4 a) Given that bias, $b = 0$ and input $X3 = 1$

Output, $Y = f(X1, X2, X3)$

Activation function → $a = \sigma$ (sigmoid function)

$\sigma = \frac{1}{1 + e^{-x}}$ $f \rightarrow \sigma$ function

$$Y = \sigma[-2.01136152\,\sigma(6.05030659X1 - 0.75120936X2) + -2.5196096\,\sigma(7.24616141X1 + 7.26413833X2) + 1.0516842\,\sigma(-3.58702172X1 + 6.1736983X2) + -4.1568864\,\sigma(2.61305967X1 + 2.81567166X2)]$$

In the above output equation, the weight co-efficients (obtained by executing the code) are substituted.

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4 b) Input: $X1 = 0$, $X2 = 0$, $X3 = 1$

$h = \sum_{i=0}^{M} w_i x_i$ → Weighted sum for each neuron in the hidden layer

$h0 = 0 + 0 - 3.58702172 + 2.61305967 = -0.97396205$

$h1 = 0 + 0 + 6.1736983 + 2.81567166 = 8.99347497$

$h2 = 0 + 0 + 1.0516842 - 4.1568864 = -3.10520215$

$h3 = 0 + 0 - 4.1568864 - 7.60022303 = -14.37275576$

$h0' = \sigma(h0) = \sigma(-0.97396205) = \frac{1}{1+e^{0.97396205}}$

$= 0.28652614$

$h1' = \sigma(h1) = \sigma(8.993474997) = 0.99976816$

$h2' = \sigma(h2) = \sigma(-14.57275576) = 1.02614818 \times 10^{-6}$

$h3' = \sigma(h3) = \sigma(-3.10320215) = 0.04539072$

Output, $Y = \sigma[(-2.01136152\,h0') + (-2.5196096\,h1') + (1.05168425\,h2') + (0.04539072\,h3')]$

$\therefore Y = 0.00765400$

Input : $X1=0$, $X2=1$, $X3=1$

$h0 = 0 - 0.75120936 - 3.58702172 + 2.61305967$

$= -2.68073283$

$h1 = 0 + 7.26413833 + 6.1736983 + 2.81567666 = 16.25957244$

$h2 = 0 + 6.1736983 + 1.05168425 - 4.15688864 = 3.06681204$

$h3 = 0 + 2.81567666 - 4.15688864 - 7.60022303 = -14.57275576$

$h0' = \sigma(-2.68073283) = 0.06837176$

$h1' = \sigma(16.25957447) = 0.99998611$

$h2' = \sigma(3.06681204) = 0.95623115$

$h3' = \sigma(-14.57275576) = 1.01261481 8 \times 10^{-6}$

$y = \sigma[(-2.01136152 h0') + (-2.5196096 h1') + (1.05168425 h2') + (-4.1568864 h3')]$

$= \boxed{0.99202571}$

Input: $x1=1$, $x2=0$, $x3=1$

$h0 = 6.05050659 - 0 - 3.58702172 + 2.61305967 = 5.09935423$

$h1 = 7.24616141 + 0 + 6.17369833 + 2.31567666 = 16.2996744$

$h2 = -3.58702172 + 0 + 1.05168425 - 4.1568864 = -6.64514437$

$h3 = 2.61305967 + 0 - 4.1568864 - 7.60022303 = -14.57275576$

$h0' = \sigma(h0) = 0.99394207$

$h1' = \sigma(h1) = 1$

$h2' = \sigma(h2) = 0.00109993$

$h3' = \sigma(h3) = 1.02614818 \times 10^{-6}$

$\boxed{y = 0.99216446}$

Input: $x1=1$, $x2=1$, $x3=1$

$h0 = 6.05050659 - 0.75120936 - 3.58702172 + 2.61305907 = 4.31340741$

$h1 = 7.24616141 + 7.26413833 + 6.1736983 + 2.91567666 = 23.49967444$

$h2 = -3.58702172 + 6.1736983 + 1.05168425 - 4.1568814 = -3.59306442$

$h3 = 2.61305967 + 2.91567666 - 4.1568864 - 7.60022303 = -18.47275576$

$h0' = \sigma(h0) = 0.98488241$

$h1' = \sigma(h1) = 1$

$h2' = \sigma(h2) = 0.02742722$

$h3' = \sigma(h3) = 1.11022302 \times 10^{-8}$

$\Rightarrow Y = 0.0884604$

Input: $X1=0, \quad X2=0, \quad X3=1$

$h0 = -7.6002 \qquad h0' = 0.00341129$

$h1 = 13.8884 \qquad h1' = 0.99202571$

$h2 = -7.4255 \qquad h2' = 0.00884604$

$h3 = -5.1792 \qquad h3' = 0.00429843$

$\therefore Y = 0.00429843$