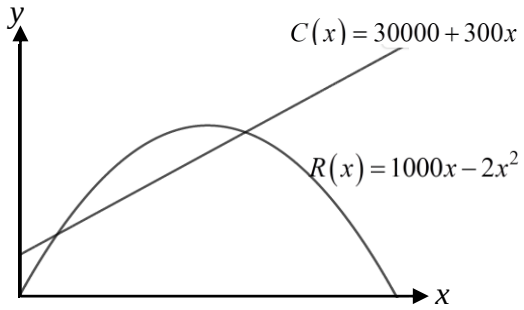
x) The given graph shows the cost incurred for producing x bottles of olive oil and the revenue generated from selling x bottles. Find the number of bottles the company must sell in order to attain neither profit nor loss.

A 50 and 300

B 50 and 500

C 100 and 300

D 100 and 500



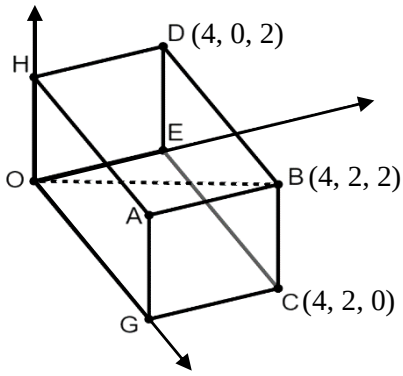
xi) Calculate the length of the diagonal OB of the given rectangular prism.

A $2\sqrt{5}$ units

B $2\sqrt{6}$ units

C $4\sqrt{5}$ units

D $4\sqrt{6}$ units



xii) Determine the regression coefficient of 'y on x' if the regression coefficient of 'x on y' is 0.8 and the correlation coefficient between x and y is 0.6.

A -0.45

B -0.36

C 0.36

D 0.45

xiii) In a football final match, 22 players along with 3 officials and 1 chief guest shake hands with each other before the start of the match. The total number of handshakes is

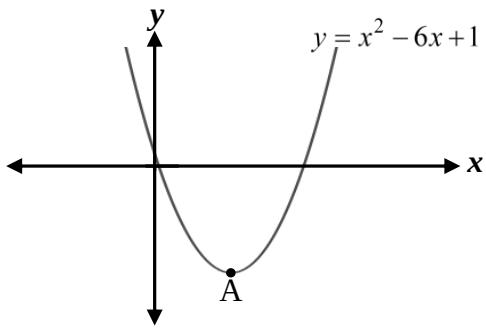
A 13.
B 26.
C 325.
D 650.

xiv) Loden Foundation deposited Nu 1,500,000 in a Bank to create a scholarship fund. If the bank pays compound interest of 8% p.a., calculate the yearly scholarship amount.

A Nu 12,000
B Nu 18,750
C Nu 120,000
D Nu 187,500

xv) Find the coordinates of point A for the given graph.

A $(-3, -8)$
B $(-3, 8)$
C $(3, 8)$
D $(3, -8)$

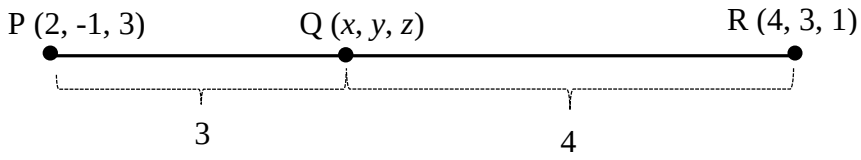


SECTION B [70 MARKS]

ATTEMPT **ANY TEN** QUESTIONS

Question 2

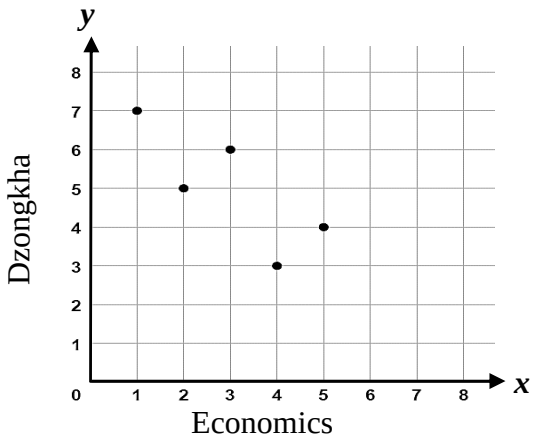
a) Find the coordinates of the point Q of the given collinear points. **[3]**



b) Rigsar Construction Private Limited has a bulldozer costing Nu 7 million that has an effective life of 10 years, and its scrap value Nu 250,000. What amount should the company put into a sinking fund annually earning 8.5% p.a. so that it can replace the machine after its effective life? Assume that a new bulldozer will cost Nu 7.5 million after 10 years. **[4]**

Question 3

a) The given scatter plot shows the marks obtained by five students in Dzongkha and Economics in a class test. Find the coefficient of correlation between the two subjects. **[3]**



b) The total cost of producing *x bangchung* sets per day is Nu $\left(\frac{1}{4}x^2+35x+25\right)$ and the price per set at which they may be sold is Nu $\left(50-\frac{1}{2}x\right)$. What should be the daily output to maximize the total profit?

[4]

Question 4

a) If $A = \begin{bmatrix} 1 & -2 \\ 3 & 4 \end{bmatrix}$, find the value of $|A|I$ without finding $|A|$. **[3]**

b) If $y = x + \cfrac{1}{x + \cfrac{1}{x + \cfrac{1}{x + \cfrac{1}{x + \ldots \infty}}}}$, prove that $\frac{dy}{dx} = \frac{y^2}{y^2 + 1}$. **[4]**

Question 5

a) Kalden purchased a second-hand car which costs Nu 450,000. The sum was borrowed from a bank with an interest of 8.5% p.a. If she pays Nu 9,233 at the end of every month, find the number of instalments she will have to pay to clear her loan. **[3]**

b) Differentiate $\frac{1}{\sqrt{2x+3}-\sqrt{2x+1}}$ w.r.t x. **[4]**

Question 6

a) Integrate: $\int \frac{(x+2)(4x^2-5)}{x} dx$ **[3]**

b) A shopkeeper in Mongar placed an order of 3 laptops from *Zala* online store. The *Zala* online store has 4 buses to post the laptops.

i. In how many ways can the store post 3 laptops through 4 buses travelling to Mongar from Thimphu? **[2]**

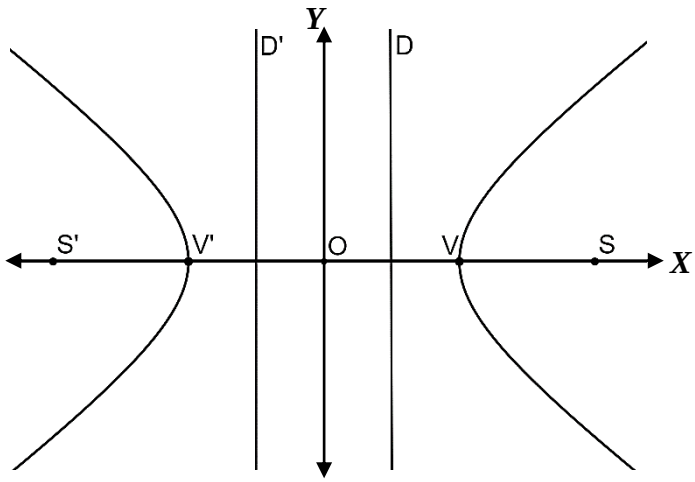
ii. In how many ways can the store post, if all the 3 laptops are not posted through the same bus? **[2]**

Question 7

a) During summer vacation, your school cultural coordinator hosted a talent show. Following are the scores of seven participants given by the two judges. Calculate the rank coefficient of correlation between the two judges. **[3]**

Judge I:	97	92	78	83	88	79	73
Judge II:	85	96	91	90	84	87	74

b) Find the labelled parts of the given conic section described by $9x^2 - 16y^2 = 144$. **[4]**



Question 8

a) If the coordinates of A and B are $(2, 3, 4)$ and $(1, -2, 1)$ respectively, prove that OA is perpendicular to OB, where O is the origin. **[3]**

b) Nado Poizokhang's marginal revenue function for x output is $MR = 20 - 5x + 3x^2$. Find the total revenue function and hence the demand function of the firm. Also calculate the price per unit when 50 units are demanded. **[4]**

Question 9

a) A bill broker discounted a certain amount of bill which was due 6 months hence at the interest rate of 10% p.a. If the Banker's Gain was Nu 10, what was the face value of the bill? **[2]**

b) Kinley has 20 *beytrangs* (antique silver coins) and wants to divide between his son and daughter. He divided in such a way that the product of the square of the number of *beytrangs* received by the son and the cube of the number of *beytrangs* received by his daughter is maximum. Find the number of *beytrangs* each child received. **[5]**

Question 10

a) An arch of a bridge is in the shape of a horizontal semi-ellipse. Its highest is 8 m, while its length is 18 m. Write the equation of the arch with its centre at the origin. **[3]**

b) Evaluate: $\int \frac{4x^3 - 4x^2 - x + 3}{2x^2 + x - 1} dx$ **[4]**

Question 11

a) Yeshi speaks the truth in 75% of the cases and Wangmo in 50% of the cases. In what percentage of cases are they likely to contradict each other in narrating the same point? **[3]**

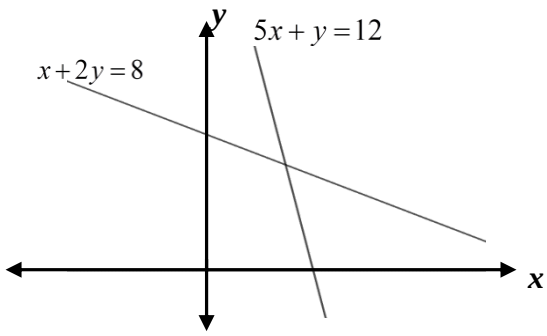
b) Sangay purchased a Power Tiller paying Nu 100,000 and promised to pay Nu 5,000 every 3 months for the next 9 years. The interest rate is 8% p.a. converted quarterly.

i. What is the cash value of the Power Tiller?

ii. If Sangay misses the first 4 payments due to pandemic, how much should he pay at the time of 5^{th} payment to update his payment. **[4]**

Question 12

a) From the given graph, find: **[3]**



i. $\bar{x}$ and $\bar{y}$

ii. b_{yx} and b_{xy}

b) Esha ordered mobile phones from a wholesaler in Thimphu to start a gadget shop. She accepted a bill for Nu 300,000 on 17th December, 2021 which was payable five months after sight. On 7th March, 2022, the wholesaler needed to restock his store and discounted the bill from a broker at 9% p.a. Find the amount the broker gave to the wholesaler. **[4]**

Question 13

a) Sherab was assigned an activity to find the correlation coefficient between the scores of 12 students in English (x) and Dzongkha (y) by his Mathematics teacher. The following calculations were made:

$\sum x = 30, \sum y = 5, \sum x^2 = 670, \sum y^2 = 285, \sum xy = 334.$

Later when his teacher verified, it was found that the score for English was taken as 11 instead of 10 and 4 instead of 14 for Dzongkha. Find the correct value of correlation coefficient. **[3]**

b) Check the consistency of the given system of equation and hence, find the solutions. **[4]**

$$5x - y = 7,$$
$$15x - 3y = 21$$

FORMULAE

Strand A: Numbers and Operations

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Strand C: Measurement & Strand D: Geometry

$SP = ePM$

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

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

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

$a_1x+b_1y+c_1z=0$ *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:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Rough Work

Rough Work