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## Activation functions

(1) Identity func'n  $f(x) = x$  for all  $x$

(2) Binary step func'n  $f(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ 0 & \text{if } x < 0 \end{cases}$

(3) Bipolar step func'n  $f(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ -1 & \text{if } x < 0 \end{cases}$

(4) Sigmoidal func'n

↳ Binary / Unipolar  $f(x) = \frac{1}{1 + e^{-1x}}$

It is steepness func'n.

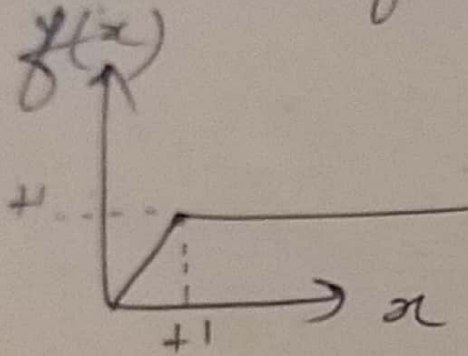
$$f'(x) = 1f(x)[1-f(x)]$$

↳ bipolar  $f(x) = \frac{2}{1+e^{-1x}} - 1$

(2)

$$f'(x) = \frac{1}{2} [1+f(x)][1-f(x)]$$

⑤ bump function  $f(x) = \begin{cases} 1 & x > 1 \\ x & 0 \leq x \leq 1 \\ 0 & x < 0 \end{cases}$

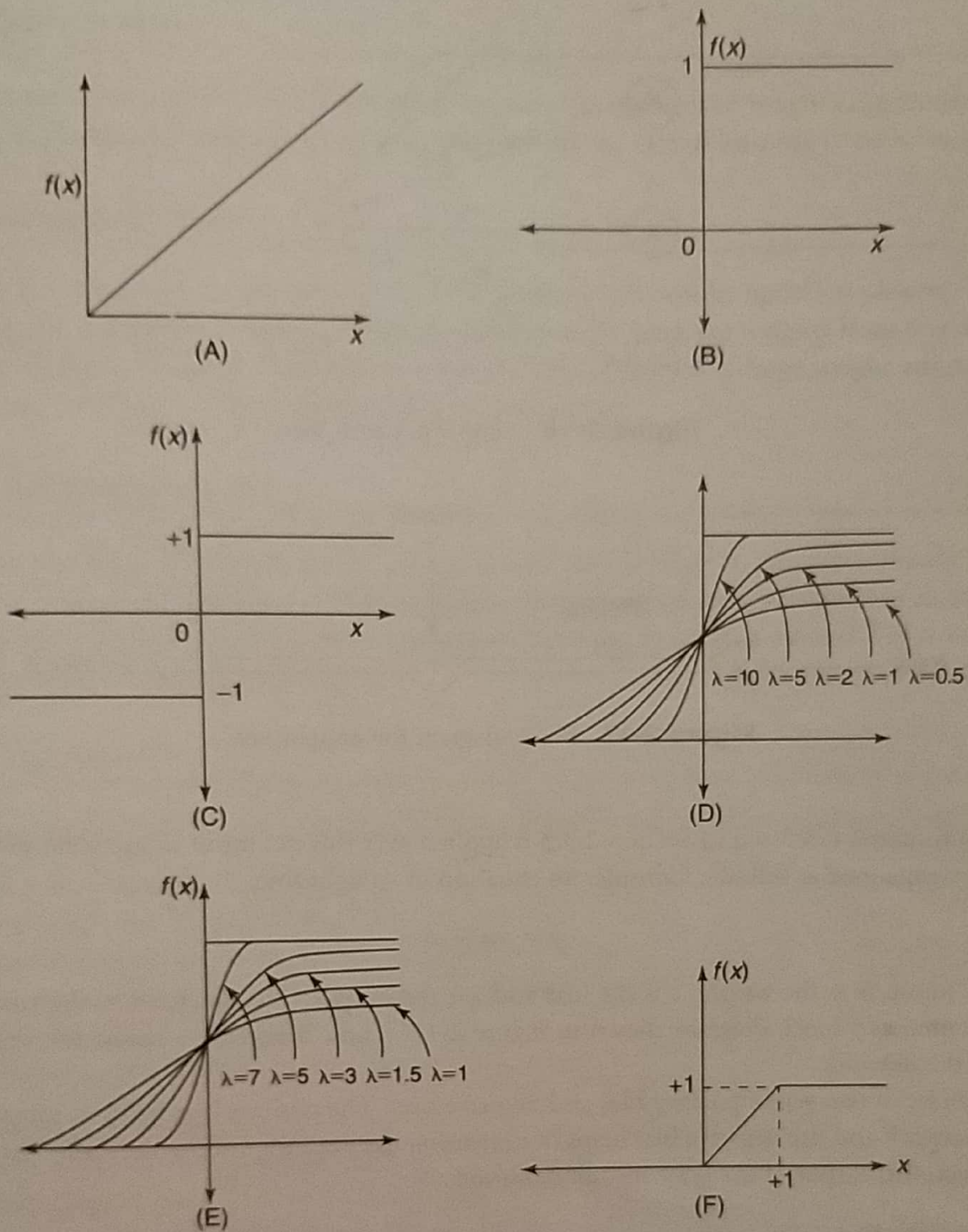


Bias :  $b_0 / w_0$

$$y = b_0 + \sum x_i w_i$$

Learning rate :  $\alpha$  : control weight adjustment. range from 0 to 1.





**Figure 2-15** Depiction of activation functions: (A) identity function; (B) binary step function; (C) bipolar step function; (D) binary sigmoidal function; (E) bipolar sigmoidal function; (F) ramp function.