1. Let \( f(x) = \begin{cases} 
  x^2 \cos \frac{1}{x} & \text{when } x \neq 0 \\
  0 & \text{when } x = 0 
\end{cases} \).

Prove that \( f(x) \) is continuous for all \( x \in \mathbb{R} \).

2. Let \( f, g : I \rightarrow \mathbb{R} \) be two continuous functions. Prove that \( h = 2f + 3g \) is continuous using the definition of continuity directly. [Do not use Theorem 93]

3. Prove directly from the definition of continuity that \( f(x) = \frac{1}{1+x^2} \) is continuous.

4. Let \( f : \mathbb{R} \rightarrow \mathbb{R} \) be continuous, with \( f(x) = 0 \) for \( x \in \mathbb{Q} \). Show that \( f(x) = 0 \) for all \( x \in \mathbb{R} \).