$$E = \sum_{i=1}^{N} \exp\left[-y_i\left(f_{m-1}(x_i) + \beta G(x_i)\right)\right]$$

$$E = \sum_{i=1}^{N} w_i^{(m)} \exp\left[-\beta y_i G(x_i)\right]$$

$$E = e^{-\beta} \cdot \sum_{y_i = G(x_i)} w_i^{(m)} + e^{\beta} \cdot \sum_{y_i \neq G(x_i)} w_i^{(m)}$$

$$E = \left(e^{\beta} - e^{-\beta}\right) \cdot \sum_{i=1}^{N} w_i^{(m)} I(y_i \neq G(x_i)) + e^{-\beta} \cdot \sum_{i=1}^{N} w_i^{(m)}$$

$$\frac{\partial E}{\partial \beta} = \left(e^{\beta} + e^{-\beta}\right) \cdot \sum_{i=1}^{N} w_i^{(m)} I(y_i \neq G(x_i)) - e^{-\beta} \cdot \sum_{i=1}^{N} w_i^{(m)} = 0$$

$$\left(e^{2\beta} + 1\right) \cdot \sum_{i=1}^{N} w_i^{(m)} I(y_i \neq G(x_i)) = \sum_{i=1}^{N} w_i^{(m)}$$

$$e^{2\beta} = \frac{\sum_{i=1}^{N} w_i^{(m)}}{\sum_{i=1}^{N} w_i^{(m)} I(y_i \neq G(x_i))} - 1$$

$$\beta = \frac{1}{2} \log\left[\frac{\sum_{i=1}^{N} w_i^{(m)}}{\sum_{i=1}^{N} w_i^{(m)} I(y_i \neq G(x_i))} - 1\right]$$

$$\boxed{\beta = \frac{1}{2} \log\left[\frac{1 - err_m}{err_m}\right] \quad \text{where } err_m = \frac{\sum_{i=1}^{N} w_i^{(m)} I(y_i \neq G_m(x_i))}{\sum_{i=1}^{N} w_i^{(m)}}}$$