Exercise-3

*** Marked Questions may have more than one correct option.**

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. **Sol.** $ax^2 + bx + c = 0$

$a(x - \alpha)\ (x - \beta) = 0$

$$\lim_{x\to\alpha}\frac{1-\cos(ax^2+bx+c)}{(x-\alpha)^2} = \lim_{x\to\alpha}\frac{2\sin^2\left(\frac{ax^2+bx+c}{2}\right)}{(x-\alpha)^2} = \lim_{x\to\alpha}\frac{2\sin^2\left(\frac{a}{2}\ (x-\alpha)\ (x-\beta)\right)}{(x-\alpha)^2}$$

$$= \lim_{x\to\alpha}\left(\frac{\sin\left(\frac{a(x-\alpha)\ (x-\beta)}{2}\right)}{\frac{a(x-\alpha)\ (x-\beta)}{2}}\right)^2 \cdot \frac{2a^2(x-\beta)^2}{4} = (1)\ \frac{2a^2(\alpha-\beta)^2}{4} = \frac{a^2(\alpha-\beta)^2}{2}$$

2. **Sol.** Since $|f(x) - f(y)| \le (x - y)^2$

$$\lim_{x\to y}\frac{|f(x)-f(y)|}{|x-y|} \le \lim_{x\to y}|x-y|$$

$\Rightarrow$ $|f'(y)| \le 0$

$\Rightarrow$ $f'(y) = 0$

$\Rightarrow$ $f(y) = \text{constant}$

$\Rightarrow$ $f(y) = 0$ $[\because\ f(0) = 0 \text{ given}]$

$\Rightarrow$ $f(1) = 0$

3. **Sol.** $f'(1) = \lim\limits_{h\to 0}\dfrac{f(1+h)-f(1)}{h}$

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

Since, $\lim\limits_{h\to 0}\dfrac{f(1+h)}{h}$ = 5, so $\lim\limits_{h\to 0}\dfrac{f(1)}{h}$ must be finite as $f'(1)$ exist and $\lim\limits_{h\to 0}\dfrac{f(1)}{h}$ can be finite only, if $f(1) = 0$ and $\lim\limits_{h\to 0}\dfrac{f(1)}{h} = 0$

$\therefore$ $f'(1) = \lim\limits_{h\to 0}\dfrac{f(1+h)}{h} = 5.$

4. **Sol.** Since, $f(x) = \dfrac{x}{1+|x|}$

Let $f(x) = \dfrac{g(x)}{h(x)} = \dfrac{x}{1+|x|}$

It is clear that $g(x) = x$ and $h(x) = 1 + |x|$ are differentiable on $(-\infty, \infty)$ and $(-\infty, 0) \cup (0, \infty)$ respectively.

Thus, $f(x)$ is differentiable on $(-\infty, 0) \cup (0, \infty)$.

Now we have to check the differentiability at $x = 0$

$$\therefore \quad \lim_{x\to 0}\frac{f(x)-f(0)}{x-0} = \lim_{x\to 0}\frac{\frac{x}{1+|x|}-0}{x}$$

$= \lim_{x\to 0}\frac{1}{1+|x|} = 1$

Hence, f (x) is differentiable on $(-\infty, \infty)$.

5. **Sol.** Now, $\lim_{x\to 0}\left(\frac{1}{x}-\frac{2}{e^{2x}-1}\right) = \lim_{x\to 0}\frac{e^{2x}-1-2x}{x(e^{2x}-1)}$

$= \lim_{x\to 0}\frac{2e^{2x}-2}{(e^{2x}-1)+2xe^{2x}}$ (using L'Hospital's rule)

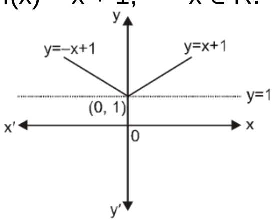
$= \lim_{x\to 0}\frac{4e^{2x}}{4e^{2x}+4xe^{2x}} = 1$ (using L'Hospital's rule)

$\therefore$ f(x) is continuous at x = 0, then

$\lim_{x\to 0} f(x) = f(0) \Rightarrow 1 = f(0)$

6. **Sol.** f(x) = min {x + 1, |x| + 1}

$f(x) = x + 1, \ \forall \ x \in R.$



It is clear from the figure that

$f(x) \geq 1, \ \forall \ x \in R.$

7. **Sol.** Now, $f'(1) = \lim_{h\to 0}\frac{f(1-h)-f(1)}{-h} = \lim_{h\to 0}\frac{f(1-h-1)\sin\left(\frac{1}{1-h-1}\right)-0}{-h} = \lim_{h\to 0}\sin\left(-\frac{1}{h}\right) = -\lim_{h\to 0}\sin\frac{1}{h}$

and $f'(1_+) = \lim_{h\to 0}\frac{f(1+h)-f(1)}{h} = \lim_{h\to 0}\frac{(1+h-1)\sin\left(\frac{1}{1+h-1}\right)-0}{h} = \lim_{h\to 0}\sin\frac{1}{h}$

$\therefore$ $f'(1_-) \neq f'(1_+)$

f is not differentiable at x = 1.

Again, now

$f'(0) = \lim_{h\to 0}\frac{(0+h+1)\sin\left(\frac{1}{0+h+1}\right)-\sin 1}{-h}$

$= \lim_{h\to 0}\frac{\left[-\left\{(h+1)\cos\left(\frac{1}{h+1}\right)\times\left(\frac{1}{(h+1)^2}\right)\right\}+\sin\left(\frac{1}{h+1}\right)\right]}{-1}$ (using L' hospital's rule)

= cos 1 – sin 1

and $f'(0_+) = \lim_{h\to 0}\frac{(0+h-1)\ \sin\ \left(\frac{1}{0+h-1}\right)-\sin\ 1}{h}$

= (using L'Hospital's rule)

$= \cos 1 - \sin 1 \Rightarrow f'(0_-) = f'(0_+)$

$\therefore$ f is differentiable at x = 0.

8. **Sol.** gof (x) = sin (x |x|)

gof (x) = $\begin{cases} \cos(x|x|)(|x|+x \cdot \frac{x}{|x|}) & , \quad x \neq 0 \\ |x|\cos(x|x|) & , \quad x = 0 \end{cases}$

∴ gof is differentiable at x = 0 and the derivatives is continuous

∴ statement-1 is true

Statement-2

$$\lim_{h\to 0^-} \frac{(gof)'(0+h)-(gof)'(0)}{h} = \lim_{h\to 0^-} \frac{\cos(h|h|)\left(|h|+h\frac{h}{|h|}\right)}{h} = \frac{\cos(h^2)(h+h)}{h} = 2$$

$$\lim_{h\to 0^-} \frac{(gof)'(0-h)-(gof)'(0)}{h} = \lim_{h\to 0^-} \frac{\cos(h|h|)\left(|h|+\frac{h^2}{|h|}\right)}{h} = \lim_{h\to 0^-} \frac{\cos(-h^2)(-h-h)}{h} = -2$$

∴ not differentiable

∴ statement-2 is false

9. **Ans.** **(4)**

Sol. $\lim_{x\to 0} \frac{f(3x)}{f(x)} = 1$

f(x) < f(2x) < f(3x) Divide by f(x)

$1 < \frac{f(2x)}{f(x)} < \frac{f(3x)}{f(x)}$

using sandwitch theorem $\Rightarrow \lim_{x\to\infty} \frac{f(2x)}{f(x)} = 1$

Hence correct option is (4)

10.
Ans. **(4)**

Sol. $e^x + 2e^{-x} \geq 2\sqrt{2}$ (AM ≥ GM)

$\frac{1}{e^x+2e^{-x}} \leq \frac{1}{2\sqrt{2}}$

$\frac{1}{2\sqrt{2}} \geq f(x) > 0$ so statement- 2 is correct

As f(x) is continuous and $\frac{1}{3}$ belongs to range $\left(0, \frac{1}{2\sqrt{2}}\right]$ of f(x),

⇒ f(c) = $\frac{1}{3}$ for some C.

Hence correction option is (4).

11. **Sol.** **(1)**

$\lim_{x\to 2} \sqrt{2}\frac{|\sin\ (x-2)|}{(x-2)}$

∴ does not exist

12. **Sol.** **(4)**

$\ell im_{x\to 5} \frac{(f(x)^2)-9}{\sqrt{|x-5|}} = 0$; $\ell im_{x\to 5}[(f(x))^2-9] = 0$; $\ell im_{x\to 5}$ f(x) = 3

13. **Sol.** **(3)**

f(0) = q

$f(0_+) = \lim\limits_{x\to 0^+} \dfrac{(1+x)^{1/2}-1}{x} = \lim\limits_{x\to 0^+} \dfrac{1+\frac{1}{2}x+.....-1}{x} = \dfrac{1}{2}$

$f(0_-) = \lim\limits_{x\to 0^-} \dfrac{\sin\ (p+1)x+\sin x}{x}$

$f(0_-) = \lim\limits_{x\to 0^-} \dfrac{(\cos(p+1)x)(p+1)+(\cos x)}{1} = (p + 1) + 1 = p + 2$

$\therefore \quad p + 2 = q = \dfrac{1}{2} \Rightarrow p = -\dfrac{3}{2}, q = \dfrac{1}{2}$ **Ans.**

14. **Sol.** $f(x) = \begin{cases} x\sin(1/x) & , \quad x \neq 0 \\ 0 & , \quad x = 0 \end{cases}$ at x = 0 ĳ

LHL = $\lim\limits_{h\to 0^-} \left\{-h\sin\left(-\dfrac{1}{h}\right)\right\}$ = 0 × a finite quantity between – 1 and 1

RHL = $\lim\limits_{h\to 0^-} h \sin \dfrac{1}{h} = 0$

f(0) = 0

∴ f(x) is continuous on R.

$f_2(x)$ is not continuous at x = 0

15. **Sol.** **(3)**

$\lim\limits_{x\to a} \dfrac{x^2f(a)-a^2f(x)}{x-a} = \lim\limits_{x\to a} \dfrac{2xf(a)-a^2f'(x)}{1} = 2af(a) - a^2f'(a)$

Alter $\lim\limits_{x\to a} \dfrac{x^2f(a)-a^2f(x)}{x-a} = \lim\limits_{x\to a} \dfrac{x^2f(a)-a^2f(a)+a^2f(a)-a^2f(x)}{x-a}$

$= \lim\limits_{x\to a} \dfrac{(x^2-a^2)f(a)-a^2(f(x)-f(a))}{x-a} = \lim\limits_{x\to a} (x+a)f(a) - a^2\left\{\dfrac{f(x)-f(a)}{(x-a)}\right\}$

$= 2af(a) - a^2f'(a)$

16. **Sol.** **Ans. (1)**

Doubtful points are x = n, n ∈ I

L.H.L = $\lim\limits_{x\to n^-} [x]\cos\left(\dfrac{2x-1}{2}\right)\pi = (n-1)\cos\left(\dfrac{2n-1}{2}\right)\pi = 0$

R.H.L. = $\lim\limits_{x\to n^+} [x]\cos\left(\dfrac{2n-1}{2}\right)\pi = n\cos\left(\dfrac{2n-1}{2}\right)\pi = 0$

f(n) = 0

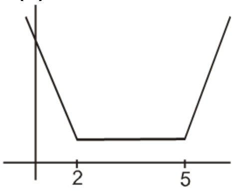
Hence continuous

17. **Sol.** **Ans. (3)**

f(x) = 3 $\quad 2 \le x \le 5$

f'(x) = 0 $\quad 2 < x < 5$

f'(4) = 0



18. **Sol.** (4)

$$I = \lim_{x\to 0}\frac{(1-\cos 2x)}{x^2}\frac{(3+\cos x)}{1}\cdot\frac{x}{\tan 4x} = \lim_{x\to 0}\frac{2\sin^2 x}{x^2}\cdot\frac{3+\cos x}{1}\cdot\frac{x}{\tan 4x} = 2.4.\ \frac{1}{4} = 2$$

19. **Sol.** **Ans.** **(2)**

$$\lim_{x\to 0}\frac{\sin(\pi\cos^2 x)}{x^2} \qquad \left(\frac{0}{0}\text{form}\right)$$

$$= \lim_{x\to 0}\frac{\sin(\pi\cos^2 x)}{x^2} = \frac{\sin(\pi\sin^2 x)}{\pi\sin^2 x}\times\frac{\pi\sin^2 x}{x^2} = \pi.$$

20. **Ans.** **(3)**

Sol. $$\lim_{x\to 0}\frac{(1-\cos 2x)(3+\cos x)}{x\tan 4x} = \lim_{x\to 0}\frac{2\sin^2 x}{x^2}\frac{(3+\cos x)}{\frac{\sin 4x}{4x}}\frac{\cos 4x}{4} = 2$$

21. **Ans.** **(1)**

Sol. $$g(x) = \begin{cases} k\sqrt{x+1} & 0\le x\le 3 \\ mx+2 & 3<x\le 5\end{cases}$$

$$L(g'(3)) = \lim_{x\to 3^-}\frac{k\sqrt{x+1}-2k}{x-3} = \lim_{x\to 3^-}k\left\{\frac{(x+1-4)}{(x-3)\left(\sqrt{x+1}+2\right)}\right\} = \frac{k}{4}$$

$$R(g'(3)) = \lim_{x\to 3^+}\frac{mx+2-2k}{x-3}$$

Since this limit exists 3m + 2 – 2k = 0 ⇒ 2k = 3m + 2 ...(i)

So R(g'(3)) = m by L-Hospital rule

Since g(x) is differentiable k = 4m ...(ii)

Solving (i) & (ii)

$m = \frac{2}{5}$, $k = \frac{8}{5}$ ⇒ k + m = 2 ...(ii)

22. **Ans.** **(2)**

Sol. $P = \lim_{x\to 0^+}\left(1+\tan^2\sqrt{x}\right)^{\frac{1}{2x}}$ then log p =

$$P = e^{\lim_{x\to 0^+}\left(1+\tan^2\sqrt{x}-1\right)\frac{1}{2x}} = e^{\lim_{x\to 0^+}\frac{\left(\tan\sqrt{x}\right)^2}{2(\sqrt{x})^2}} = e^{\frac{1}{2}}$$

$$\log P = \log e^{\frac{1}{2}} = \frac{1}{2}$$

23 **Ans.** **(1)**

Sol. $f(x) = |\ell n2-\sin x|$

$f(f(x)) = |\ell n2-\sin|\ell n2-\sin x||$

In the vicinity of x = 0

g(x) = ℓn2 – sin(ℓn2– sinx)

Hence g(x) is differentiable at x = 0 as it is sum and composite of differentiable function

vr%g(x), x = 0 ij vodyuh; gS tSlk fd ;g vodyuh; Qyuksa dk ;ksx rFkk la;kstu gSA

g'(x) = cos(ℓn2 – sinx). cosx

$g'(0) = \cos(\ell n2)$

24. Ans. (2)

Sol. $x \to \dfrac{\pi}{2} + t$

$$\lim_{t \to 0} \frac{-\tan t + \sin t}{(2t)^3}$$

$$\lim_{t \to 0} \frac{-\sin t(1-\cos t)}{-8t^3 \cos t} = \frac{1}{16}$$

25. Sol. (1)

$\lim\limits_{x\to0^+} x\left(\left[\frac{1}{x}\right]+\left[\frac{2}{x}\right]+......+\left[\frac{15}{x}\right]\right)$

$\lim\limits_{x\to0^+}\left(x\left[\frac{1}{x}\right]+x\left[\frac{2}{x}\right]+......+x\left[\frac{15}{x}\right]\right)$

= 1 + 2 + 3 + ………+ 15

$= \frac{15}{2}(15+1)=120$

26. Sol. (3)

$f(x) = |x - \pi|. (e^{|x|}-1) \sin|x|$

According to given options we have to check only at x = 0 and π

at x = 0, f(0) = 0

LHD = $\lim\limits_{h\to0^-}\frac{f(0-h)-f(0)}{-h}$

$= \lim\limits_{h\to0^-}\frac{(\pi+h).(e^h-1)\sin h}{-h}$

$=$ RHD $= \lim\limits_{h\to0^-}\frac{(\pi-h)(e^h-1)\sin h}{h}$

= 0 ⇒ diff. at x = 0

Now at x = π

f(π) = 0

LHD = $\lim\limits_{h\to0^-}\frac{f(\pi-h)-f(\pi)}{-h} = \lim\limits_{h\to0^-}\frac{k.(e^{\pi-h}-1).\sinh}{h} = 0$

RHD = $\lim\limits_{h\to0}\frac{f(\pi+h)-f(\pi)}{h} = \lim\limits_{h\to0}\frac{-h(e^{\pi+h}-1)\sinh}{h} = 0$

differential at x = π also, hence answer is (3)

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. **Sol.** $\lim\limits_{x \to 0} \dfrac{(\cos x - 1)\ (\cos x - e^x)}{x^n}$

$$\lim_{x \to 0} \frac{\left[\left(1 - \frac{x^2}{2\ !} + \frac{x^4}{4\ !} - \ldots\ldots\right) - 1\right]\ \left[\left(1 - \frac{x^2}{2\ !} + \frac{x^4}{4\ !} - \ldots\ldots\right) - \left(1 + x + \frac{x^2}{2\ !} + \frac{x^3}{3\ !}\ldots\ldots\right)\right]}{x^n}$$

$$\lim_{x \to 0} \frac{x^3\ \left(-\frac{1}{2\ !} + \frac{x^2}{4\ !} - \ldots\ldots\right)\ \left(-1 - x\left(\frac{1}{2\ !} + \frac{1}{2\ !}\right) - \ldots\ldots\right)}{x^n}$$

$$\lim_{x \to 0} \frac{\left(-\frac{1}{2\ !} + \frac{x^2}{4\ !} - \ldots\ldots\right)\ \left(-1 - x\ \left(\frac{1}{2\ !} + \frac{1}{2\ !}\right) - \ldots\ldots\right)}{x^{n-3}}$$

is finite and non-zero if n = 3

2. **Solution**

$$f(x) = \begin{cases} -\frac{1}{2}(x+1) & , \quad x < -1 \\ \tan^{-1} x & , \quad -1 \le x \le 1 \\ \frac{1}{2}(x-1) & , \quad x > 1 \end{cases}$$

at $x = -1$ LHL = 0

RHL $= -\dfrac{\pi}{4}$ so LHL ≠ RHL

therefore function is discontinuous at x = – 1

therefore function is not differentiable at x = – 1

At x = 1, LHL $= \dfrac{\pi}{4}$

RHL = 0

therefore LHL ≠ RHL so function is discontinuous at x = 1

therefore function is not differentiable at x = 1

f(x) is discontinuous at x = –1 and x = 1.

3. **Solution** $\lim\limits_{x\to 0}\left(\dfrac{f(1+x)}{f(1)}\right)^{1/x}$ (1^∞ form) (1^∞ :i) $= e^{\lim\limits_{x\to 0}\frac{1}{x}\left(\frac{f(1+x)-f(1)}{f(1)}\right)} = e^{\frac{f'(1)}{f(1)}} = e^{6/3} = e^2$.

4. **Sol.** $\lim\limits_{x\to 0} \dfrac{((a-n)nx - \tan x)\sin nx}{x^2} = 0$

$\Rightarrow \lim\limits_{x \to 0} \left(\dfrac{\sin nx}{nx}\right)\ (n)\ \left[(a-n)\ \ n - \dfrac{\tan x}{x}\right] = 0$

$\Rightarrow$ (1) (n) [(a – n) (n) – 1] = 0

$\Rightarrow$ n(a – n) –1 = 0 [∵ n ≠ 0]

$\Rightarrow$ $a - n = \dfrac{1}{n}$

$\Rightarrow \quad a = n + \dfrac{1}{n}$

5. **Solution**

$\lim\limits_{x\to 0} \dfrac{f(x^2)-f(x)}{f(x)-f(0)}$. Put x = 0 and we get $\dfrac{0}{0}$ form. Also because 'f' is strictly increasing and differentiable. Apply L-Hospital rule, weget

$\lim\limits_{x\to 0} \dfrac{2xf'(x^2)-f'(x)}{f'(x)}$ = – 1. Since 'f' is strictly increasing f'(x) ≠0 in an internal

6. **Sol.** for x > 0 x > 0 ds fy,

$\ell im_{x\to 0} (\sin x)^{\frac{1}{x}} + \left(\dfrac{1}{x}\right)^{\sin x}$

$\ell im_{x\to 0}(\sin x)^{\frac{1}{x}} + \ell im_{x\to 0} \left(\dfrac{1}{x}\right)^{\sin x} = 0 + \ell im_{x\to 0} \left(\dfrac{1}{x}\right)^{\sin x} = e^{\ell im_{x\to 0} (\sin x).\, \ell n\left(\frac{1}{x}\right)} = e^{\ell im_{x\to 0} \frac{\ell n(x)}{-\operatorname{cosec} x}} \left(\dfrac{\infty}{\infty} \text{ form}\right)$

$= e^{\ell im_{x\to 0} \frac{\frac{1}{x}}{(\operatorname{cosec} x \cot x)}} = e^{\ell im_{x\to 0} \frac{\sin^2 x}{x\cos x}} = e^o = 1$

7. **Sol.** Clearly 'p' = $\text{Lim}_{h\to 0^+} \dfrac{f(1-h)-f(1)}{-h} = \dfrac{|h| - \;\; 0}{-h} = -1$

Now $\text{Lim}_{x\to 1^-} \dfrac{(x-1)^n}{\log\cos^m(x-1)} = -1$

$\text{Lim}_{x\to 1^-} \dfrac{(x-1)^n}{m\dfrac{\log\;[1+\cos(x-1)-1]}{\cos(x-1)-1} \times [\cos(x-1)-1]} = -1$

or, $\text{Lim}_{x\to 1^-} \dfrac{(x-1)^n}{m} \dfrac{1}{-2\sin^2\dfrac{(x-1)}{2}} = -1$

Hence n = 2, m = 2. (C) is correct answer.

Aliter : LHD of |x – 1| at 1 is – 1 ≡ p

$\lim\limits_{x\to 1^+} g(x) = \lim\limits_{t\to 0^-} \dfrac{t^n}{\log\cos^m t} = \dfrac{1}{m} \lim\limits_{t\to 0^-} t_{n-2} . \dfrac{\cos t - 1}{\log\cos t} . \dfrac{t^2}{\cos t - 1}$

$= -\dfrac{2}{m} \lim\limits_{t\to 0^-} t_{n-2} \qquad (\because \lim\limits_{t\to 0} \dfrac{1-\cos t}{t^2} = \dfrac{1}{2})$

$\therefore \quad -\dfrac{2}{m} \lim\limits_{t\to 0^-} t_{n-2} = -1 \quad \Rightarrow \quad n = 2, m = 2$

8. **Sol.** **Ans** **(B)**

$\ell im_{x\to\infty} \left(\dfrac{x^2+x+1}{x+1} - ax - b\right) = 4$

$\ell im_{x\to\infty} \left(\dfrac{x^2(1-a)+x(1-a-b)+(1-b)}{x+1}\right) = 4$

Limit is finite

It exists when 1 – a = 0 ⇒ a = 1

then $\lim_{x\to\infty}\left(\dfrac{1-a-b+\dfrac{1-b}{x}}{1+\dfrac{1}{x}}\right) = 4$

$\therefore \quad 1-a-b = 4 \quad \Rightarrow \quad b = -4$

9. Sol. Ans (B)

(I) for derivability at x = 0

L.H.D. $= f'(0_-) = \lim_{h\to0^-}\dfrac{f(0-h)-f(0)}{-h} = \lim_{h\to0^-}\dfrac{h^2.\left|\cos\left(-\dfrac{\pi}{h}\right)\right|-0}{-h} = \lim_{h\to0^-} -h.\left|\cos\dfrac{\pi}{h}\right| = 0$

RHD $f'(0_+) = \lim_{h\to0^-}\dfrac{f(0+h)-f(0)}{h} = \lim_{h\to0^-}\dfrac{h^2.\left|\cos\left(\dfrac{\pi}{h}\right)\right|-0}{h} = 0$

So f(x) is derivable at x = 0

(ii) check for derivability at x = 2

RHD $= f'(2_+) = \lim_{h\to0^-}\dfrac{f(2+h)-f(2)}{h} = \lim_{h\to0^-}\dfrac{(2+h)^2.\left|\cos\left(\dfrac{\pi}{2+h}\right)\right|-0}{h} = \lim_{h\to0^-}\dfrac{(2+h)^2.\cos\left(\dfrac{\pi}{2+h}\right)}{h}$

$= \lim_{h\to0^-}\dfrac{(2+h)^2.\sin\left(\dfrac{\pi}{2}-\dfrac{\pi}{2+h}\right)}{h} = \lim_{h\to0^-}\dfrac{(2+h)^2.\sin\left(\dfrac{\pi h}{2(2+h)}\right)}{\left(\dfrac{\pi}{2(2+h)}\right)h}.\dfrac{\pi}{2(2+h)} = (2)^2.\dfrac{\pi}{2(2)} = \pi$

LHD $= \lim_{h\to0^-}\dfrac{f(2-h)-f(2)}{-h} = \lim_{h\to0^-}\dfrac{(2-h)^2.\left|\cos\left(\dfrac{\pi}{2-h}\right)\right|-0}{-h}$

$= \lim_{h\to0^-}\dfrac{(2-h)^2.\left(-\cos\left(\dfrac{\pi}{2-h}\right)\right)-0}{-h} = \lim_{h\to0^-}\dfrac{(2-h)^2\cos\left(\dfrac{\pi}{2-h}\right)}{h}$

$= \lim_{h\to0^-}\dfrac{(2-h)^2.\sin\left(\dfrac{\pi}{2}-\dfrac{\pi}{2-h}\right)}{h} = \lim_{h\to0^-}\dfrac{(2-h)^2.\sin\left(-\dfrac{\pi h}{2(2-h)}\right)}{\left(-\dfrac{\pi h}{2(2-h)}\right)}.\dfrac{-\pi}{2(2-h)}$

$= -\pi$

So f(x) is not derivable at x = 2