**1. a) By using De-Moivres theorem find the cube root of i.**

➢ **Solution :**

Let $z^3 = i = 0 + 1 . i = \cos 90° + i \sin 90°$

$= \cos(90° + k.360°) + i \sin(90° + k.360°)$

$\therefore z = \{\cos(90° + k.360°) + i \sin(90° + k.360°)\}^{\frac{1}{3}}$

$= \cos\frac{90° + k.360}{3} + i\, sin\frac{90° + k.360}{3}$

$= \cos(30° + k.120°) + i \sin(30° + k.120°)$

Where, $k = 0, 1, 2$. For $k = 0, 1, 2$, the roots are,

$\cos 30° + i \sin 30°$, $\cos 150° + i \sin 150°$, $\cos 270° + i \sin 270°$

$i.e., \frac{\sqrt{3}}{2} + \frac{1}{2}i, \quad -\frac{\sqrt{3}}{2} + \frac{1}{2}i, -i.$

**b) If w be a cube root of unity, prove that:**

$$(2 + \omega + \omega^2)^3 + (1 + \omega - \omega^2)^8 - (1 - 3\omega + \omega^2)^4 = 1$$





➢ **Solution,**

LHS,

$= (2 + \omega + \omega^2)^3 + (1 + \omega - \omega^2)^8 - (1 - 3\omega + \omega^2)^4$

$= (1 + 1 + \omega + \omega^2)^3 + (1 + \omega - \omega^2)^8 - (1 - 3\omega + \omega^2)^4$

$[\because 1 + \omega + \omega^2 = 0]$

$= (1 + 0)^3 + (-\omega^2 - \omega^2)^8 - (\omega - 3\omega)^4$

$= 1 + (-2\omega^2)^8 - (-4\omega)^4$

$= 1 + 256\omega^{16} - 256\omega^{14}$

$= 1 + 256(\omega^3)^5\, \omega - 256\, \omega^3 . \omega$

$[\because \omega^3 = 1]$

$= 1 + 256\, \omega - 256\, \omega$

$= 1$

$\therefore$ RHS = LHS , Proved.

**2. a) Find the area of the traingles determined by the Vectors $\overrightarrow{2\imath}-\vec{\jmath}+\vec{k}$ and $3\vec{\imath}+4\vec{\jmath}-\vec{k}$**

➢ **Solution**

$Let, \vec{a} = \overrightarrow{2\imath}-\vec{\jmath}+\vec{k}$ $and$ $\vec{b} = 3\vec{\imath}+4\vec{\jmath}-\vec{k}$

Then, $\vec{a} \times \vec{b} = \begin{vmatrix} \vec{\imath} & \vec{\jmath} & \vec{k} \\ 2 & -1 & 1 \\ 3 & 4 & -1 \end{vmatrix}$

$$= (1-4)\vec{\imath} - (-2-3)\vec{\jmath} + (8+3)\vec{k}$$

$$= -3\vec{\imath} + 5\vec{\jmath} + 11\vec{k}$$





$$|\vec{a} \times \vec{b}| = -3\vec{\imath} + 5\vec{\jmath} + 11\vec{k}$$

$$= \sqrt{(-3)^2 + (5)^2 + 11^2} = \sqrt{155}$$

$$Area\ of\ triangle = \frac{1}{2} \times |\vec{a} \times \vec{b}| = \frac{\sqrt{155}}{2}$$

$$\therefore The\ required\ area\ of\ triangle = \frac{\sqrt{155}}{2} sq.units$$

**b) Find the equation of the plane through the points (4, 5, 1), (3, 9, 4) and (-4, 4, 4).**

➢ **Solution,**

Equation of the plane through (4,5, 1) is

$$a(x-4)+b(y-5)+c(z-1)=0 \quad \cdots\cdots\cdots (i)$$

**Since,**

Equation $(i)$ Passes through (3,9,4) & (−4,4,4)

So,

$$a(3-4)+b(9-5)+c(4-1)=0$$

$$or, \quad -a+4b+3c=0 \quad \cdots\cdots\cdots (ii)$$

$$a(-4-4)+b(4-5)+c(4-1)=0$$

$$or, \quad -8a+b+3c=0 \quad \cdots\cdots\cdots (iii)$$

**Solving, $(ii)$ & $(iii)$ by cross multiplication method,**

$$\frac{a}{12+3}=\frac{b}{-24+1}=\frac{c}{1+32}$$





$$or, \quad \frac{a}{15}=\frac{b}{-21}=\frac{c}{33}=K \ (say)$$

$$a=15K, \quad b=-21K, \quad c=33K$$

Equation $(i)$ becomes,

$$15K(x-4)-21K(y-5)+33K(Z-1)=0$$

$$or, \ 5(x-4)-7(y-5)+11(z-1)=0$$

$$\therefore \ 5x-7y+11z-4=0$$

**Which is the required Eq$^n$ of plane.**

3. a) Solve by using Cramer's rule or Row equivalent matrix:

$$x + 2y - 3z = 9$$
$$2x - y + 2z = -8$$
$$3x - y - 4z = 3$$

➢**Solution,** *Row equivalent matrix method,*

The augmented matrix is

$$\begin{bmatrix} 1 & 2 & -3 & : 9 \\ 2 & -1 & 2 & : -8 \\ 3 & -1 & -4 & : 3 \end{bmatrix}$$

$R_2 \to R_2 - 2R_2,\ R_3 \to R_3 - 2R_3$ $$\begin{bmatrix} 1 & 2 & -3 & : 9 \\ 0 & -5 & 8 & : -26 \\ 0 & -7 & 5 & : -24 \end{bmatrix}$$





$R_2 \to -\frac{1}{5}R_2$ $$\begin{bmatrix} 0 & 2 & -3 & : 9 \\ 0 & 1 & \frac{-8}{5} & : \frac{26}{5} \\ 0 & -7 & 5 & : -24 \end{bmatrix}$$

$R_1 \to R_1 - 2R_2, R_3 \to R_3 - 7R_2$ $$\begin{bmatrix} 1 & 0 & \frac{1}{5} & : \frac{-7}{5} \\ 0 & 1 & \frac{-8}{5} & : \frac{26}{5} \\ 0 & 0 & \frac{-31}{5} & : \frac{62}{5} \end{bmatrix}$$

$R_3 \to -\frac{5}{31}R_3$ $$\begin{bmatrix} 1 & 0 & \frac{1}{5} & : \frac{-7}{5} \\ 0 & 1 & \frac{-8}{5} & : \frac{26}{5} \\ 0 & 0 & -1 & : -2 \end{bmatrix}$$

$R_1 \to R_1 - \frac{1}{5}R_3,\ R_2 \to R_1 + \frac{8}{5} + R_3$ $$\begin{bmatrix} 1 & 0 & 0 & : -1 \\ 0 & 1 & 0 & : 2 \\ 0 & 0 & 1 & : -2 \end{bmatrix}$$

**Hence,**

$$x = -1,\ y = 2,\ z = -2\,.$$

**Or**

$$x + 2y - 3z = 9$$
$$2x - y + 2z = -8$$
$$3x - y - 4z = 3$$

**Solving by Cramer's rule :**





$$\text{Let } D = \begin{vmatrix} 1 & 2 & -3 \\ 2 & -1 & 2 \\ 3 & -1 & -4 \end{vmatrix} = 1(4+2) - 2(-8-6) + (-3)(-2+3)$$
$$= 6 + 28 - 3$$
$$= \mathbf{31}$$

$$D_1 = \begin{vmatrix} 1 & 2 & -3 \\ -8 & -1 & 2 \\ 3 & -1 & -4 \end{vmatrix} = 9(4+2) - 2(32-6) + (-3)(8+3)$$
$$= 54 - 52 - 33$$
$$= \mathbf{-31}$$

$$D_2 = \begin{vmatrix} 1 & 9 & -3 \\ 2 & -8 & 2 \\ 3 & 3 & -4 \end{vmatrix} = 1(32-6) - 9(-8-6) + (-3)(-6+24)$$
$$= 26 + 126 - 90$$
$$= \mathbf{62}$$

$$D_3 = \begin{vmatrix} 1 & 2 & 9 \\ 2 & -1 & -8 \\ 3 & -1 & 3 \end{vmatrix} = 1(-3-8) - 2(6+24) + 9(-2+3)$$
$$= -11 - 60 + 9$$
$$= \mathbf{-62}$$

**Now,**

$$x = \frac{D_1}{D} = \frac{-31}{31} = \mathbf{-1}, \quad y = \frac{D_2}{D} = \frac{62}{31} = \mathbf{2}, \quad z = \frac{D_3}{D} = \frac{-62}{31} = \mathbf{-2}$$

**Hence,**

$$\boldsymbol{x = -1, \ y = 2, \ z = -2}\ .$$

**b) Prove that:**

$$\begin{vmatrix} b+c & a & b \\ c+a & c & d \\ a+b & b & c \end{vmatrix} = (a+b+c)(a-c)^2$$





➢ $\text{LHS} = \begin{vmatrix} b+c & a & b \\ c+a & c & a \\ a+b & b & c \end{vmatrix}$

$= \begin{vmatrix} 2(a+b+c) & a+b+c & a+b+c \\ c+a & c & a \\ a+b & b & c \end{vmatrix}$ $(R_1 \to R_1 + R_2 + R_3)$

$= (a+b+c)\begin{vmatrix} 2 & 1 & 1 \\ c+a & c & a \\ a+b & b & c \end{vmatrix}$ (Taking a+b+c common from $R_1$)

$= (a+b+c)\begin{vmatrix} 1 & 1 & 1 \\ a & c & a \\ a & b & c \end{vmatrix}$ $(C_1 \to C_1 - C_2)$

$= (a+b+c)\begin{vmatrix} 1 & 0 & 0 \\ a & c-a & 0 \\ a & b-a & c-a \end{vmatrix}$ $(C_2 \to C_2 - C_1, C_3 \to C_3 - C_1)$

$= (a+b+c)\begin{vmatrix} c-a & 0 \\ b-a & c-a \end{vmatrix}$

$= (a+b+c)\,[\,(c-a)^2 - 0\,]$

$= (a+b+c)\,(c-a)^2$

$\therefore$ **RHS = LHS** Proved.

**4) Sand is pouring from a pipe at the rate of 18 cm³/sec. The falling sand forms a cone on the ground in such a way that the height of the cone is one-sixth of the radius of the base. How fast is height of the cone increasing when its height is 3cm?**

## ➢Solution,

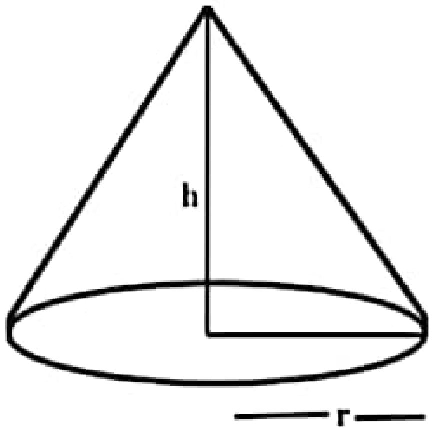
Let r be the radius of the base, h be the height and v be the volume of the sand cone at time t.

By question,

$$\mathrm{h} = \frac{1}{6}\,\mathrm{r}$$

$$or, \qquad \mathrm{r} = 6\mathrm{h}$$

$$\frac{dv}{dt} = \frac{18cm^3}{sec}$$




$$h = 3cm\,, \qquad \frac{dh}{dt} = ?$$

We have, $\mathrm{v} = \frac{1}{2}\pi r^2 h = \frac{1}{3}\pi(6h)^2 h = 12\pi h^3$

$$or, \qquad \frac{dv}{dt} = \frac{d}{dt}12\pi h^3 = 12\pi\frac{dh^3}{dt} = 36\pi h^2\frac{dh}{dt}$$

$$or, \qquad 18 = 36\pi \times (3)^2 \times \frac{dh}{dt}$$

$$\therefore \qquad \frac{dh}{dt} = \frac{1}{18\pi}\; cm/sec.$$

**5) A man who has got 144 metres of fencing material Wishes to enclose a rectangular garden. Find the maximum area he can enclose.**

## ➢Solution,

Let $x$ be the length and $y$ be the breath of the garden. If P be perimeter and A be the area of the garden, then

$$\text{P} = 2(x + y)$$

or, $144 = 2(x + y)$

or, $x + y = 72 \quad \cdots\cdots\cdots (i)$

and $A = xy \quad \cdots\cdots\cdots (ii)$

**Now,** eliminating y between $(i)$ *and* $(ii)$, we have

$$A = x(72 - x)$$

$$\frac{dA}{dx} = 72 - 2x$$

and, $\dfrac{d^2A}{dx^2} = -2$

For maximum area A,

$$\frac{dA}{dx} = 0$$

or, $72 - 2x = 0$

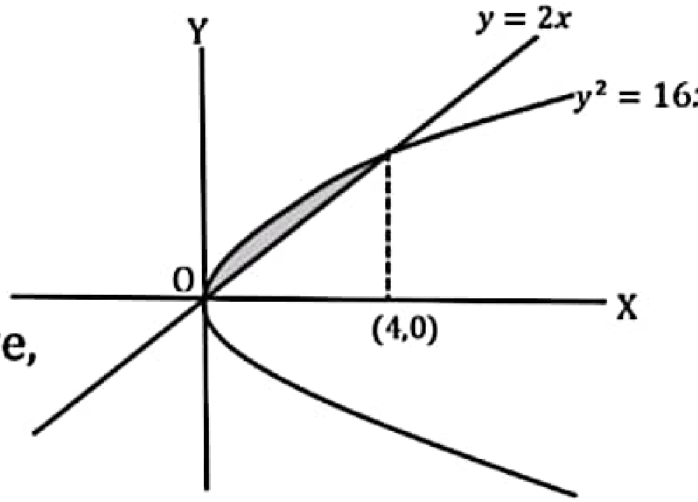
$\therefore \quad x = 36$

When x $= 36$ $y = 72 - 36 = 36$

At $x = 36$ $\dfrac{d^2A}{dx^2} = -2$ which is negative.

**Hence,** the area is maximum when $x = 36$ *and* $y = 36$ *and the maximum area* $A = 36 \times 36 = 1296\ sq.mtrs$

**6) Find the Area bounded by the curve $y^2 = 16x$ and the line $y = 2x$.**




➢ **Solution,**

Given curve and line are $y^2 = 16x$ and $y = 2x$ respectively.

Eliminating $y$ between them, we have,

$$(2x)^2 = 16x$$

or, $x^2 = 4x$

or, $x(x-4) = 0$

Either $x = 0$ or $x = 4$

∴ Ordinates are $x = 0$, $x = 4$.

Hence the required area, $A = \int_0^4 (y_1 - y_2)dx$, where $y_1 = 4\sqrt{x}$ and $y_2 = 2x$.

$$= \int_0^4 (y_1 - y_2)dx$$

$$= \int_0^4 (4\sqrt{x} - 2x)dx$$

$$= \left[\frac{8}{3}x^{\frac{3}{2}} - x^2\right]_0^4$$

$$= \frac{8}{3}4^{\frac{3}{2}} - 4^2$$

$$= \frac{64}{3} - 16$$

$$\therefore A = \frac{16}{3} \text{ sq. units}$$

**$OR$) Find the area bounded by the curve $\frac{x^2}{16}+\frac{y^2}{9}=1$**

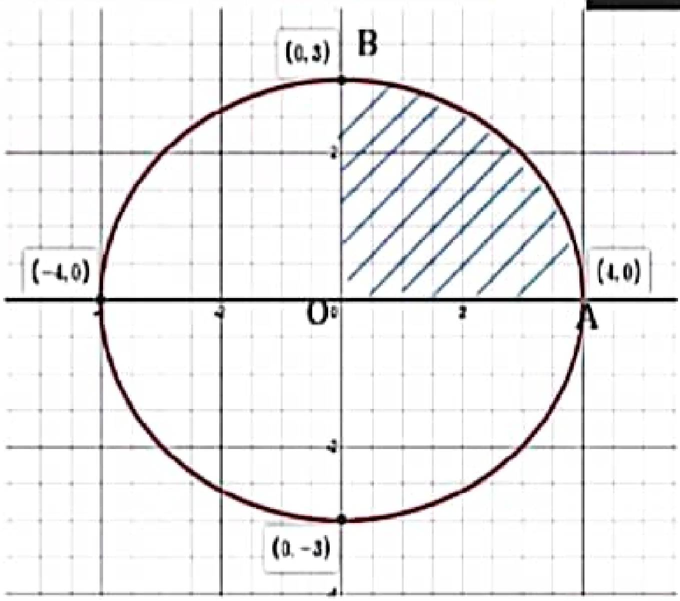
- **Solution,**

Given Equation,

$$\frac{x^2}{16}+\frac{y^2}{9}=1$$

$$y^2 = 9\left(1-\frac{x^2}{16}\right)$$

$$\Rightarrow y = \frac{3}{4}\sqrt{16-x^2}$$




Its center is (0,0) and is symmetrical about both $x-axis$ and $y-axis$ .

Total area Bounded by Curve = 4 × Area of OAB which lies between the ordinates $x = 0, x = 4$.

**Hence,** Total area of the Curve, A $= 4 \times$ *area of* OAB

$$A = 4\int_0^4 y\,dx$$

$$= 4\int_0^4 \frac{3}{4}\sqrt{16-x^2}dx$$

$$let\ x = 4\sin\theta\ ,\quad dx = 4\cos\theta\, d\,\theta$$

Limits, $x = 0 \rightarrow \theta = 0 \quad \& \quad x = 4 \rightarrow \theta = \frac{\pi}{2}$

$$A = 4 \times \frac{3}{4} \int_0^{\frac{\pi}{2}} \sqrt{16 - 16\, sin^2\theta}\,.\,4\cos\theta\, d\theta$$

$$= 3 \int_0^{\frac{\pi}{2}} 4\cos\theta \,.\, 4\cos\theta\, d\theta$$

$$= 3 \times 16 \int_0^{\frac{\pi}{2}} \cos^2\theta\, d\theta$$

$$= 3 \times 16 \times \int_0^{\frac{\pi}{2}} \frac{(1 + \cos 2\theta) d\theta}{2}$$

$$= \frac{3 \times 16}{2} \left[\theta + \frac{\sin 2\theta}{2}\right]_0^{\frac{\pi}{2}}$$

$$= 3 \times 8 \left(\frac{\pi}{2} + 0\right)$$

$$= 24 \times \frac{\pi}{2}$$

$$= \mathbf{12\pi}\ \boldsymbol{sq.units}$$

**∴ Area Bounded By the Curve is 12π** ***sq. unit***

**7) Prove that the line joining the points (1, 2, 3) and (-1, -2, -3) is perpendicular to the line joining the pints $(-2, 1, 5)$ and $(3, 3, 2)$.**

➢ **Solution,**





The direction ratios of the line joining the points (1, 2, 3) and (-1, -2, -3) are -2, -4, -6.

The direction ratios of the line joining the points (-2, 1, 5) and (3, 3, 2) are $3 + 2, 1 - 3, 2 - 5,$

$i.e.\ 5, \quad +2, \quad -3$

**Now,**

$-2(5) - 4(+2) - 6(-3) = 0$

or, $-10 - 8 + 18 = 0$

**So,** the lines joining the given points are perpendicular to each other.

**8) Maximize and minimize F $= 9x + 7y$ subject to $x + 2y \leq 7$, $x - y \leq 4$, $x \geq 0$, $y \geq 0$.**

➢ **Solution,**

$\boldsymbol{When\ x = 0, y = 0}$

**$0 + 2.0 \leq 7 \Rightarrow 0 \leq 7$ ( true) so, it is directed towards origin.**

The boundary lines of the given inequalities are

$$x + 2y = 7 \quad \cdots\cdots\cdots (i)$$
$$x - y = 4 \quad \cdots\cdots\cdots (ii)$$

From equation $(i)$

| $x + 2y = 7$ | |
|---|---|
| $x$ | $y$ |
| 0 | $\frac{7}{2}$ |
| 7 | 0 |

So, C $\left(0, \frac{7}{2}\right)$ & (7,0) are passes through equation $(i)$

From equation $(ii)$,

When, $x = 0, y = 0$

**$0 \leq 4$ ( true) so, it is directed towards origin.**

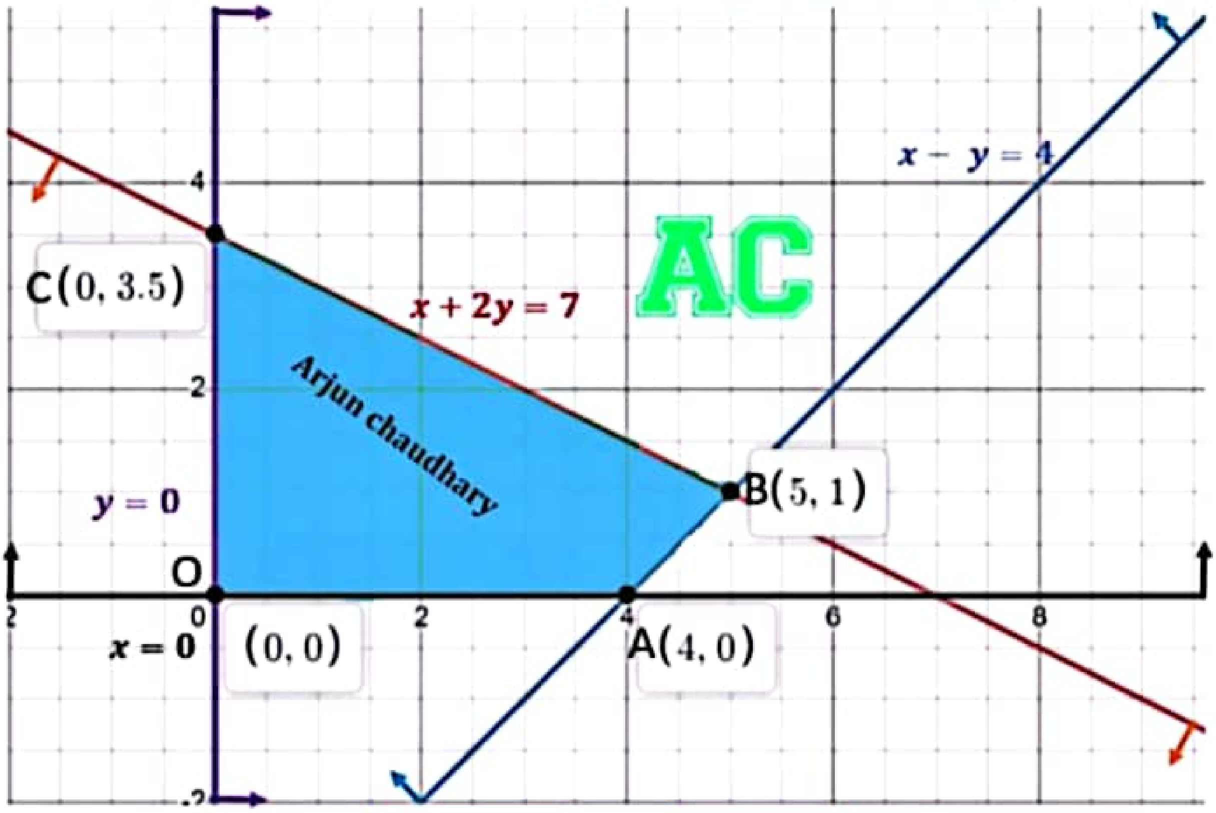
| $x - y = 4$ | |
|---|---|
| $x$ | $y$ |
| 0 | 4 |
| 4 | 0 |

So,(0,4) & $A(4,0)$ are passes through equation $(ii)$

When, $x = 0, y = 0$

**$0 \leq 6$ ( true) so, it is directed towards origin.**

Also, From graph the vertices B are calculated by solving equation




For Vertices **B**,

Solving equation $(i)$ and $(ii)$

We get, B (5,1)

**Hence,** The Vertices of ABCD are O(0,0) ,A(4,0) , B(5,1) and C(0,3.5).

| Vertices | $F = 9x + 7y$ |
|---|---|
| O(0,0) | $9 \times 0 + 7 \times 0 = \mathbf{0}$ **(MIN)** |
| A(4,0) | $9 \times 4 + 7 \times 0 = 36$ |
| B(5,1) | $9 \times 5 + 7 \times 1 = \mathbf{52}$ **(MAX)** |
| C(0, 3.5) | $9 \times 0 + 7 \times 3.5 = 24.5$ |

**Hence,** Maximum Value = 52 at C(5,1)

Minimum Value = 0 at O(0,0)

**9) A committee of 3 is to be formed from 6 men and 4 women. What is the probability that all three are women?**

➢ **Solution,**

The selection of member in the committee can made as follows.

| men(6) | women (4) | Selection of 3 |
|---|---|---|
| 0 | 3 | C(6,0) × C(4,3) |

The Probability that all three are women.

$$= C(6,0) \times C(4,3)$$

$$= \frac{6!}{6!\,0!} \times \frac{4!}{1!\,3!}$$

$$= 1 \times 4$$

$$= \mathbf{4}$$

**10) A company that produces 10% of its products are defective among such 6 products find the probability that one is defective.**

➢ **Solution**

$\mathrm{P} = \text{Prob. of getting defective product} = \frac{10}{100} = \mathbf{\frac{1}{10}}$

$\mathrm{q} = \text{Prob. of getting tail} = 1 - p = 1 - \frac{1}{10} = \mathbf{\frac{9}{10}}$

$\mathrm{n} = 6$





***we have,***

$\mathrm{P(r)} = \text{Prob. of getting } \boldsymbol{r} \text{ defective product in } \boldsymbol{n} \text{ products}$

$\mathrm{P(r)} = \mathrm{C(n, r)}\ \mathrm{p}^r q^{n-r} \quad \cdots\cdots\cdots\cdots (\boldsymbol{i})$

**To find :** probability that one is defective, $r = 1$

**From** $(\boldsymbol{i})$

$$\mathrm{P}(r = 1) = \mathrm{C}(6,1)\ \mathrm{p}^1 q^{6-1}$$

$$\mathrm{P}(r = 1) = 6 \times \left(\frac{1}{10}\right)^1 . \left(\frac{9}{10}\right)^5$$

$$\mathrm{P}(r = 1) = 0.3543 = 35.43\%$$

∴ **Probability that one is defective $= 35.43\%$**

**11) Calculate the quartile deviation (Q.D.) and its coefficient from the following data :**

| Class | 10-15 | 15-20 | 20-25 | 25-30 | 30-35 | 35-40 | 40-45 |
|---|---|---|---|---|---|---|---|
| Frequency | 2 | 4 | 6 | 7 | 3 | 1 | 5 |

➢**Solution**





| Class | Frequency (F) | C.F |
|---|---|---|
| 10-15 | 2 | 2 |
| 15-20 | 4 | 6 |
| 20-25 | 6 | 12 |
| 25-30 | 7 | 19 |
| 30-35 | 3 | 22 |
| 35-40 | 1 | 23 |
| 45-45 | 5 | 28 |

$\mathbf{N = 28}$

**For $Q_1$:**

$$Q_1 = \left(\frac{N}{4}\right)^{th} \text{item} = \frac{28}{4} = \boldsymbol{7^{th} item}$$

C.f is just greater than 7 and is 12. So, it lies between 20 − 25.

$\mathbf{L = 20, F = 6, C.f = 6, i = 5}$

$$Q_1 = L + \frac{\frac{N}{4} - c.f}{f} \times i$$

$$= 20 + \frac{7-6}{6} \times 5$$

$$= 20 + 0.83$$

$$\mathbf{Q_1 = 20.83}$$

**For $Q_3$:**

$$Q_3 = 3\left(\frac{N}{4}\right)^{th} \text{item} = 3 \times 7 = \boldsymbol{21^{th} item}$$

C.f is just greater than 21 and is 22. So, it lies between 30-35.

$$\mathbf{L = 30,\ f = 3,\ C.f\ = 19,\ i = 5}$$

$$Q_3 = L + \frac{\frac{3N}{4} - c.f}{f} \times i$$

$$= 30 + \frac{21 - 19}{3} 5$$

$$= 30 + 3.33$$

$$\mathbf{Q_3 = 33.33}$$

$$\textbf{Coefficient of Q.D} = \frac{Q_3 - Q_1}{Q_3 + Q_1}$$

$$= \frac{33.33 - 20.83}{33.33 + 20.836}$$

$$= \frac{12.47}{54.16}$$

$$\therefore \textbf{Coefficient of Q.D} = \mathbf{0.230}$$

**12) Find the regression equation of $y$ on $x$ from the following data Also, estimate the value of y when $x = 5$.**

| X | 2 | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|
| Y | 5 | 6 | 13 | 16 | 23 | 24 |

➢ **Solution,**





| $x$ | $y$ | $x^2$ | $xy$ |
|---|---|---|---|
| 2 | 5 | 4 | 10 |
| 4 | 6 | 16 | 24 |
| 6 | 13 | 36 | 78 |
| 8 | 16 | 64 | 128 |
| 10 | 13 | 100 | 130 |
| 12 | 24 | 144 | 288 |
| $\sum x = 42$ | $\sum y = 77$ | $\sum x^2$=364 | $\sum xy$=658 |

Here, n = 6

$$\overline{x} = \frac{\sum x}{n} = \frac{42}{6} = \mathbf{7}, \overline{y} = \frac{\sum y}{n} = \frac{77}{6} = \mathbf{12.83}$$

$$b_{yx} = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2} = \frac{6 \times 658 - 42 \times 77}{6 \times 364 - (42)^2} = \frac{714}{420} = \mathbf{1.7}$$

**Hence**, the regression $y$ on $x$ is ,

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

or, $y - 12.83 = 1.7\,(x - 7)$

or, $y - 12.83 = 1.7\,x - 11.9$

**Therefore,** $y = 1.7\,x + 0.93$

∴ The regression Equation $y$ on $x$ is , $y = 1.7\,x + 0.93$

When $y = 5$ then, $y = 1.7 \times 5 + 0.93 = \mathbf{9.43}$

**13) Show that the vectors: $\vec{i}+\vec{j}+\vec{k}$, $2\vec{i}+3\vec{j}-\vec{k}$, $-\vec{i}-2\vec{j}+2\vec{k}$ are co-planar.**

➢ **Solution**

$$\vec{r_1} = \vec{i}+\vec{j}+\vec{k}$$

$$\vec{r_2} = 2\vec{i}+3\vec{j}-\vec{k}$$

$$\vec{r_3} = -\vec{i}-2\vec{j}+2\vec{k}$$

**To show:** $\overrightarrow{r_1}, \overrightarrow{r_2}$ *and* $\overrightarrow{r_3}$ **are coplanar**

➢ If three vector are coplanar, one can expressed as the sum of the scalar multiples of the other two.

$$\vec{r_3} = x\vec{r_1} + y\vec{r_2} \qquad \textit{where, x and y are scalars}$$

$$or, \quad -\vec{i}-2\vec{j}+2\vec{k} = x(\vec{i}+\vec{j}+\vec{k}) + y(2\vec{i}+3\vec{j}-\vec{k})$$

$$-\vec{i}-2\vec{j}+2\vec{k} = (x+2y)\vec{i} + (x+3y)\vec{j} + (x-y)\vec{k}$$

Equating Coefficient of likes vectors,

$$(x+2y) = -1 \quad \cdots\cdots\cdots\cdots (i)$$

$$x+3y = -2 \quad \cdots\cdots\cdots\cdots (ii)$$

$$x-y = 2 \quad \cdots\cdots\cdots\cdots (iii)$$

Solving eqn $(i)$ *and* $(ii)$ weget, $\boldsymbol{x = 1}$ ***and*** $\boldsymbol{y = -1}$





Put, $x = 1$ *and* $y = -1$ in eqn $(iii)$

$1 \times 1 - 1 \times -1 = 2$

$2 = 2$, satisfied.

**Hence,** Three vector are coplanar and its *can expresssed as*

$$\overrightarrow{r_3} = \overrightarrow{r_1} - \overrightarrow{r_2}$$