$\boxed{1}$ As we define $K(A) = \infty$ when A is singular, the prob is meaningless if A is singular.
Spse A is non-singular.

$\|A\|_2 = \sigma_1 = 100$ by Thm 5.3.

$\|A_F\|_2^2 = \sigma_1^2 + \cdots + \sigma_m^2 = 10201$

$m = \text{rank}(A)$

$K(A) = \|A\|_2 \|A^{-1}\|_2 = 100 \, \|A^{-1}\|_2$

Let $A = U\Sigma V^*$ (svd of A, exist by thm 4.1)
Then $A^{-1} = V\Sigma^{-1}U^*$ where $\Sigma^{-1} = \begin{bmatrix} 1/\sigma_1 & & \\ & \ddots & \\ & & 1/\sigma_m \end{bmatrix}$
Note that $\sigma_i > 0$ by assumption.. if $\Sigma = \begin{bmatrix} \sigma_1 & & \\ & \ddots & \\ & & \sigma_m \end{bmatrix}$.

And, $\|A^{-1}\|_2 = \dfrac{1}{\sigma_m}$ as $\sigma_1 \geq \cdots \geq \sigma_m > 0$.

$\|A_F\|_2^2 = \sum_{i=1}^{m} \sigma_i^2 = 10201 \geq \sigma_1^2 + 201\sigma_m^2 \rightsquigarrow 1 \geq \sigma_m^2,\ 0 < \sigma_m \leq 1. \rightsquigarrow \dfrac{1}{\sigma_m} \geq 1$

$\therefore K(A) = \dfrac{\sigma_1}{\sigma_m} \geq \sigma_1 = 100.$ Note that equality holds when $\Sigma = \begin{bmatrix} 100 & & & \\ & 1 & & \\ & & \ddots & \\ & & & 1 \end{bmatrix}$.