Q2:
First we claim that for $x \in \mathbb{R}^n$, $\|x\| \leq \sum_{i=1}^n |x_i|$
We will first prove that for $a, b \geq 0, \sqrt{a+b} \leq \sqrt{a} + \sqrt{b}$

$$\begin{aligned}
&\sqrt{a+b} \leq \sqrt{a} + \sqrt{b} \\
\iff &a + b \leq a + b + 2\sqrt{ab} \\
\iff &0 \leq \sqrt{ab}
\end{aligned}$$

Which is clearly true for all nonnegative a, b. We now repeatedly apply this fact to $\|x\|$.

$$\begin{aligned}
\|x\| &= \sqrt{\sum_{i=1}^n x_i^2} \\
&\leq \sqrt{x_1^2} + \sqrt{\sum_{i=2}^n x_i^2} \\
&\leq \sqrt{x_1^2} + \sqrt{x_2^2} + \sqrt{\sum_{i=3}^n x_i^2} \\
&\vdots \\
&\leq \sum_{i=1}^n |x_i| \quad \blacksquare
\end{aligned}$$

Now we let $T(x) = y$. Let $A = max(|a_{ij}|)$ and let a_i be the i'th row vector of the matrix of T, then by above,

$$\begin{aligned}
\|y\| &\leq \sum_{i=1}^n |y_i| \quad \text{(by the claim)} \\
&= \sum_{i=1}^n |\sum_{j=1}^m a_{ij} x_j| \\
&= \sum_{i=1}^n |\langle a_i, x \rangle| \quad \text{(by the definition of inner product)} \\
&\leq \sum_{i=1}^n \|a_i\| \|x\| \quad \text{(by Cauchy-Schwarz inequality)} \\
&= \|x\| \sum_{i=1}^n \|a_i\| \\
&\leq \|x\| \sum_{i=1}^n \sum_{j=1}^m |a_{ij}| \quad \text{(by the claim)} \\
&\leq mnA \|x\|
\end{aligned}$$

Thus by taking $M = mnA$ we have that $\|T(x)\| \leq M \|x\|$ $\blacksquare$