

MODEL PAPER OF IIT JEE

ANSWERS

PAPER I

- 1.(b) 2.(b) 3.(c) 4.(d) 5.(b) 6.(d) 7.(b) 8.(b, d) 9.(b, d) 10.(a, b, c)
11.(b, c, d) 12.(a) 13.(c) 14.(a) 15.(c) 16.(a) 17.(c) 18.(5) 19.(4) 20.(12)
21.(5) 22.(1) 23.(3) 24.(5)

PAPER II

- 1.(d) 2.(b) 3.(a) 4.(c) 5.(b) 6.(a) 7.(c) 8.(a) 9.(b, c, d) 10.(c)
11.(b) 12.(d) 13.(1) 14.(2) 15.(6) 16.(4) 17.(1) 18.(≥ 2)
19. (A) \rightarrow (r);(B) \rightarrow (r);(C) \rightarrow (p),(q),(r),(s);(D) \rightarrow (p) 20. (A) \rightarrow (r);(B) \rightarrow (p);(C) \rightarrow (s);(D) \rightarrow (q)

HINTS & SOLUTIONS

PAPER I

Sol.1

$$\sin(A-B) = \sin A \cos B - \cos A \sin B \dots\dots (i)$$

Substituting the values of $\cos A$ and $\sin A$ from the given eq. (i), we have

$$\sin(A-B) = \frac{\sin B \cos B}{\sqrt{2}} \dots\dots\dots (ii)$$

On squaring and adding given equation, we get $\cos 2B = 1/3$

$$\sin(A-B) = \pm 1/3$$

Sol.2

Obviously $\alpha = -i$ where $i^2 = -1$

$$\text{So, } \omega = \begin{vmatrix} 1 & 1 & 1 \\ 1 & -i & i \\ i & 1 & 0 \end{vmatrix} = -1 - i, \arg(\omega) = -3\pi/4$$

Sol.3

We have , $\vec{a} \times \vec{x} = 0$

$$x = b + (x \times a)$$

$$x \times a = b \times a + (x \times a) \times a$$

$$x \times a = b \times a + (x \cdot a)a - (a \cdot a)x$$

$$x - b = b \times a - x$$

$$|2x| = |b + b \times a|$$

$$\Rightarrow |x| = \frac{1}{\sqrt{2}}$$

Sol.4

The required point is the point of intersection of

$$x^2 + y^2 = 2a^2$$

And $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

Sol.5

We have,

$$\frac{x^2}{\tan 9^\circ} + \frac{y^2}{\tan 27^\circ} + \frac{z^2}{\tan 63^\circ} + \frac{w^2}{\tan 81^\circ} \geq \frac{25}{4\sqrt{5}} \geq \frac{5\sqrt{5}}{4}$$

Sol.6

$$\sin^{-1} \sin \sqrt{1-\alpha} = \sqrt{1-\alpha}$$

$$\Rightarrow \alpha \leq 1 \text{ and } \alpha \leq \sqrt{1-\alpha} \leq \pi/2$$

$$1-\alpha \leq \pi/4$$

$$1-\pi/4 \leq \alpha$$

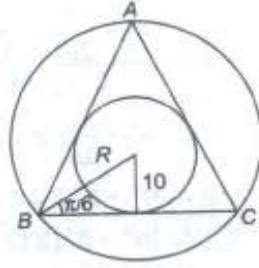
$$\Rightarrow \alpha \geq \frac{4-\pi}{4}$$

Sol.7

$$\sin \pi / 6 = 10 / R$$

$$\Rightarrow R = 20$$

$$\Rightarrow R = 2r$$

**Sol.8**

$$f\left(\frac{1}{x}\right) = \int_1^{1/x} \frac{\ln t}{1+t} dt$$

Put $t = 1/u$

$$= \int_1^x \left(\frac{\ln u}{1+u}\right) \left(-\frac{1}{u^2}\right) du = \int_1^x \frac{\ln t}{t(1+t)} dt$$

$$\text{Now, } f(x) + f\left(\frac{1}{x}\right) = \frac{(\ln x)^2}{2}$$

Sol.9

$$f(1) = a + 1 + c - a > 0 \quad [\because c > -1]$$

$$\text{Also, } f\left(\frac{1}{2}\right) = \frac{a}{4} + \frac{1}{2} + c - a > 0$$

$$\Rightarrow 2 + 4c > 3a$$

Sol.10

$$\text{Now, } \sum \cos^2 \alpha_1 \sin^2 \beta_1 \geq (\sum \cos \alpha_1 \sin \beta_1)^2$$

$$\because \sin^2 \theta_1 \leq 1$$

$$\Rightarrow \sin^2 \theta_1 = 1$$

$$\text{Similarly, } \cos^2 \theta_2 = 1$$

Sol.12

$$\text{Equation of tangent at P is } \frac{x+y-4}{\sqrt{2}} = \frac{3x+4y+5}{5}$$

$$5x + 5y - 20 = \sqrt{2}x + 4\sqrt{2}y + 5\sqrt{2}$$

$$x(5 - 3\sqrt{2}) + y(5 - 4\sqrt{2}) - (20 + 5\sqrt{2}) = 0$$

Sol.13

$$2ac = 13\sqrt{2}$$

$$\therefore 2a = 26$$

$$a = 13$$

$$\Rightarrow 2 \times 13 \times e = 13\sqrt{2}$$

$$\Rightarrow e = \frac{1}{\sqrt{2}}$$

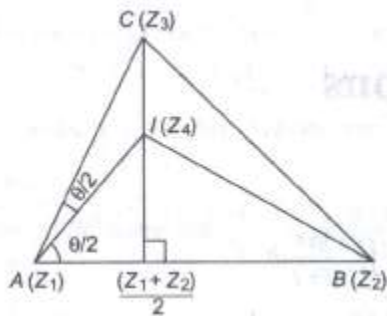
Sol.15

$$\frac{z_2 - z_1}{|z_2 - z_1|} = \frac{z_4 - z_1}{|z_4 - z_1|} \cdot e^{\frac{i\theta}{2}}$$

$$\frac{z_3 - z_1}{|z_3 - z_1|} = \frac{z_4 - z_1}{|z_4 - z_1|} \cdot e^{\frac{i\theta}{2}}$$

$$\Rightarrow \frac{(z_2 - z_1)(z_4 - z_1)}{|z_2 - z_1||z_3 - z_1|} = \frac{(z_4 - z_1)^2}{|z_4 - z_1|^2} \cdot e^{\theta}$$

$$\Rightarrow \frac{(z_2 - z_1)(z_4 - z_1)}{(z_4 - z_1)^2} = \frac{AB \cdot AC}{(IA)^2}$$



Similarly, others

Sol.18

Since, the equation has unequal real roots, the discriminant is positive , that is

$$4(a + b)^2 > 4(a - b + 8)$$

$$\Rightarrow a^2 + 2ab + b^2 > a - b + 8$$

$$\Rightarrow a^2 + (2b - 1)a + (b^2 + b - 8) > 0, \forall a \in R$$

\therefore Discriminant should be negative.

$$\Rightarrow (2b - 1)^2 < 4(b^2 + b - 8)$$

$$\Rightarrow 4b^2 - 4b + 1 < 4b^2 + 4b - 32$$

$$\Rightarrow 33 < 8b \quad \therefore b > \frac{33}{8}$$

Hence, smallest natural number $b=5$.

Sol.19

Put $x = r\cos\theta, y = r\sin\theta$

Hence, we have to minimize r^2 ?

Now $r^2\cos\theta\sin\theta r^2(\cos^2\theta - \sin^2\theta = r^2)$

$$r^2\sin 2\theta\cos 2\theta = 2$$

$$r^2 \frac{\sin 4\theta}{4} = 1$$

$$r^2 = \frac{4}{\sin 4\theta}$$

$$r^2 = 4\operatorname{cosec} 4\theta$$

$$\therefore r^2|_{\max} = 4$$

Sol.20

Equation of normal at $(2t^2, 4t)$ is

$$y = -tx + 4t + 2t^3$$

Since, it passes through (α, β)

$$\therefore \beta = -\alpha t + 4t + 2t^3$$

$$\therefore t_1 + t_2 + t_3 = 0$$

$$\text{And } t_1 t_2 + t_2 t_3 + t_3 t_1 = \frac{4-\alpha}{2}$$

The normal intersects the axis at $4 + 2t^2, 0$

$$\begin{aligned} \therefore OQ + OR + OS &= \Sigma(4 + 2t_i^2) = 12 + 2(t_1^2 + t_2^2 + t_3^2) \\ &= 12 + 2[(t_1 + t_2 + t_3)^2 - 2(t_1 t_2 + t_2 t_3 + t_3 t_1)] \\ &= 12 + 2\left[0 - 2\frac{4-\alpha}{2}\right] = 12 - 2(4 - \alpha) \\ &= 2(\alpha + 2) > 12 \quad (\because \alpha > 4) \end{aligned}$$

Hence, greatest value of k is 12.

Sol.21

$$\begin{aligned} &\int_0^8 (\sqrt{\cot^{-1}(\cot \pi x)} + \cot^{-1}(\cot \pi \sqrt{x})) dx \\ &= 8 \int_0^1 \sqrt{\cot^{-1}(\cot \pi x)} dx + \int_0^1 \cot^{-1}(\cot \pi \sqrt{x}) dx + \\ &\int_1^4 \cot^{-1}(\cot \pi \sqrt{x}) dx + \int_4^8 \cot^{-1}(\cot \pi \sqrt{x}) dx \\ &= \int_0^1 \sqrt{\pi} \sqrt{x} dx + \int_0^1 \pi \sqrt{x} dx + \int_1^4 (\pi \sqrt{x} - \pi) dx + \int_4^8 (x\sqrt{x} - 2\pi) dx + \int_4^8 (x\sqrt{x} - 2x) dx = \\ &\frac{16}{3}\sqrt{\pi} + \frac{32\sqrt{2}\pi}{3} - 11\pi \end{aligned}$$

$$\therefore A = \frac{16}{3}, b = 11 \therefore 3a - b = 5$$

Sol.27

Roots of equation $ax^3 + x - 1 - \alpha = 0$ are 1, α , β

$$\therefore \alpha + \beta = -1 \text{ and } \alpha\beta = \frac{1+a}{a}$$

$$= \lim_{x \rightarrow \frac{1}{\alpha}} \frac{(1+a)x^3 - x^2 - a}{(e^{1-ax} - 1)(x-1)}$$

$$= \frac{\lim_{x \rightarrow \frac{1}{\alpha}} (x-1) (1+a)x^2 + ax + a}{(e^{1-ax} - 1)(x-1)}$$

$$= \frac{\lim_{x \rightarrow \frac{1}{\alpha}} a\alpha\beta x^2 + ax + a}{(e^{1-ax} - 1)}$$

$$= \frac{\lim_{x \rightarrow \frac{1}{\alpha}} a(1-\alpha x - \beta x + \alpha\beta x^2)}{1-\alpha x}$$

$$= \frac{\lim_{x \rightarrow \frac{1}{\alpha}} a(1-\alpha x)(1-\beta x)}{1-\alpha x}$$

$$= \lim_{x \rightarrow \frac{1}{\alpha}} a(1-\beta x) = \frac{a(\alpha-\beta)}{\alpha}$$

$\therefore k=1$ and $l=1$ and so $kl=1$

Sol.23

$$\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta = a^2 - 2\left(-\frac{1}{2a^2}\right) = a^2 + \frac{1}{a^2}$$

$$\alpha^4 + \beta^4 = (\alpha^2 + \beta^2)^2 - 2\alpha^2\beta^2$$

$$= \left(a^2 + \frac{1}{a^2}\right)^2 - 2\left(\frac{1}{4a^2}\right) = a^4 + \frac{1}{a^4} + 2 - \frac{1}{2a^4}$$

$$= a^4 + \frac{1}{2a^4} + 2$$

$$\frac{a^4 + \frac{1}{2a^4}}{2} \geq \sqrt{a^4 \cdot \frac{1}{2a^4}} = \frac{1}{\sqrt{2}}$$

$$\therefore a^4 + \frac{1}{2a^4} \geq \sqrt{2}$$

$$\therefore \alpha^4 + \beta^4 \geq 2 + \sqrt{2}$$

$$\therefore [\alpha^4 + \beta^4] \geq [2 + \sqrt{2}] = 3$$

$$\therefore \text{Least value of } [\alpha^4 + \beta^4] = 3$$

Sol.24

$$\frac{dy}{dx} = \sec^2 x$$

$$\Rightarrow \left. \frac{dy}{dx} \right|_{x=\frac{\pi}{4}} = \sec^2 \frac{\pi}{4} = 2$$

Thus, the equation of the tangent to the curve C at

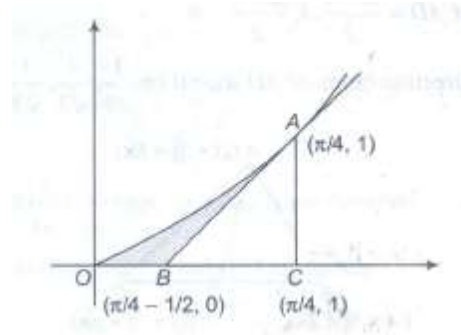
$$\left(\frac{\pi}{4}, \tan \frac{\pi}{4} \right) = \left(\frac{\pi}{4}, 1 \right) \text{ is } y - 1 = 2 \left(x - \frac{\pi}{4} \right)$$

This meets the x-axis at $\left(\frac{\pi}{4} - \frac{1}{2}, 0 \right)$. Therefore, the required area is area of $\Delta OAB = \text{area of } \Delta OAC - \text{area of } \Delta ABC$

$$\Delta ABC = \int_0^{\frac{\pi}{4}} \tan x dx - \frac{1}{2} (BC) \times AC$$

$$= \ln \sec x \Big|_0^{\pi/4} - \frac{1}{2} \times \left[\frac{\pi}{4} - \left(\frac{\pi}{4} - \frac{1}{2} \right) \right] \times 1 = \frac{1}{2} \left(\ln 2 - \frac{1}{2} \right)$$

Hence, k=5



PAPER -II

Sol.1

$$\begin{vmatrix} 1 & -k & -1 \\ k & -1 & k \\ 1 & 1 & -1 \end{vmatrix} = 0$$

$$\Rightarrow k = \pm 1$$

Sol.2

$$A^2 = A \Rightarrow A^3 = A^4 = A^n = A$$

Also, $(I + A)^n$

$$= I^n + {}^n C_1 I^{n-1} A + {}^n C_2 I^{n-2} A^2 + \dots + {}^n C_n I^n A^n$$

$$= I + A \left[{}^n C_1 + {}^n C_2 + \dots + {}^n C_n \right] = I + A(2^n - 1)$$

Sol.3

$$f'(x) - pf(x) \leq 0$$

$$\Rightarrow \frac{d}{dx} e^{-pf} f(x) \leq 0 \quad \dots(1)$$

$$\text{Let } g(x) = e^{-pf} f(x)$$

$$g'(x) \leq 0, \forall x \geq 1 \quad [\text{from Eq.(i)}]$$

$$\Rightarrow g(x) \leq g(1), \forall x \geq 1$$

$$g(x) \leq 0 \Rightarrow f(x) \leq 0$$

But given $f(x) \geq 0$

$$\Rightarrow f(x) = 0, \forall x \geq 1$$

Sol.4

We have,

$$\frac{s^2}{P\left(\frac{A}{B}\right)} + \frac{(s-a)^2}{P\left(\frac{A}{B}\right)} + \frac{(s-b)^2}{P\left(\frac{B}{A}\right)} + \frac{(s-c)^2}{P\left(\frac{B}{A}\right)} \geq 2s^2 \geq 6\sqrt{3}\Delta$$

Sol.5

$$S_n = \frac{0}{(nC_0)^k} + \frac{1}{(nC_1)^k} + \frac{2}{(nC_2)^k} + \dots + \frac{n}{(nC_{0n})^k}$$

$$S_n = \frac{n}{(nC_0)^k} + \frac{n-1}{(nC_1)^k} + \frac{n-2}{(nC_2)^k} + \dots + \frac{0}{(nC_{0n})^k}$$

$$2S_n = nt_n$$

$$\Rightarrow \frac{S_n}{nt_n} = \frac{1}{2}$$

Sol. 6

$$\sqrt{2} + \sqrt{3} > \pi (1.414 + 1.732 = 3.146 > \pi)$$

$$\therefore \frac{\sqrt{2} + \sqrt{3}}{2} > \frac{\pi}{2}, \text{ also } 0 < 13 - \sqrt{2} < \frac{\pi}{4}$$

$$\left(\sqrt{3} - \sqrt{2} = 0.318 < \frac{\pi}{4} \right)$$

$$\text{Now, } \sin \sqrt{2} - \sin \sqrt{3} = 2 \cos \frac{\sqrt{2} + \sqrt{3}}{2} \sin \frac{\sqrt{2} - \sqrt{3}}{2} > 0$$

$$\text{And } \cos \sqrt{2} - \cos \sqrt{3} = 2 \sin \frac{\sqrt{2} + \sqrt{3}}{2} \sin \frac{\sqrt{3} - \sqrt{2}}{2} > 0$$

Sol.7

$$\pi \log_3 \left(\frac{1}{x} \right) = k\pi, k \in I$$

$$\log_3 \left(\frac{1}{x} \right) = k \Rightarrow x = 3^{-k}$$

Possible values of k are -1, 0, 1, 2, 3,

$$S = (3 + 1) + \left(\frac{1}{3} + \frac{1}{3^2} + \frac{1}{3^3} + \dots \infty \right)$$

$$= 4 + \frac{(1/3)}{1 - (1/3)} = 4 + \frac{1}{2} = \frac{9}{2}$$

Sol.8

$$\sin^2 x + \sin^4 x + \sin^6 x + \dots \infty = \frac{\sin^2 x}{1 - \sin^2 x} = \tan^2 x$$

\therefore We have, $e^{\tan^2 x} \ln 3 = 3^{\tan^2 x}$ satisfies the equation

$$(t - 27)(t - 1) = 0$$

$$\therefore 3^{\tan^2 x} = 27 \text{ or } 3^{\tan^2 x} = 1$$

$$\tan^2 x = 3 \text{ as } \tan^2 x = 0 \quad (\text{rejected think!})$$

$$\tan x = \sqrt{3} \text{ or } x \in \left(0, \frac{\pi}{2} \right) \Rightarrow x = \frac{\pi}{2}$$

$$\text{Now, } \frac{1}{\sin x + \cos x} = \frac{\sec x}{1 + \tan x} = \frac{\sqrt{1 + \tan^2 x}}{1 + \tan x} = \frac{2}{\sqrt{3} + 1} = \frac{2\sqrt{3} - 1}{2} = (\sqrt{3} - 1)$$

Sol.9

$$\text{L.H.S}=(1 + 2x^2 + x^4)(1 + C_1x + C_2x^2 + C_3x^3 + \dots)$$

$$\text{RHS}=a_0 + a_1x + a_2x^2 + a_3x^3 + \dots$$

Comparing the coefficients of $x, x^2, x^3 \dots$

$$\text{Now, } 2a_2 = a_1 + a_3$$

$$2(n_{C_2+2}) = n_{C_1+(n_{C_3}+2^n C_1)}$$

$$2 \frac{n(n-1)}{2} + 4 = 3n + \frac{n(n-1)(n-2)}{6}$$

$$\text{Or } n^3 - 9n^2 + 26n - 24 = 0$$

$$\therefore (n-2)(n^2 - 7n + 12) = 0 \quad (\because 8+52+=36+24)$$

$$\text{Or } (n-2)(n-3)(n-4) = 0$$

$$\therefore n = 2,3,4$$

Sol.10

$$f(x) = \int_0^x e^{|t-x|} dt + \int_x^1 e^{|t-x|} dt = e^x + e^{1-x} - 2$$

$$\Rightarrow f'(x) = e^x - e^{1-x}$$

Clearly, $x = \frac{1}{2}$ is the point of minima of $f(x)$

$$\text{Also, } f'(0) = f(1) = e - 1$$

Sol.11

$$f(x) = \frac{\sin(\pi\{x\})}{x^4 + 3x^2 + 7}$$

Hence, $f\left(\frac{1}{2}\right) = f\left(-\frac{1}{2}\right) \Rightarrow$ Clearly, $f(x)$ is not one-one and also it is dependent on x .

Sol.12

Since, $f(x)$ and $g(x)$ are one-one and onto and are also the mirror images of each other which respect to the line $y = a$. It clearly indicates that $h(x) = f(x) + g(x)$ will be a constant function and will always be equal to $2a$.

Sol.13

Let $B = 2A$ and BD be the bisector of angle B, then

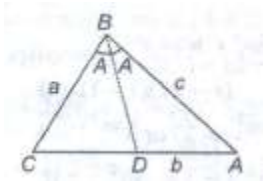
$$CD = \frac{ab}{a+c} \text{ and } AD = \frac{ac}{a+c}$$

Now, ΔABC and ΔBDC are similar, so

$$\frac{BC}{AC} = \frac{CD}{BC} \Rightarrow a^2 = \frac{ab}{a+c} b \Rightarrow b^2 = a(a+c) \dots (i)$$

Since, $b > a \Rightarrow$ Either $b = a + 1$ or $b = a + 2$, if $b = a + 1$, then

[from Eq.(i)]



$$(a+1)^2 = a(a+c) \Rightarrow c = 2 + \frac{1}{a}$$

$\because c$ is integer $\Rightarrow a = 1, b = 2, c = 3$ but then, no triangle will form.

If $b = a + 2$, then obviously $c = a + 1$ and then, [from Eq. (i)]

$$(a+2)^2 = a(2a+1)$$

$$\Rightarrow a^2 - 3a - 4 = 0 \text{ or } a = 4$$

$\therefore a = 4, b = 6, c = 5$ is the only possible solution.

Sol.14

$$\text{PV of } D = \frac{\lambda-1}{2} \hat{i} + 4\hat{j} + \frac{\mu+2}{2} \hat{k}$$

$$\text{DR of } AD = \frac{\lambda-4}{2}, 1, \frac{\mu+8}{2}$$

But direction ratios of AD should be $\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}$.

$$\Rightarrow \frac{\lambda-4}{2} = 1 = \frac{\mu+8}{2}$$

$$\lambda = 6, \mu = 10$$

$$2\lambda - \mu = 2$$

Sol.15

Provided that $x_1 + x_2 + x_3 = 24$

$$x_1^2 + x_2^2 + x_3^2 = 210$$

$$x_1x_2x_3 = 440$$

⇒ According to given question

$$x_1x_2 + x_2x_3 + x_3x_1 = \frac{(x_1 + x_2 + x_3)^2 - (x_1^2 + x_2^2 + x_3^2)}{2}$$

$$\Rightarrow x_1x_2 + x_2x_3 + x_3x_1 = 183$$

So, x_1, x_2, x_3 are the roots of the equation

$$x^3 - 24x^2 + 183x - 440 = (x - 5)(x - 8)(x - 11) = 0$$

$$\Rightarrow x = 5, 8, 11$$

Number of possible permutations = 6

Sol.16

$f(3) = 3, f(1) = 3, f(4) = f(2 + 1 + 1) = 2 + 1 + 1 = 4$ and so on.

In general, we get $f(r) = r \forall r \in N$

$$\Rightarrow \lim_{n \rightarrow \infty} \frac{\sum_{r=1}^n (4r)f(3r)}{n^3} = \lim_{n \rightarrow \infty} \frac{12n(n+1)(2n+1)}{6n^3} = 4$$

Sol.17

In given ΔABC both $\frac{A}{2}$ and $\frac{B}{2}$ lie strictly between $(0, \frac{\pi}{2})$ and

$\sin x$ is always increasing in $(0, \frac{\pi}{2})$ whereas $\cos x$ is always decreasing throughout $(0, \frac{\pi}{2})$.

So, if $\frac{A}{2} > \frac{B}{2}$

$$\Rightarrow \sin \frac{A}{2} > \sin \frac{B}{2} \text{ or } x_1 > x_2$$

And $\frac{1}{x_3} > \frac{1}{x_4}$

So, $x_1^{2007} x_4^{2006} = x_2^{2007} x_3^{2006}$ is not valid.

Similarly , for $\frac{A}{2} < \frac{B}{2}$

$$\Rightarrow \sin \frac{A}{2} < \sin \frac{B}{2}$$

$$\Rightarrow x_1 < x_2$$

And $\frac{1}{x_3} < \frac{1}{x_4}$ again equality is not possible,

Therefore, only possible case is when

$$\frac{A}{2} = \frac{B}{2} \Rightarrow x_1 = x_2$$

And $\frac{1}{x_3} = \frac{1}{x_4}$

Hence, in that case ΔABC is isosceles with

$$\angle ABC = \angle CAB$$

$$\Rightarrow BC = AC = 1 \text{ unit}$$

Sol.19

(A) $P(\text{two faulty identified}) + P(\text{two correct identified})$

$$= 2 \binom{2 \cdot \frac{c_2}{4}}{4 \cdot \frac{c_2}{2}} = 2 \binom{1.2}{4.3}$$

$$= 2 \binom{2 \cdot \frac{1}{4}}{4 \cdot \frac{1}{3}} = \frac{1}{3}$$

(B) $n(s) = 6 \times 6 = 36$

$$n(E) = 12$$

$$p = \frac{12}{36}$$

$$= \frac{1}{3}$$

(C) k may be any real constant.

(D) $n(E) = 1, n(s) = 2$

Sol.20

(A) $x = \frac{a+b+c}{2}$

(B) Rationalize and solve

(C) $\lim_{x \rightarrow 0} \frac{1}{3} \left(\frac{a^x-1}{x} + \frac{b^x-1}{x} + \frac{c^x-1}{x} \right)$
 $= e^{\frac{1}{3}(\log_e a + \log_e b + \log_e c)} = \sqrt[3]{abc}$

(D) $f(1) = (a + b - c) + (b + c - a) + (c + a - b)$
 $= a + b + c = 0$

As $a^3 + b^3 + c^3 = 3abc$

$\Rightarrow (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca) = 0$

$\Rightarrow a + b + c = 0$