4. $J(w) = C(w) + \lambda R(w)$

$$R(w) = \|w\|^2 = \sum_{i,j} w_{i,j}^2$$

Find $\frac{\partial J}{\partial w}$ where $C(w) = \frac{1}{N} \sum_{n=1}^{N} C^n(w)$

Thus we know:

$$\frac{\partial J}{\partial w} = \frac{\partial C(w)}{\partial w} + \lambda \cdot \frac{\partial R(w)}{\partial w}$$

$$\frac{\partial C^n(w)}{\partial w_{kj}} = -x_j^n \left(y_k^n - \hat{y}_k^n \right)$$

$$\frac{\partial R(w)}{\partial w} = \frac{\partial}{\partial w} \cdot \sum_{i,j} w_{i,j}^2 = 2 w_{i,j}$$

$$\underline{\underline{\frac{\partial J}{\partial w} = -x_j^n \left(y_K^n - \hat{y}_K^n \right) + \lambda \cdot 2 \cdot w_{i,j}}}$$