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Limit point / Cluster point :

(i) Terms of Sequence : Let $\langle a_n \rangle$ be a sequence then $a_1, a_2, \ldots, a_n$ are called term of sequence.

Definition : A number p is said to be a limit point of a sequence $\langle a_n \rangle$, if every neighbourhood of p contain infinite terms of $\langle a_n \rangle$.

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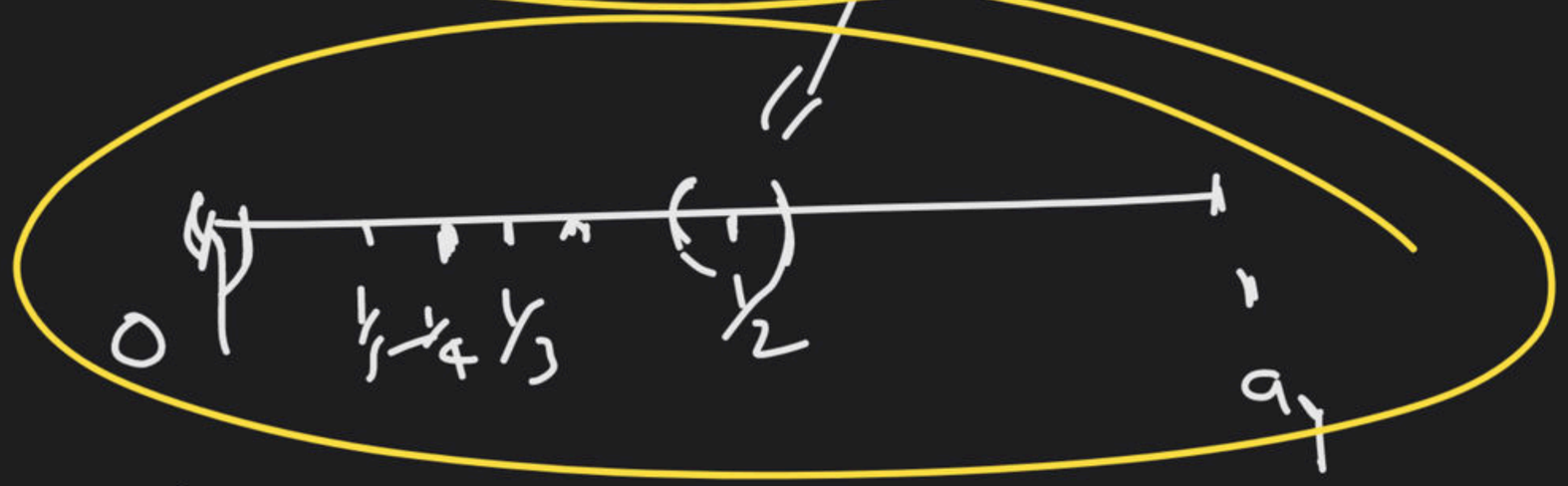
$q_1\ q_2\ q_3\ q_4\ q_5 - q_6\ q_7\ \ldots$

$\langle (-1|^n) \rangle = \langle -1, 1, -1, 1, -1, 1, -1, 1, \ldots \rangle$

$-1, 1$

$\langle a_n \rangle = \langle \frac{1}{n} \rangle = \langle 1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \cdots \rangle$



$\frac{1}{1000000}$

$\frac{1}{10000001}$

$$a_n = \begin{cases} 2 & \text{if } n \text{ is from} \\ n & \text{if } n \text{ is not from} \end{cases}$$

$\in$

$\langle 1, 2, 2, 4, 2, 6, 2, 8, 9, 10, 2, 12, 2, \ldots \rangle$

$a_1 = \langle -1, 0, 1, -1, 0, 1, -1, 0, 1, -1, 0, 1 \cdots \rangle$

$\langle h \rangle = \langle 1, 2, 3 \cdots \rangle \propto$

$\left\langle \frac{n^2+1}{n^2} \right\rangle$

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

$\langle a_n \rangle = \left\langle n \sin \frac{1}{n} \right\rangle$

$\lim_{n\to\infty} n \sin \frac{1}{n} = \infty$

Another Definition : A number 'p' repeated infinitely times, then p is said to be limit points of $\langle a_n \rangle$.

Note : Let $\langle a_n \rangle$ be a sequence of real number and let p be a real number, if there exist a neighbourhood of p which contain only finite terms of sequence, then p is not limit point.

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Result :

(1) **Bolzano – Weierstrass Theorem :** Every bounded sequence has a limit point.

(2) Unbounded sequence may have limit point.

Limit of a sequence : Let $\langle a_n \rangle$ be a sequence, limit of the sequence is denoted by $\lim_{n\to\infty} a_n$.

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Result :

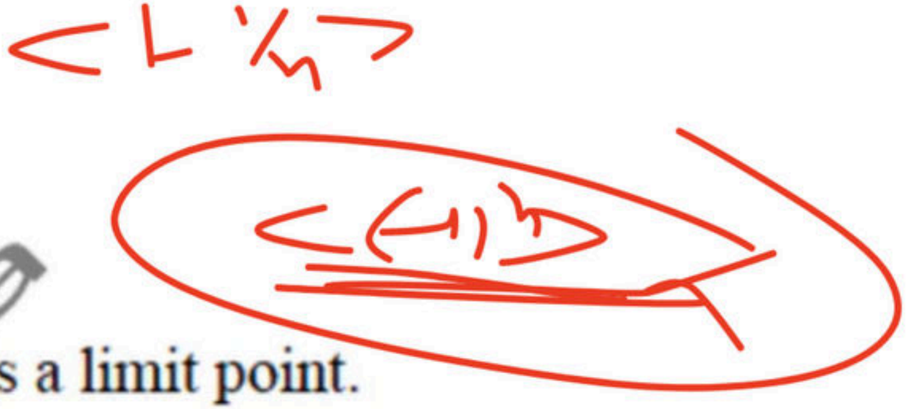
(1) A sequence can have atmost one limit.

(2) Unbounded sequence cannot have limit

Example : $a_n = \begin{cases} 2 & if \quad n \text{ is prime} \\ n & if \quad n \text{ is not prime} \end{cases}$

It has no limit because it is unbounded but it has a limit point.

(3) A non-monotonic sequence can have limit.



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(4) A bounded sequence may not have limit

(5) If limit point of a sequence is unique, then it is limit of sequence.

(6) If limit points of a sequence are more than one then sequence cannot have limit.

(7) Limit of a sequence is also a limit point of a sequence but conversely need not be true.

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Q1 Which of the following is true

(a) Every sequence has a limit point

(b) A limit point is a limit of sequence

(c) Unbounded sequence may have a limit

(d) Unbounded sequence may have limit point

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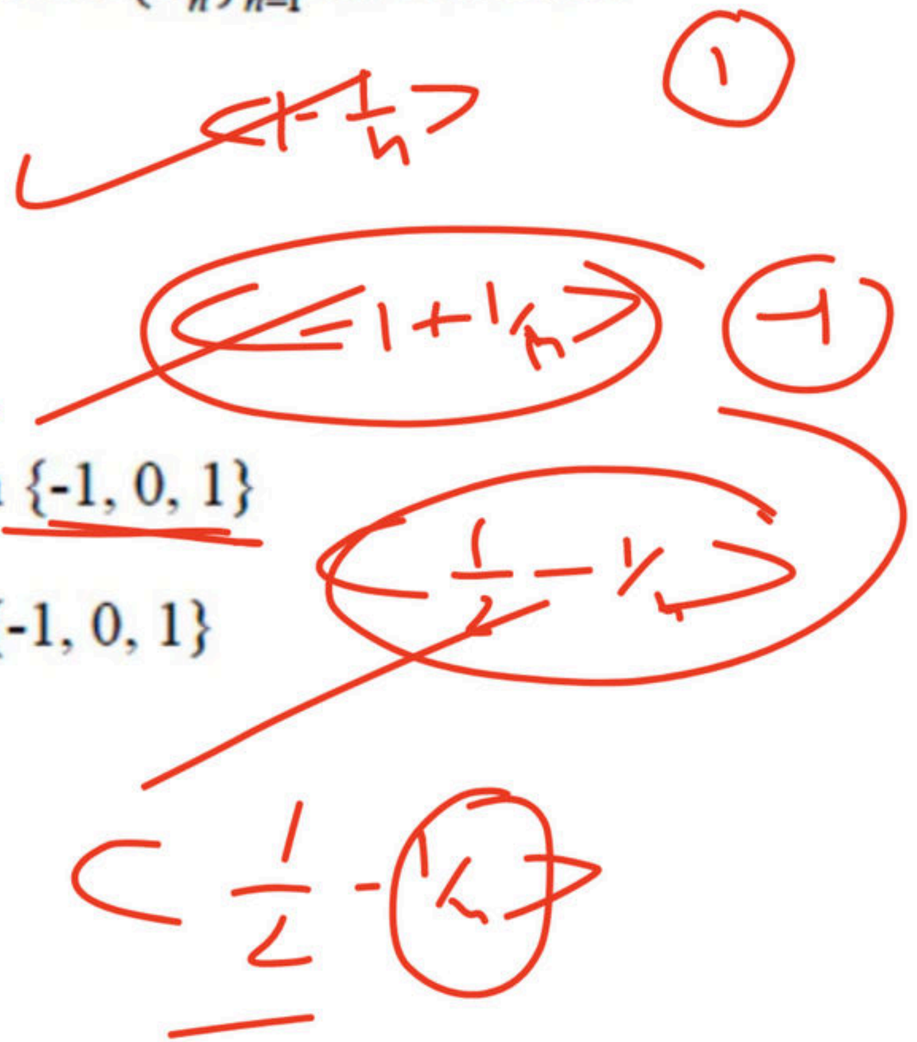
Q2. Consider the interval (-1, 1) and a sequence $\{a_n\}_{n=1}^{\infty}$ of elements in (-1 , 1). Then

(a) Every limit point of $\{a_n\}$ is in (-1, 1)

(b) Every limit point of $\{a_n\}$ is in [-1, 1]

(c) The limit points of $\{a_n\}$ can only be in {-1, 0, 1}

(d) The limit points of $\{a_n\}$ cannot be in {-1, 0, 1}



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Q3. Which of the following statement is true?

(a) A number 'p' is said to be limit point of sequence $\langle a_n \rangle$ if every neighbourhood of 'p' contain infinite number of terms of $\langle a_n \rangle$

(b) A number 'q' is said to be limit point of sequence $\langle b_n \rangle$ if every neighbourhood of 'q' contain finite number of terms of $\langle b_n \rangle$.

(c) Any point of a sequence is said to be limit point of a sequence if every neighbourhood of this point contain atmost two point of given sequence.

(d) None of these

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Q.4. Define $S = \lim_{n\to\infty}\left(1-\frac{1}{2^2}\right)\left(1-\frac{1}{3^2}\right)\cdots\left(1-\frac{1}{n^2}\right)$ **IIT JAM 2021**

(a) 3/4 (b) 1

(c) 1/2 (d) 1/4

$(1-\frac{1}{2})(1+\frac{1}{2})(1-\frac{1}{3})(1+\frac{1}{3})\cdots(1-\frac{1}{n})(1+\frac{1}{n})$

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

$= \frac{1}{2}(\frac{n+1}{n})$

$= \frac{1}{2}\lim_{n\to\infty}(\frac{n+1}{n})$

$= \frac{1}{2}\lim_{n\to\infty}\frac{n(1+1/n)}{n}$

$= \frac{1}{2}$

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Limit of seq. $\sqrt{7}, \sqrt{7+\sqrt{7}}, \sqrt{7+\sqrt{7+\sqrt{7}}}, \ldots$

(a) $\frac{1+\sqrt{33}}{2}$ (b) $\frac{1+\sqrt{57}}{2}$

(c) $\frac{1+\sqrt{30}}{2}$ (d) $\frac{1+\sqrt{29}}{2}$

$a_{n+1} = \sqrt{7+a_n}$

$l = \sqrt{7+l}$

$l^2 = 7+l$

$\frac{1+\sqrt{29}}{2}$

$l^2 - l - 7 = 0$

$l = \frac{1 \pm \sqrt{1+28}}{2}$

$$a_{n+1} = \frac{a_n}{2} + \frac{9}{8 a_n}$$

then Limit from ip

(a) 1.5

(b) $\sqrt{2}$

(c) 1.4

(d) 1.4

$a_1 = 0.5$

$l = \frac{l}{2} + \frac{9}{8l}$

$l = \frac{4l^2 + 9}{8l}$

$8l^2 = 4l^2 + 9$

$4l^2 = 9$

$l^2 = 9/4$

$l = 3/2$

Q.5. Let $\langle a_n \rangle$ be the sequence of the real numbers such that $a_1 = 1$ and $a_{n+1} = a_n + a_n^2$ for all $n \geq 1$ Then **IIT JAM 2019**

(a) $a_4 = a_1(1 + a_1)(1 + a_2)(1 + a_3)$

(b) $\lim_{n\to\infty} \frac{1}{a_n} = 0$

(c) $\lim_{n\to\infty} \frac{1}{a_n} = 1$

(d) $\lim_{n\to\infty} a_n = 0$

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Q6. Let $a_n = \frac{b_{n+1}}{b_n}$, where $b_1 = -1$, $b_2 = -1$ and $b_{n+2} = b_n + b_{n+1}$, $n \in N$.

Then $\lim_{n\to\infty} a_n$ is **IIT-JAM – 2018**

(a) $\frac{1-\sqrt{5}}{2}$ (b) $\frac{1-\sqrt{3}}{2}$

(c) $\frac{1+\sqrt{3}}{2}$ (d) $\frac{1+\sqrt{5}}{2}$

$\frac{b_{n+2}}{b_{n+1}} = \frac{b_n}{b_{n+1}} + 1$

$\frac{b_{n+2}}{b_{n+1}} = \frac{1}{\frac{b_{n+1}}{b_n}} + 1$

$a_{n+1} = \frac{1}{a_n} + 1$

$l = \frac{1}{l} + 1$

$l^2 = 1 + l$

$l^2 = l - 1 \Rightarrow$

$l = \frac{1 \pm \sqrt{1+4}}{2}$ — $\frac{1+\sqrt{5}}{2}$

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Q7. Let $\langle S_n \rangle$ be a sequence of positive real numbers satisfying $2S_{n+1} = S_n^2 + \frac{3}{4}$, $n \geq 1$, if α and β are the roots of the equation $x^2 - 2x + \frac{3}{4} = 0$ and $\alpha < S_1 < \beta$, then which of the following is true? **IIT-JAM 2016**

(a) $\langle S_n \rangle$ is monotonically decreasing

(b) $\langle S_n \rangle$ is monotonically increasing

(c) $\lim_{n\to\infty} S_n = \alpha$

(d) $\lim_{n\to\infty} S_n = \beta$

$2\lambda = \ell^2 + \lambda_1$

$\lambda^2 - 2\lambda + 3/4$

$\alpha = 1/2$

$\beta = 3/2$

$S_2 = 7/8$ $S_1 = 1$

$1/2$ $S_3 = 97/128$ $3/2$

$2S_2 = S_1^2 + 3/4$

$2S_2 = 1 + 3/4 = 7/8$

$2S_3 = 49/64 + 3/4 = 97/128$

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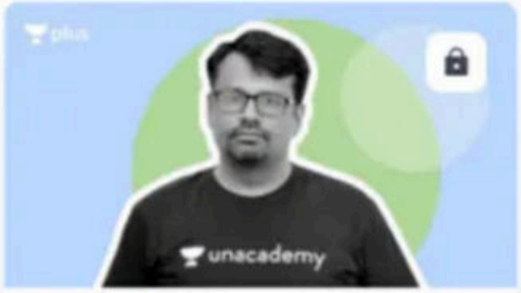

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Educator highlights

- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
- PhD, NET | Plus Educator For CSIR NET | Youtuber (260K+Subs.) | Director Pacific Science College |
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