

SECTION A [30 MARKS]
ANSWER ALL THE QUESTIONS

Question 1

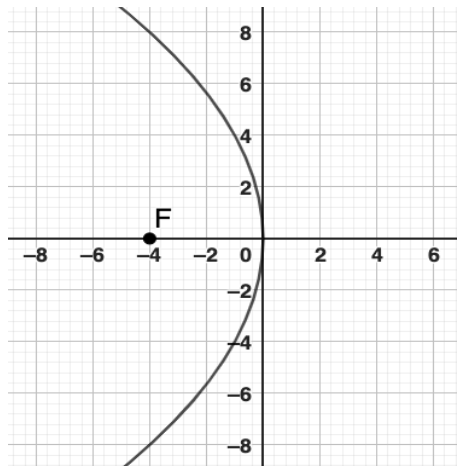
[30]

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. A banker's discount and gain of a bill are Nu 345 and Nu 234 respectively. Find the true discount.

A 79
B 111
C 121
D 579

- ii. From the graph, find the equation of the directrix.

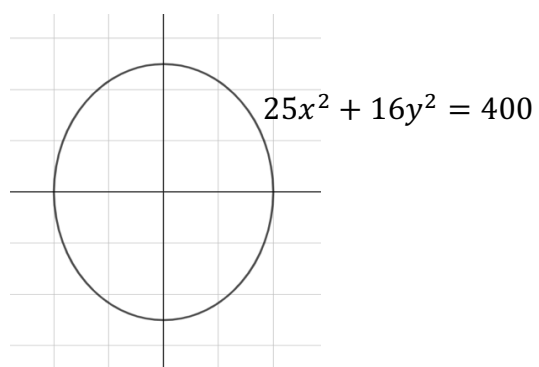


A $x - 4 = 0$
B $x + 4 = 0$
C $y - 4 = 0$
D $y + 4 = 0$

- iii. Bhutan Lottery Limited wants to launch a new online game to generate 4-digit serial number with the digits 0, 1, 3, 4, 5, 7, 8. How many 4-digit different even numbers can be formed when repetition of the digits is allowed?

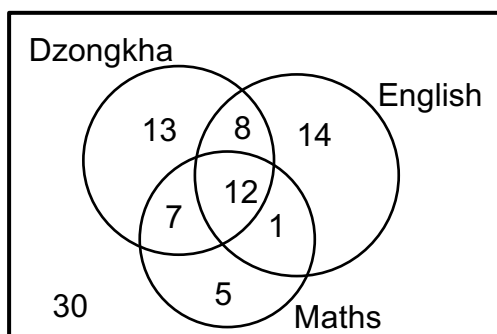
A 588 ways
B 686 ways
C 882 ways
D 1029 ways

- iv. Using the given diagram, find the eccentricity.



- A $\frac{\sqrt{41}}{4}$
- B $\frac{\sqrt{41}}{5}$
- C $\frac{3}{5}$
- D $\frac{4}{5}$

- v. Find the probability that a randomly chosen student studied only one of the subjects.



- A 0.05
- B 0.13
- C 0.14
- D 0.32

vi. Integrate: $\int \frac{3x-2}{(3x^2+x-2)} dx$

- A $\frac{x^2}{2} + x + c$
- B $\frac{x^2}{2} - x + c$
- C $\log|x + 1| + c$
- D $\frac{1}{\log}|x + 1| + c$

vii. Mr. Karma Rangdrol wishes to create a fund to provide a cash prize of Nu 1953 for the first rank holder in RCSC preliminary examinations every year. If the fund is invested at 4% p.a. compound interest, the amount invested is

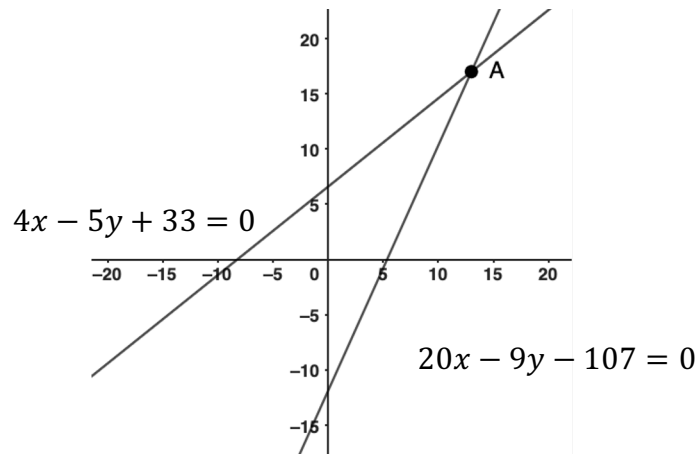
- A Nu 3126.81.
- B Nu 18,329.04.
- C Nu 29,345.39.
- D Nu 48,825.00.

viii. The correct pairs from the following table are

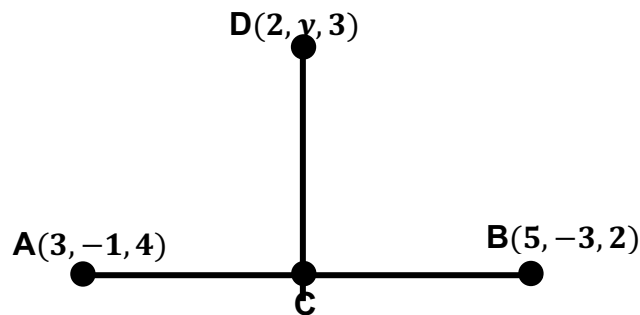
Conditions	Turning points
I. $\frac{d^2y}{dx^2} > 0$	a. Point of inflexion
II. $\frac{d^2y}{dx^2} < 0$	b. Maximum point
III. $\frac{d^3y}{dx^3} \neq 0$	c. Minimum point

- A I $\rightarrow$ c, II $\rightarrow$ b, III $\rightarrow$ a.
- B I $\rightarrow$ b, II $\rightarrow$ c, III $\rightarrow$ a.
- C I $\rightarrow$ a, II $\rightarrow$ c, III $\rightarrow$ b.
- D I $\rightarrow$ c, II $\rightarrow$ a, III $\rightarrow$ b.

- ix. Find the intersection point of the regression lines from the graph.

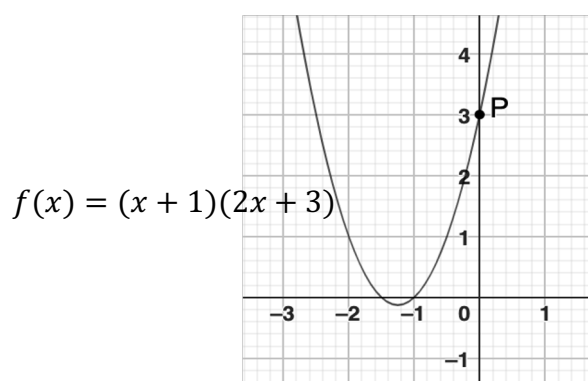


- A $x = 13.25, y = 17.25$
 B $x = 13.5, y = 17.5$
 C $x = 14, y = 18$
 D $x = 13, y = 17$
- x. The point C divides the line segment AB in the ratio 2:2. Find the missing coordinate of point D if the two lines AB is perpendicular to CD.



- A -6
 B -4
 C 4
 D 6
- xi. In EURO 2024 football tournament, each team played with every other team exactly once. If the total number of matches played is 36, how many teams participated in the tournament?
- A 72 teams
 B 36 teams
 C 24 teams
 D 9 teams

- xii. A mathematics teacher used GeoGebra app to draw a graph of a function. A random variable point P was plotted on a graph as shown below. The teacher wants the students to calculate the slope at point P. What is the slope at the given point?



- A 17
B 8
C 5
D 3
- xiii. An amateur entrepreneur visited his friend to seek financial suggestions on a setup of new business. He was provided with the following profit functions. What would be the best choice to generate maximum profit when $x = 10$?

- A $-1300 + 400x - 20x^2$
B $-x^2 + 20x + 350$
C $133 - 45x + 5x^2$
D $\frac{15}{x^2} + 30x + 250$

- xiv. The table below shows the rank differences of 10 students in Economics and History. Calculate the correlation coefficient between the two subjects.

Sl.No	1	2	3	4	5	6	7	8	9	10
D	-1	-2	2	-1	2	-3	0	-2	x	2

- A 1.00
B 0.75
C -0.75
D -1.00
- xv. What is $\det(A^{-1})$, if A is an invertible matrix?

- A $\det(A)$
B $\frac{1}{\det(A)}$
C I_n
D 0

SECTION B [70 MARKS]

ANSWER ANY TEN QUESTIONS

Question 2

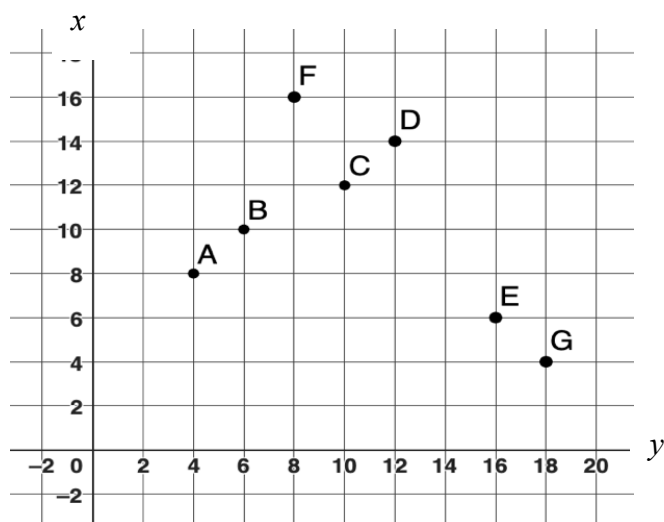
a) If $\begin{bmatrix} x & y \\ 3 & -1 \end{bmatrix} + \begin{bmatrix} y & -x \\ 2 & 1 \end{bmatrix} = \begin{bmatrix} 5 & 11 \\ 5 & 0 \end{bmatrix}$, then find the missing elements.

[3]

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- b) The following graph depicts the test scores of 7 students in Dzongkha (x) and English (y).

[4]



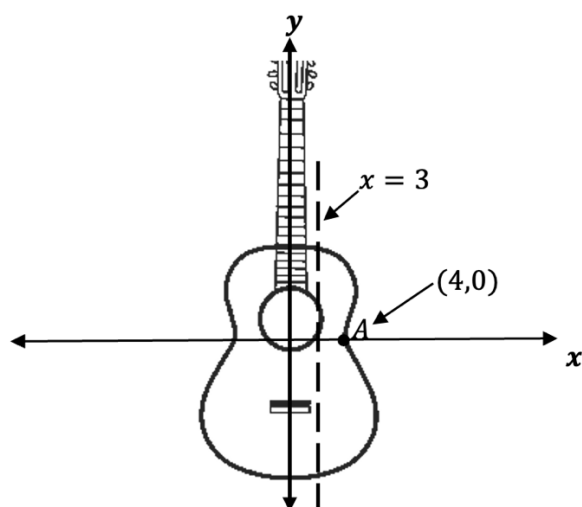
A student scored 5 marks in Dzongkha but was absent from the English test. Estimate his probable score for the later test.

Question 3

- a) The marginal cost function of manufacturing x units of a product is $5 + 16x - 3x^2$. [3]
The total cost of producing 5 units is Nu 500. Find the total cost function.

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- b) Determine the type of the conic section whose directrix and vertex A are given.



Find the following:

- i. Coordinates of foci.

[1]

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- ii. Eccentricity.

[1]

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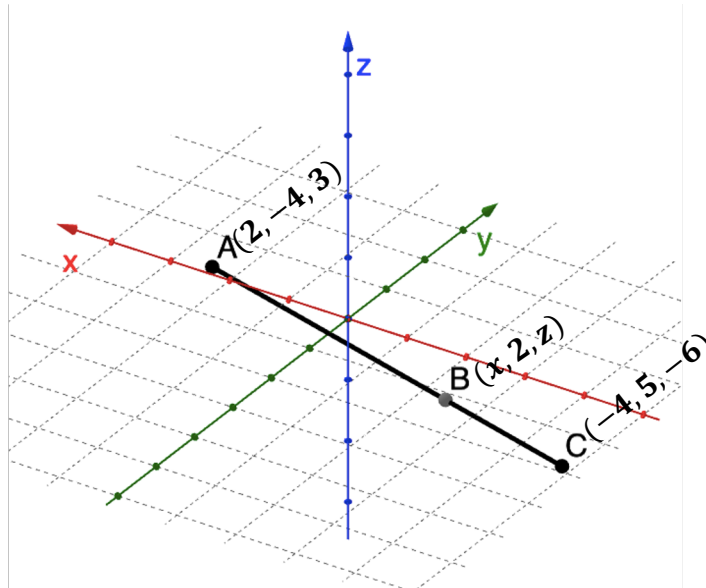
- iii. Equation of the conic section.

[2]

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Question 4

- a) Ms. Rigzin Om plots the three points on the cartesian coordinate system as shown below. However, she could not find two coordinates of the point B which is two-thirds of the way from AC. Find the missing coordinates. [3]



- b) Mr. Karma set up a dairy farm in his village. He borrowed Nu 30,000 from Bhutan Development Bank Limited on a condition to repay it with compound interest at 5% p.a. at the annual installments of Nu 4,017. In how many years will his debt be liquidated? **[4]**

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Question 5

- a) Ms. Pema Dema was playing a game to form different words using the letters of her last name D, E, M, A. She could form $4!$ different words. Then, she was excited to try with a different word 'MATHEMATICS'. Find the number of combinations of four letters taken from the word MATHEMATICS. [3]

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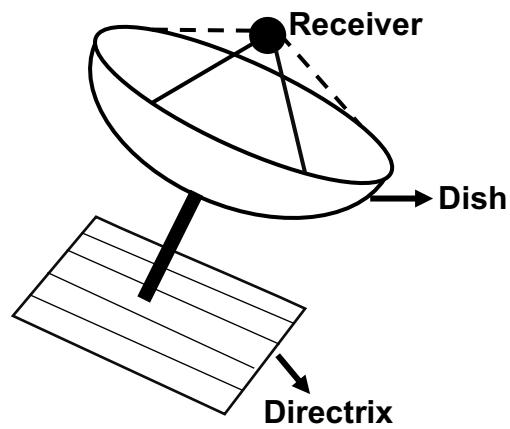
b) Integrate: $\int \frac{10x^2+9x-7}{(x+2)(x^2-1)} dx$

[4]

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Question 6

- a) A satellite dish has its receiver located at the focus.



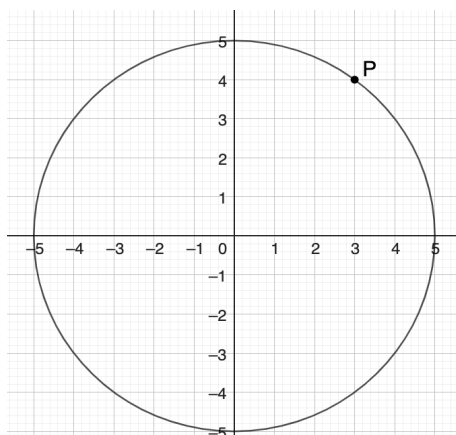
- i. How far is the receiver from the vertex if the dish is 10ft across and 3ft deep at the center? [1.5]

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- ii. Find the equation of the parabola. [1.5]

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- b) You are a math teacher and one of your students is struggling to understand how to find the gradient at the point P for the given graph. How would you guide the student to find the gradient? [4]



Question 7

- a) Imagine you are managing quality control for a factory that produces light bulbs. The checklist of tested bulbs is recorded in a table with tick mark as shown below. You randomly select one bulb to test.

Sl. No	1	2	3	4	5	6	7	8	9	10	11	12	13
Defective			✓			✓	✓	✓				✓	✓
Not defective	✓	✓		✓	✓				✓	✓	✓		

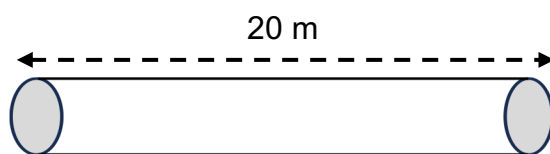
- i. What is the probability that the bulb you selected is not defective? [1.5]

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- ii. The bulb selected is defective and it is not replaced, and a second bulb is selected at random from the rest, what is the probability that the second bulb is defective? [1.5]

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- b) A house proprietor brought a 12 mm thick iron rod. He wants to cut the rod into two parts so that the product of the square of the one and the cube of the other may be the greatest possible. Find the length of two parts of the iron rod. [4]



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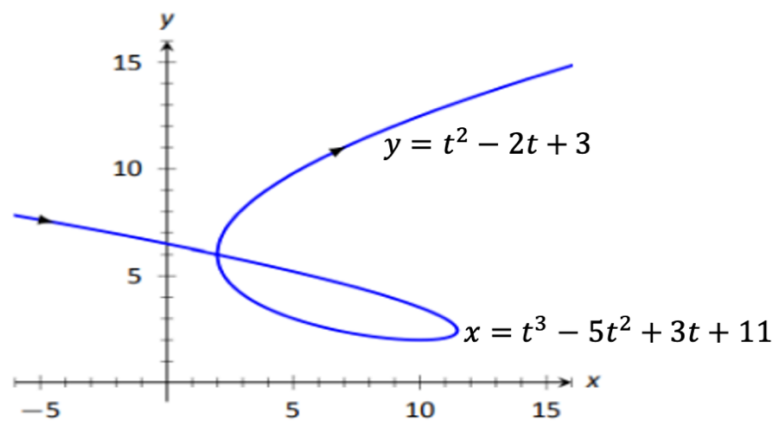
Question 8

- a) A merchant visits Bank of Bhutan to avail the service of bill of exchange. He chose an 8 months bill for Nu 1860. The true discount on the bill is Nu 60. Find the rate of interest. [3]

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- b) Verify that $\frac{d^2y}{dx^2} = \frac{1}{8}$, when $t = 1$.

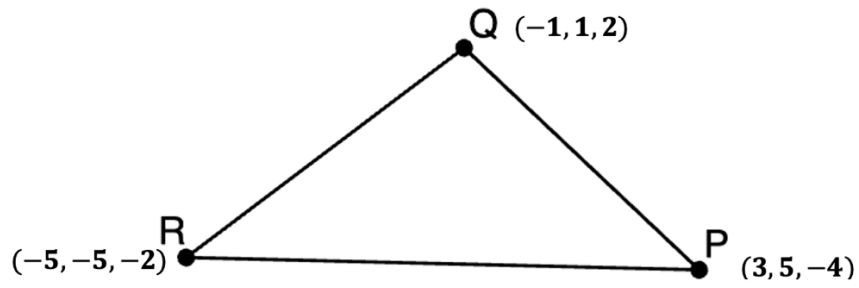
[4]



Question 9

- a) Show that the given polygon is an isosceles triangle.

[3]



- b) The cost function of producing x units of a product is given by $C(x) = \sqrt{ax + b}$. Show how the nature of the average cost curve continuously changes with increasing output when both a and b are positive and when they are negative? [4]

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Question 10

- a) A school administrator wants to determine if there is a significant relationship between students' study time (in hours) and examination scores.

[3]

Study time (in hours)	5	3	2	6	1	4
Examination scores	72	50	45	80	25	60

What does it suggest about the relationship between students' study time and examination scores?

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b) Integrate the following functions:

i. $\frac{7x^3-6x}{\sqrt{x}}$

[2]

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ii. $\frac{6x+5}{\sqrt{3x^2+5x+2}}$

[2]

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Question 11

- a) Two dealers are selling the same model of a refrigerator.

[3]

	Wangchuk's Shop	Sonam's Shop
Discount Offer	Gives successive discounts of 25% and 5%	Gives successive discounts of 16% and 14%

As a customer, which one would you prefer?

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- b) The school management team (SMT) comprising of Principal, Vice Principal, Academic Head, Student Support Service, and Staff Secretary sits around a round table.

i. In how many ways can they be seated?

[1]

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ii. In how many ways can they be seated if the Principal and the Vice Principal choose to sit next to each other?

[1]

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iii. If there are 4 gentlemen and 2 ladies in SMT, in how many ways 4 gentlemen and 2 ladies can be seated round a table so that every gentleman may have a lady by his side?

[2]

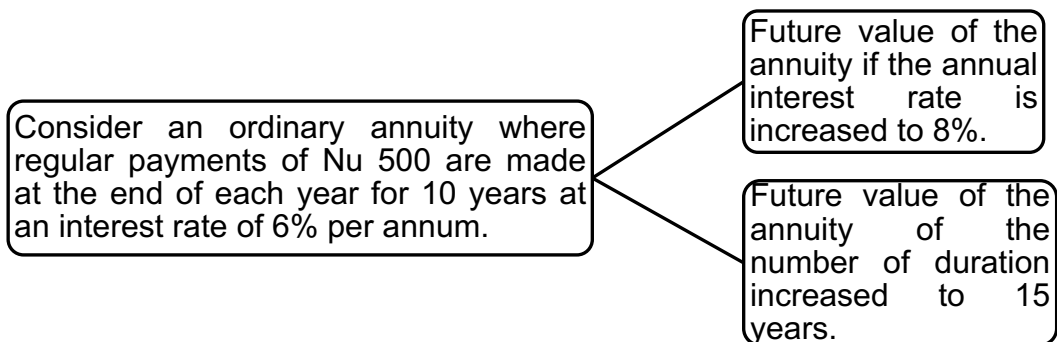
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Question 12

- a) Create a system of two linear equations that have no solution without repeating the elements. [3]

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- b) Bank of Bhutan officially announced the new year offers on annuity scheme as shown in the tree diagram. Study the offers and answer the following questions.



- i. How would the changes in the interest rate affect the future value of the annuity? [2.5]

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- ii. How would the future value change with each increase in the investment duration? [1.5]

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Question 13

- a) Determine the probability that either A or B occurs if the two events A and B are such that $P(A) = 0.8$, $P(B) = 0.3$ and $P(A/B) = 0.6$. [2]

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- b) Mr. Sonam gave RCSC preliminary examinations coaching to graduate students. He grouped them in pairs so that students in a pair have nearly equal scores from first mock test. In each pair one student was taught by method I and the other by method II. The marks obtained by them are as follows: (65, 67), (66, 68), (67, 65), (67, 68), (68, 72), (69, 72), (70, 69), (72, 71). Find the rank correlation coefficient and interpret the result. [5]

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Formulae

Strand A: Numbers and Operations

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

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

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

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

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

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

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

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

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

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

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

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

$$\begin{aligned} \text{Banker's Gain}(B.G.) &= B.D. - T.D. \\ &= \frac{A(ni)^2}{1+ni} \end{aligned}$$

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

Strand B: Patterns and Algebra

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$SP = ePM$$

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

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

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

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

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

Conditions of perpendicularity
and parallelism:

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

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

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

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

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

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**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Rough work

Rough work