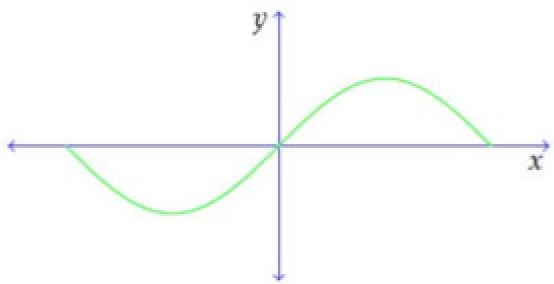
Chapter 5
Continuity and Differentiability

- **Continuity of function at a point:** Geometrically we say that a function $y = f(x)$ is continuous at $x = a$ if the graph of the function $y = f(x)$ is continuous (without any break) at $x = a$.

  If the graph of a function has no break or gap, then it is continuous, otherwise it is discontinuous.

  e.g., Graph of sin x is continuous



A funciton $f(x)$ is said to be continuous at a point $x = a$ if:

(i) $f(a)$ exists
(ii) $\lim\limits_{x \to a} f(x)$ exists.

i.e. $\lim_{x \to a^+} f(x) = \lim_{x \to a^-} f(x)$

(iii) $\lim\limits_{x \to a} f(x) = f(a)$

- **Continuity of a function in a closed interval**: A function $f(x)$ is said to be continuous in the closed interval if it is continuous for every value of x lying between a and b continuous to the right of a and to the left of $x = b$ i.e., $\lim\limits_{x \to a-0} f(x) = f(a)$ and $\lim\limits_{x \to b-0} f(x) = f(b)$
- **Continuity of a function in a open interval**: A function $f(x)$ is said to be continuous in an open interval (a, b) if it is continuous at every point in (a, b).
- **Discontinuity (Discontinuous function)**: A function $f(x)$ is said to be discontinuous in an interval if it is discontinuous even at a single point of the interval.

- **Discontinuity:** The function f will be discontinuous at x = a in any of the following cases :

  (i) $\lim_{x \to a^+} f(x)$ and $\lim_{x \to a^-} f(x)$ exist but are not equal

  (ii) $\lim_{x \to a^+} f(x)$ and $\lim_{x \to a^-} f(x)$ exist and are equal but not equal to f (a)

  (iii) f (a) is not defined.

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