For a given probability density function $p(x|Y)$ with $x \in R^D$ and $Y \in \{0, 1\}$, and a distribution on the random variable Y, $P(Y)$, find the function $f(x) \in \{0, 1\}$ that minimizes the following cost function (Note that only $p(x|Y)$ and $P(Y)$ are known):

$$L(x) = \sum_{Y \in \{0,1\}} \int p(x, Y) \left[Y \log f(x) + (1 - Y) \log(1 - f(x)) \right] dx$$

Hint: Use the Bayes rule $P(A|B) = \frac{P(B|A)P(A)}{P(B)}$.