4] For $X=0$:-

$$\text{Variance} = E\left[\left(\hat{f}\left((X=0)|(X=0)\right) - E\left[\hat{f}(X=0)|(X=0)\right]\right)^2\right]$$

$$= E\left[\left(\hat{f}\left((X=0)|(X=0)\right) - \frac{1}{3}\right)^2\right]$$

$$= E\left[\left(\hat{f}\left((X=0)|(X=0)\right)\right)^2 + \frac{1}{9} - \frac{2}{3}\cdot\left(\hat{f}\left((X=0)|(X=0)\right)\right)\right]$$

$$= \frac{1}{9} + E\left[\hat{f}\left((X=0)|(X=0)\right)^2\right] - \frac{2}{3}\cdot E\left[\hat{f}\left((X=0)|(X=0)\right)\right]$$

We know:-

$$E[X^2] = \sum_{i=1}^{n} x_i^2 \cdot P(X=x_i)$$

$$\therefore = \frac{1}{9} + \sum\left|\hat{f}\left((X=0)|(X=0)\right)\right|^2 \cdot P\left(\hat{f}\left((X=0)|(X=0)\right)\right) - \frac{2}{3}\cdot\frac{1}{3}$$

$$= \frac{1}{9} + \left\{(0)^2\cdot\left(\frac{2}{3}\right) + (1)^2\cdot\left(\frac{1}{3}\right)\right\} - \frac{2}{9}$$

$$= \frac{1}{9} + \frac{1}{3} - \frac{2}{9}$$

$$= \frac{2}{9}$$