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← Solutions of worksheet NO: 7 → (1)

Differentiation & Continuity

Ans 1 → $f(x) = x - [x]$ let k is any integer

$$f(x) = \begin{cases} x-(k-1) & ; \; k-1 \le x < k \\ x-k & ; \; k \le x < k+1 \end{cases}$$

Main point

Continuity at $x = k$

$LHL = \lim_{x \to k^-} [x-(k-1)]$ put $x = k-h$ & $h \to 0$

$LHL = \lim_{h \to 0} \left(k-h-(k-1) \right) = k-k+1 = 1$

$RHL = \lim_{x \to k^+} (x-k)$ put $x = k+h$ & $h \to 0$

$RHL = \lim_{h \to 0} \left(\cancel{k}+h-k \right) = \lim_{h \to 0} (h) = 0$

Since $LHL \neq RHL$

$\therefore f(x)$ is not continuous at $x = k$

Since $k \in Z$

$\therefore f(x)$ is not continuous at all the Integers **Ans.**

Ans 2 → $f(x) = \dfrac{\tan\left(\frac{\pi}{4}-x\right)}{\cot(2x)}$

here we have to find $f\left(\frac{\pi}{4}\right)$

Since $f(x)$ is continuous in $\left[0, \frac{\pi}{2}\right]$ $\therefore f(x)$ is also continuous at $x = \frac{\pi}{4}$

$\therefore$ By definition of continuity

$\lim_{x \to \pi/4} (f(x)) = f\left(\frac{\pi}{4}\right)$

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Solution of worksheet No 7 (DPC (2)

$$\Rightarrow \lim_{x\to\frac{\pi}{4}}\left[\frac{\tan(\frac{\pi}{4}-x)}{\cot(2x)}\right] = f(\tfrac{\pi}{4})$$

put $x = \frac{\pi}{4}+h$ & $h\to 0$

$$\Rightarrow \lim_{h\to 0}\left[\frac{\tan(\frac{\pi}{4}-\frac{\pi}{4}-h)}{\cot(2(\frac{\pi}{4}+h))}\right] = f(\tfrac{\pi}{4})$$

$$\Rightarrow \lim_{h\to 0}\left(\frac{\tan(-h)}{\cot(\frac{\pi}{2}+2h)}\right] = f(\tfrac{\pi}{4})$$

$$\Rightarrow \lim_{h\to 0}\left(\frac{\cancel{-}\tan h}{\cancel{-}\tan(2h)}\right) = f(\tfrac{\pi}{4}) \quad \ldots \left\{\cot(90+\theta) = -\tan\theta\right\}$$

$$\Rightarrow \lim_{h\to 0}\left(\frac{\frac{\tan h}{h}\times \cancel{h}}{\frac{\tan(2h)}{2h}\times 2\cancel{h}}\right) = f(\tfrac{\pi}{4})$$

$$\Rightarrow \frac{1}{1\times 2} = f(\tfrac{\pi}{4})$$

$$\therefore f(\tfrac{\pi}{4}) = \frac{1}{2} \quad \underline{\text{Ans.}}..$$

Ans 3 → $f(x) = \dfrac{(4^x-1)^3}{\sin(x/4)\cdot\log(1+\frac{x^2}{3})}$

given $f(x)$ is continuous at $x=0$

∴ By defination of continuity

$$\lim_{x\to 0}(f(x)) = f(0)$$

$$\Rightarrow \lim_{x\to 0}\left(\frac{(4^x-1)^3}{\sin(\frac{x}{4})\ \log(1+\frac{x^2}{3})}\right) = f(0)$$

adjustments

$$\Rightarrow \lim_{x\to 0}\left[\frac{\left(\frac{4^x-1}{x}\right)^3\times x^3}{\frac{\sin(\frac{x}{4})}{\frac{x}{4}}\times\frac{x}{4}\cdot\frac{\log(1+\frac{x^2}{3})}{x^2/3}\times\frac{x^2}{3}}\right] = f(0)$$

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Solution of worksheet No. 7 (DCC) (3)

$$\Rightarrow \frac{(\log 4)^3}{(1)\times\frac{1}{4}\times 1\times\frac{1}{3}} = f(0) \quad \cdots \left\{ \because \lim_{x\to 0}\left(\frac{a^x-1}{x}\right) = \log a,\ \lim_{x\to 0}\left(\frac{\log(1+x)}{x}\right) = 1,\ \lim_{x\to 0}\left(\frac{\sin x}{x}\right) = 1 \right\}$$

$$\Rightarrow 12\log(4)^3 = f(0)$$

$$\therefore f(0) = 12(\log 4)^3 \quad \underline{\text{Ans..}}$$

Qn 4 → $f(x) = \begin{cases} x-1 : & x<2 \\ 2x-3 : & x\geq 2 \end{cases}$

$$LHD = \lim_{x\to 2^-}\left(\frac{(x-1)-f(2)}{x-2}\right)$$
$$= \lim_{x\to 2^-}\left(\frac{(x-1)-(4-3)}{x-2}\right)$$
$$= \lim_{x\to 2^-}\left(\frac{\cancel{x-2}}{\cancel{x-2}}\right)$$
$$= \lim_{x\to 2^-}(1)$$
$$\therefore LHD = 1$$

$$RHD = \lim_{x\to 2^+}\left(\frac{2x-3-f(2)}{x-2}\right)$$
$$= \lim_{x\to 2^+}\left(\frac{2x-3-(4-3)}{x-2}\right)$$
$$= \lim_{x\to 2^+}\left(\frac{2x-4}{x-2}\right)$$
$$= \lim_{x\to 2^+}\left(\frac{2\cancel{(x-2)}}{\cancel{x-2}}\right)$$
$$RHD = 2$$

Clearly $LHD \neq RHD$

$\therefore f(x)$ is not differentiable at $x=2$ Ans..

Qn 5 → $f(x) = x^2$

for LHD & RHD we have to use same function (here)

$$LHD = \lim_{x\to 1^-}\left(\frac{x^2-f(1)}{x-1}\right)$$
$$= \lim_{x\to 1^-}\left(\frac{x^2-1}{x-1}\right)$$
$$= \lim_{x\to 1^-}\left(\frac{(x+1)\cancel{(x-1)}}{\cancel{x-1}}\right)$$

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put $x = 1-h$ & $h \to 0$

$LHD = \lim_{h \to 0} (1-h+1)$

$LHD = 2$

Similarly do $RHD = 2$

$\therefore f(x)$ is differentiable at $x = 1$ Ans..

Qn 6 → $f(x) = x|x|$

Redefine the function

$$f(x) = \begin{cases} x(x) & ; x \geq 0 \\ x(-x) & ; x < 0 \end{cases}$$

$$f(x) = \begin{cases} x^2 & ; x \geq 0 \\ -x^2 & ; x < 0 \end{cases}$$

Differentiability at $x = 0$

$LHD = \lim_{x \to 0^-} \left(\frac{-x^2 - f(0)}{x - 0}\right)$

$LHD = \lim_{x \to 0^-} \left(\frac{-x^2 - 0}{x}\right)$

$LHD = \lim_{x \to 0^-} (-x^2)$

put $x = 0-h = -h$ & $h \to 0$

$LHD = \lim_{h \to 0} (-h^2)$

$LHD = 0$

$RHD = \lim_{x \to 0^+} \left(\frac{x^2 - f(0)}{x - 0}\right)$

$= \lim_{x \to 0^+} \left(\frac{x^2 - 0}{x}\right)$

$= \lim_{x \to 0^+} (x)$

put $x = 0+h = h$ & $h \to 0$

$RHD = \lim_{h \to 0} (h)$

$RHD = 0$

$\therefore f(x)$ is differentiable at $x = 0$ Ans

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Solutions of worksheet No. 7 (D2C) 5

Qn. 7 → $f(x) = |x-1| - |x-2|$
① ②

Redefine the function

$$f(x) = \begin{cases} -(x-1) + (x-2) & ; \quad x < 1 \\ (x-1) + (x-2) & ; \quad 1 \le x < 2 \\ (x-1) - (x-2) & ; \quad x \ge 2 \end{cases}$$

$$f(x) = \begin{cases} -1 & : \quad x < 1 \\ 2x-3 & : \quad 1 \le x < 2 \\ 1 & ; \quad x \ge 2 \end{cases}$$

Differentiability at $x = 1$

$LHD = \lim_{x\to 1^-} \left(\frac{-1 - f(1)}{x-1} \right)$

$LHD = \lim_{x\to 1^-} \left(\frac{-1 - (2-3)}{x-1} \right)$

$LHD = \lim_{x\to 1^+} \left(\frac{0}{x-1} \right)$

$LHD = 0$

$RHD = \lim_{x\to 1^+} \left(\frac{2x-3 - f(1)}{x-1} \right)$

$RHD = \lim_{x\to 1^+} \left(\frac{2x-3 - (2-3)}{x-1} \right)$

$= \lim_{x\to 1^+} \left(\frac{2x-2}{x-1} \right)$

$= \lim_{x\to 1^+} \left(\frac{2\cancel{(x-1)}}{\cancel{x-1}} \right)$

$RHD = 2$

Since $LHD \neq RHD$ $\therefore f(x)$ is not differentiable at $x=1$

Similarly (do yourself) $f(x)$ is not differentiable at $x=2$

Ans

Qn 8 → $f(x) = \begin{cases} x^2 & : \quad x \le 2 \\ ax+b & : \quad x > 2 \end{cases}$

given that $f(x)$ is differentiable at $x=2$

$\therefore f(x)$ must be continuous at $x=2$ also

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Continuity at $x=2$

$LHL = RHL = f(2)$

$\Rightarrow \lim_{x\to 2^-}(x^2) = \lim_{x\to 2^+}(ax+b) = f(2)$

put $x=2-h$, $h\to 0$ put $x=2+h$, $h\to 0$

$\Rightarrow \lim_{h\to 0}\left((2-h)^2\right) = \lim_{h\to 0}\left(a(2+h)+b\right) = (2)^2$

$\Rightarrow 4 = 2a+b = 4$

$\Rightarrow \boxed{2a+b=4}$ ---- (1)

Differentiability at $x=2$

$LHD = \lim_{x\to 2^-}\left(\frac{x^2 - f(2)}{x-2}\right)$

$LHD = \lim_{x\to 2^-}\left(\frac{x^2-4}{x-2}\right)$

$LHD = \lim_{x\to 2^-}\left(\frac{(x+2)\cancel{(x-2)}}{\cancel{x-2}}\right)$

put $x=2-h$ & $h\to 0$

$LHD = \lim_{h\to 0}(2-h+2)$

$\boxed{LHD = 4}$

$RHD = \lim_{x\to 2^+}\left(\frac{ax+b-f(2)}{x-2}\right)$

$RHD = \lim_{x\to 2^+}\left(\frac{ax+b-4}{x-2}\right)$ from eq (1)

$RHD = \lim_{x\to 2^+}\left(\frac{ax+(4-2a)-4}{x-2}\right)$

$\Rightarrow RHD = \lim_{x\to 2^+}\left(\frac{ax-2a}{x-2}\right)$

$RHD = \lim_{x\to 2^+}\left(\frac{a\cancel{(x-2)}}{\cancel{x-2}}\right)$

$\boxed{RHD = a}$

Since $LHD = RHD$ (given)

$\Rightarrow \boxed{a=4}$ put in equation (1)

$8+b=4$

$\Rightarrow \boxed{b=-4}$ Ans.

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Solution of worksheet No: 7 (DEC (7)

Qn 9 → $f(x) = \sin^2 x \; ; \quad 0 \le x \le \pi$

Soln (1) Sine function is everywhere continuous function and product of two continuous functions is also continuous. $\therefore f(x)$ is continuous in $[0, \pi]$

(2) Diff w.r.t x $\quad f'(x) = 2\sin x \cos x = \sin(2x)$

Clearly $f'(x)$ exists for all $x \in (0, \pi)$

$\therefore f(x)$ is differentiable in open interval $(0, \pi)$

(3) $f(0) = \sin^2(0) = 0$

$f(\pi) = \sin^2(\pi) = 0$

$f(0) = f(\pi)$

the three conditions of Rolle's theorem are satisfied then there exists a value $c \in (0, \pi)$ such that

$f'(c) = 0$

$\Rightarrow \quad \sin(2c) = 0$

$\Rightarrow \quad 2c = 0 \;\;\; c = 0$ (X) $\quad \Big| \quad 2c = \pi \;\;\; c = \frac{\pi}{2} \quad \Big| \quad 2c = 2\pi \;\;\; c = \pi$ (X)

$c = 0 \ \& \ \pi \notin (0, \pi)$

$\therefore c = \frac{\pi}{2} \in (0, \pi)$

Hence Rolle's theorem is verified. Ans

Qn 10 → $f(x) = x^3 - 6x^2 + 11x - 6 \; ; \quad x \in [1, 3]$

Soln (1) Given $f(x)$ is a polynomial function, which is everywhere continuous $\therefore f(x)$ is continuous in $[1, 3]$

(2) Diff w.r.t x $\quad f'(x) = 3x^2 - 12x + 11$

Clearly $f'(x)$ exists for all $x \in (1, 3)$

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$\therefore f(x)$ is differentiable in $(1,3)$

(3) $f(1) = 1-6+11-6 = 0$

$f(3) = 27-54+33-6 = 0$

$f(1) = f(3)$

then there exists a value $c \in (1,3)$ such that $f'(c) = 0$

$\Rightarrow 3c^2 - 12c + 11 = 0$

$c = \dfrac{12 \pm \sqrt{144-132}}{2\times 3}$

$c = \dfrac{12 \pm \sqrt{12}}{6}$

$c = \dfrac{12 \pm 2\sqrt{3}}{6}$

$c = 2 \pm \dfrac{\sqrt{3}}{3}$

Clearly $c = 2 \pm \dfrac{\sqrt{3}}{3}$ (both values) $\in (1,3)$

Hence Rolle's theorem is verified Ans

Qn. 11 → $f(x) = e^x(\sin x - \cos x)$; $x \in \left[\frac{\pi}{4}, \frac{5\pi}{4}\right]$

Soln (1) Sine function, cosine function & exponential function are everywhere continuous & subtraction and multiplication of two continuous functions is also continuous

$\therefore f(x)$ is continuous in $\left[\frac{\pi}{4}, \frac{5\pi}{4}\right]$

(2) Diff wrt x

$f'(x) = e^x(\cos x + \sin x) + (\sin x - \cos x)e^x$

$f'(x) = 2e^x \sin x$

Clearly $f'(x)$ exists for all $x \in \left(\frac{\pi}{4}, 5\pi/4\right)$

$\therefore f(x)$ is differentiable in $\left(\frac{\pi}{4}, \frac{5\pi}{4}\right)$

(3) $f\left(\frac{\pi}{4}\right) = e^{\pi/4}\left(\sin\frac{\pi}{4} - \cos\frac{\pi}{4}\right) = e^{\pi/4}\left(\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{2}}\right) = 0$

$f\left(\frac{5\pi}{4}\right) = e^{5\pi/4}\left(\sin\left(\frac{5\pi}{4}\right) - \cos\left(\frac{5\pi}{4}\right)\right) = e^{5\pi/4}\left(\sin\left(\pi+\frac{\pi}{4}\right) - \cos\left(\pi+\frac{\pi}{4}\right)\right)$

$= e^{5\pi/4}\left(-\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right) = 0$

$\therefore f\left(\frac{\pi}{4}\right) = f\left(\frac{5\pi}{4}\right)$

Hence there exists a value $c \in \left(\frac{\pi}{4}, \frac{5\pi}{4}\right)$ such that $f'(c) = 0$

$\Rightarrow 2e^{c}\sin c = 0$

$\Rightarrow e^{c}\sin c = 0$

$\Rightarrow \sin c = 0$ ---- $\{\because e^{x} \neq 0$ for all $x \in R\}$

$\Rightarrow c = 0$ | $c = \pi$

(X) | $c = \pi \in \left(\frac{\pi}{4}, \frac{5\pi}{4}\right)$

Hence Rolle's theorem is verified Ans.

Ques 12 → $f(x) = x(x+3)e^{-x/2}$; $x \in [-3, 0]$

or $f(x) = (x^2+3x)\cdot e^{-x/2}$

Soln (1) Since polynomial function & exponential function are everywhere continuous & product of two continuous functions is also continuous

$\therefore f(x)$ is continuous in $[-3, 0]$

(2) Diff. wrt x $f'(x) = (x^2+3x)e^{-x/2}\cdot\left(-\frac{1}{2}\right) + e^{-x/2}\cdot(2x+3)$

$f'(x) = e^{-x/2}\left(-\frac{(x^2+3x)}{2} + 2x+3\right)$

$f'(x) = e^{-x/2}\left(\frac{-x^2+x+6}{2}\right)$

Solution of Worksheet No 7 (DEC

$f'(x) = -\frac{e^{-x/2}}{2}(x^2 - x - 6)$

Clearly $f'(x)$ exists for all $x \in (-3, 0)$

(3) $f(-3) = (9-9)e^{3/2} = 0$

$f(0) = 0$

$\therefore f(-3) = f(0)$

then there exists a value $c \in (-3, 0)$ such that

$f'(c) = 0$

$\Rightarrow -\frac{e^{-c/2}}{2}(c^2 - c - 6) = 0$

$\Rightarrow e^{-c/2}((c-3)(c+2)) = 0$

$\Rightarrow c = 3$ or $c = -2$ --- $\{e^{-c/2} \neq 0$ for any value of $c\}$

$c = 3 \notin (-3, 0)$ & $c = -2 \in (-3, 0)$

$\therefore$ Rolle's theorem is verified Ans

Qn 13 $\Rightarrow$ $f(x) = \sin^4 x + \cos^4 x \quad ; x \in [0, \frac{\pi}{2}]$

Soln (1) Sine function & cosine function are everywhere continuous & product & addition of two continuous functions is also continuous.

$\therefore f(x)$ is continuous in $[0, \frac{\pi}{2}]$

(2) Diff wrt x

$f'(x) = 4\sin^3 x \cdot \cos x + 4\cos^3 x \cdot (-\sin x)$

$f'(x) = 4\sin x \cos x(\sin^2 x - \cos^2 x)$

$f'(x) = -2\sin(2x)(\cos^2 x - \sin^2 x)$

$f'(x) = -2\sin(2x)\cos(2x)$ --- $\left\{ \because 2\sin x\cos x = \sin(2x),\ \cos^2 x - \sin^2 x = \cos(2x) \right\}$

$f'(x) = -\sin(4x)$

Clearly $f'(x)$ exists for all $x \in (0, \frac{\pi}{2})$

$\therefore f(x)$ is differentiable in $(0, \frac{\pi}{2})$

(3) $f(0) = \sin^4(0) + \cos^4(0) = 0 + 1 = 1$

$f(\frac{\pi}{4}) = \sin^4(\frac{\pi}{2}) + \cos^4(\frac{\pi}{2}) = 1 + 0 = 1$

$\therefore f(0) = f(\pi/4)$

then there exists a value $c \in (0, \frac{\pi}{2})$ such that

$f'(c) = 0$

$\Rightarrow -\sin(4c) = 0$

$\Rightarrow \sin(4c) = 0$

$\Rightarrow 4c = 0$	$4c = \pi$	$4c = 2\pi$	$4c = 3\pi$
$c = 0$	$c = \frac{\pi}{4}$	$c = \frac{\pi}{2}$	$c = \frac{3\pi}{4}$ (x)
(x)		(x)	

Clearly $c = \frac{\pi}{4} \in (0, \frac{\pi}{2})$

Hence Rolle's theorem is verified Ans

Qn 14 → $f(x) = 12(x+1)(x-2)$; $x \in [-1, 2]$

Sol $f(x) = 12(x^2 - x - 2)$

- polynomial function which is everywhere continuous
  $\therefore f(x)$ is continuous in $[-1, 2]$

- $f'(x) = 12(2x - 1)$ Clearly $f'(x)$ exists for all $x \in (-1, 2)$
  $\therefore f(x)$ is differentiable in $(-1, 2)$

$f(-1) = 12(1+1-2) = 0$
$f(2) = 12(4-2-2) = 0$
$\therefore f(-1) = f(2)$

then there exists a value $c \in (-1,2)$ such that
$f'(c) = 0$
$\Rightarrow 12(2c-1) = 0$
$\Rightarrow c = 1/2 \in (-1,2)$
$\therefore$ R-T is verified

Now $f(c) = f(\frac{1}{2}) = 12(\frac{1}{2}+1)(\frac{1}{2}-2)$
$= 12(\frac{3}{2})(\frac{-3}{2}) = -27$

$(c, f(c))$ is the point on the curve where tangent is parallel to x-axis
$\therefore (\frac{1}{2}, -27)$ Ans

Qn-15 → $f(x) = x(x-1)(x-2)$; $x \in [0, \frac{1}{2}]$

Soln $f(x) = x(x^2-3x+2) = x^3-3x^2+2x$
(1) $f(x)$ is a polynomial function which is everywhere continuous $\therefore f(x)$ is continuous in $[0, 1/2]$

(2) $f'(x) = 3x^2-6x+2$
Clearly $f'(x)$ exists for all $x \in (0, 1/2)$
$\therefore f(x)$ is differentiable in $(0, 1/2)$

two conditions of LMV are satisfied, then there exists a value $c \in (0, 1/2)$ such that
$$f'(c) = \frac{f(\frac{1}{2}) - f(0)}{\frac{1}{2} - 0}$$

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Solution of Worksheet No. 7 CD&C (13)

$$3c^2-6c+2 = \frac{\left(\frac{1}{8}-\frac{3}{4}+1\right)-(0)}{\frac{1}{2}}$$

$$\Rightarrow 3c^2-6c+2 = \frac{1-6+8}{4}$$

$$\Rightarrow 3c^2-6c+2 = \frac{3}{4}$$

$$\Rightarrow 12c^2-24c+5=0$$

$$c = \frac{24 \pm \sqrt{576-240}}{24}$$

$$c = \frac{24 \pm \sqrt{336}}{24}$$

$$c = \frac{24 \pm \sqrt{16\times 21}}{24}$$

$$c = \frac{24 \pm 4\sqrt{21}}{26}$$

$$c = 1 \pm \frac{\sqrt{21}}{6}$$

$$c = 1+\frac{\sqrt{21}}{6} > \frac{1}{2} \quad \therefore \quad c \notin \left(0,\frac{1}{2}\right)$$

$$c = 1-\frac{\sqrt{21}}{6} \in (0, 1/2) \quad \therefore \text{ LMV verified Ans}$$

Qn. 16 → $f(x) = (x-3)^2$ chord joining $(3,0)$ & $(4,1)$

Sol: here $a=3$, $b=4$ $\therefore x \in [3,4]$

do yourself verify LMV

find $c = \frac{7}{2}$

$\therefore f(c) = f(\frac{7}{2}) = 1/4$

$\therefore (7/2, 1/4)$ is the point on the curve where tangent is parallel to the chord Ans

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Solution worksheet No: 7 (DEC

Qn. 17 → $f(x) = x^3 + bx^2 + ax \; ; \quad x \in [1, 3]$

$c = 2 + \frac{1}{\sqrt{3}}$

Soln:

Given Rolle's theorem holds

$\therefore f(1) = f(3)$

$\Rightarrow 1 + b + a = 27 + 9b + 3a$

$\Rightarrow 2a + 8b = -26$

$\Rightarrow \boxed{a + 4b = -13} \quad \text{---} (1)$

Diff wrt x $\quad f'(x) = 3x^2 + 2bx + a$

$f'(c) = 3c^2 + 2bc + a$

Since Rolle's theorem holds

$\therefore f'(c) = 0$

$\Rightarrow 3c^2 + 2bc + a = 0$

put $c = 2 + \frac{1}{\sqrt{3}}$ (given)

$\Rightarrow 3\left(2 + \frac{1}{\sqrt{3}}\right)^2 + 2b\left(2 + \frac{1}{\sqrt{3}}\right) + a = 0$

$\Rightarrow 3\left(4 + \frac{1}{3} + \frac{4}{\sqrt{3}}\right) + 4b + \frac{2b}{\sqrt{3}} + a = 0$

$\Rightarrow \cancel{3}\left(\frac{12\sqrt{3} + \sqrt{3} + 12}{\cancel{3}\sqrt{3}}\right) + \frac{2b}{\sqrt{3}} + (a + 4b) = 0$

$\Rightarrow \frac{13\sqrt{3} + 12}{\sqrt{3}} + \frac{2b}{\sqrt{3}} + (-13) = 0$ -- {from eq(1)}

$\Rightarrow \cancel{13\sqrt{3}} + 12 + 2b - \cancel{13\sqrt{3}} = 0$

$\Rightarrow \cancel{\sqrt{3}} \quad 2b + 12 = 0$

$\rightarrow b = -6$ put in eq(1)

$a - 24 = -13$

$a = 11$ Ans

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