Bloom Filter

Calculate theoretical false positive rate :

$$P(\text{false positive}) = \left(1 - e^{-\frac{kn}{m}}\right)^k$$

where, $m = 100$ [number of bits]
$k = 2$ [number of Hash function]
$n = 4$ [number of inserted items]

For exponent, $-\frac{kn}{m}$

$$-\frac{kn}{m} = -\frac{2 \cdot 4}{100} = -\frac{8}{100} = -0.08$$

Now, for $e^{-0.08}$

$$e^{-x} = 1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \cdots$$

$$e^{-8} \approx 1 - 0.08 + \frac{0.08^2}{2} = 1 - 0.08 + 0.0032 = 0.9232$$

For $1 - e^{-0.08}$,

$$1 - e^{-0.08}$$
$$= 1 - 0.9232$$
$$= 0.0768$$

Now, raise $(1 - e^{-0.08})$ to the power k

So, $P(\text{false positive}) = (0.0768)^2$

$$= 0.0768 \times 0.0768$$
$$= 0.0059$$