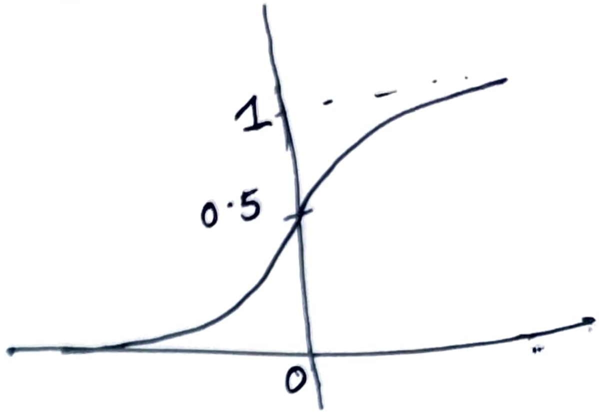
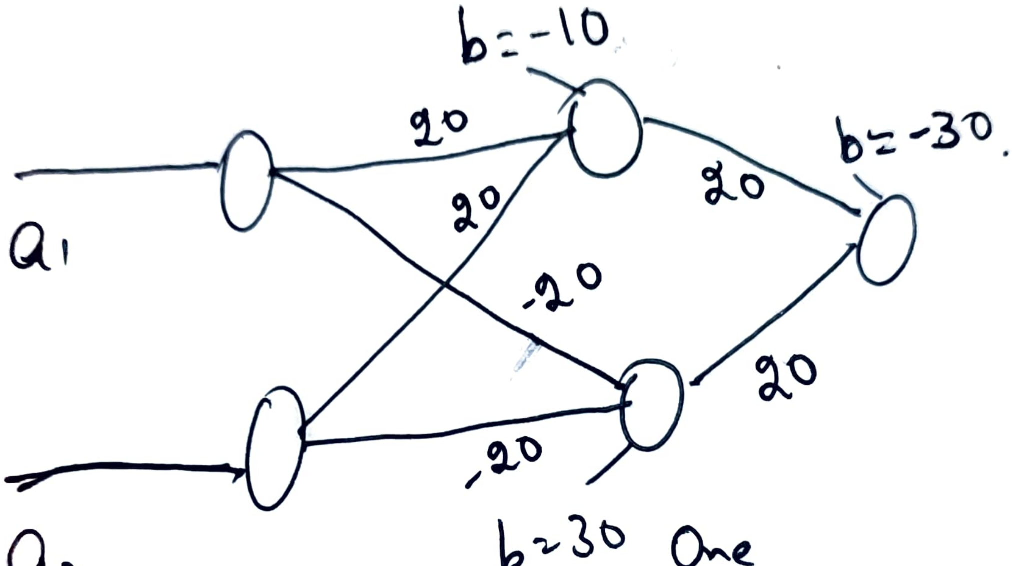
(1.)

	a_1	a_2	y
a.)	T_1	T_1	F_0
	T_1	F_0	T_1
	F_0	T_1	T_1
	F_0	F_0	F_0

$a_1\bar{a}_2 + a_2\bar{a}_1$





I/p layer

One hidden layer.

add sigmoid functions in neurons of hidden layer and o/p layer.

0,0 Input

at h_1

$(20\times0+20\times0-10)=0$

at h_2

$(-20\times0-20\times0+30)=1$

at y

$(20\times0+20\times1-30)=\underline{\underline{0}}$

(1,0) Input

$(20\times1+20\times0-10)=1$

$(-20\times1-20\times0+30)=1$

$(20\times1+20\times1-30)=1$

(0,1) Input

$(20\times0+20\times1-10)=1$

$(-20\times0-20\times1+30)=1$

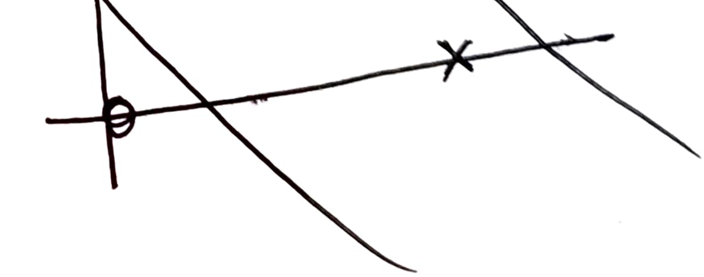
$(20\times1+20\times1-30)=1$

(1,1) Input

$(20\times1+20\times1-10)=1$

$(-20\times1-20\times1+30)=0$

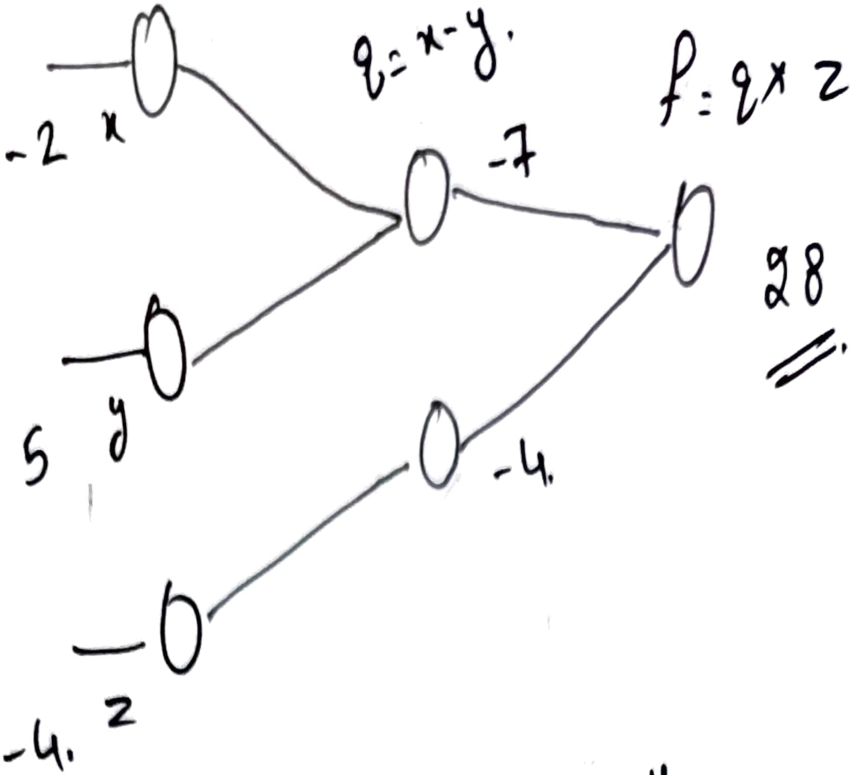
$(20\times1+20\times0-30)=\underline{\underline{0}}$



XOR o
problem

1.

b)



$$f = qz \qquad q = x - y.$$

$$\frac{\partial f}{\partial x} = \frac{\partial f}{\partial q} \times \frac{\partial q}{\partial x} = z \times (1) = z$$

$$\frac{\partial f}{\partial y} = \frac{\partial f}{\partial q} \times \frac{\partial q}{\partial y} = z \times (-1) = -z$$

$$\frac{\partial f}{\partial z} = \frac{\partial f}{\partial z} = q$$

(itself in between linear transformation)

(Q.)

$$E[w] = -\sum_{n=1}^{N} \sum_{k=1}^{K} t_{kn} \ln y_k(x_n, w)$$

$k \to$ No. of classes

$N \to$ no. of data samples.

$t \to$ expected o/p.

$y_k \to$ n/w o/p.

$$y_k(x_n, w) = p(t_k = 1 | x)$$

$$y_k(x, w) = \frac{\exp(a_k(x, w))}{\sum_j \exp(a_k(x, w))}$$

$$\Rightarrow \frac{\partial E}{\partial a_k} = \frac{\partial E}{\partial y_k} \times \frac{\partial y_k}{\partial a_k}.$$

$$\frac{\partial y_k}{\partial a_k} = \frac{\cancel{\exp(a_k(x, w))} \sum \exp(a_k(x, w)) - \cancel{\exp(a_k(x, w))} \exp(a_k(x, w))}{\left(\sum_j \exp(a_k(x, w))\right)^2}$$

$k = j$

$$= y_k(1 - y_k)$$

$$\frac{\partial y_k}{\partial a_k} = \frac{0 - e^{a_k} \cdot e^{a_j}}{\left(\sum e^{a_k}\right)^2} = -y_k y_j$$

$k \neq j$

Now $\frac{\partial E}{\partial y_k} = -\sum_{n=1}^{N}\sum_{k=1}^{K} t_{kN} \cdot \frac{1}{y_k(x_n, w)}$

$$\frac{\partial E}{\partial a_k} = -\sum\sum_{k \neq n} t_{kN} \cdot \frac{1}{y_k(x_n, w)} \times \frac{\partial y_k}{\partial a_k}$$

$$- t_{kN} \times \frac{1}{y_k} \times \frac{\partial y_k}{\partial a_k}$$

$$= -\sum\sum_{k \neq n} \frac{t_{kN}}{\cancel{y_k(x_n, w)}} (-\cancel{y_k} y_j) - \frac{t_{kN}}{\cancel{y_k}} \cancel{y_k} (1 - y_k)$$

$$\frac{\partial E}{\partial a_k} = \sum\sum_{k \neq n} t_{kN} y_k + t_{kN} y_k - t_{kN}.$$

$$= \sum\sum t_{kN} y_k - t_{kN}.$$

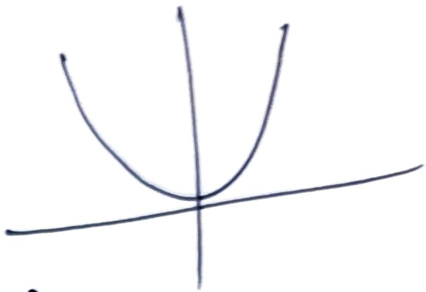
$$= y_k \underbrace{\sum t_{kN}}_{\text{This will be } 1} - t_{kN}$$

$$\therefore \boxed{\frac{\partial E}{\partial a_k} = y_k - t_k}$$

③ $f(x) = x^2$ $\quad E_{AV} = \frac{1}{M} \sum_{m=1}^{M} E_x \left[(y_m(x) - f(x)^2 \right]$

$$E_{ENS} = E_x \left[\frac{1}{M} \sum_{m=1}^{M} (y_m(x) - f(x)^2 \right].$$

$f(x) = x^2$



$$E_{ENS} = E_x \left[\frac{1}{M} \sum_{m=1}^{M} (y_m(x) - f(x)^2 \right]$$

$$E_{AV} = \frac{1}{M} \sum_{m=1}^{M} E_x \left[(y_m(x) - f(x)^2 \right]$$

Rearranging

$$E_x \left[\frac{1}{M} \sum_{m=1}^{M} y_m(x) - f(x)^2 \right] \leq \frac{1}{M} \sum_{m=1}^{M} E_x \left[(y_m(x) - f(x)^2 \right]$$

all the Terms of E_{ENS} are Continuous in E_{AV} and hence proved.

$$E_{ENS} \leq E_{AV}.$$

It is hold for any error function $E(y)$ not just for sum of squares.