1. Determine if the following functions are differentiable at 0. Find $f'(0)$ if exists

   (a) $f(x) = \begin{cases} x, & x \in \mathbb{Q} \\ \sin x, & x \notin \mathbb{Q}. \end{cases}$

   (b) $f(x) = \begin{cases} \sqrt{x} \sin \frac{1}{x}, & x \neq 0 \\ 0, & x = 0. \end{cases}$

   (c) $f(x) = \begin{cases} x^2 \cos \frac{1}{x}, & x \neq 0 \\ 0, & x = 0. \end{cases}$

   (d) $f(x) = \begin{cases} e^{-\frac{1}{x^2}}, & x \neq 0 \\ 0, & x = 0. \end{cases}$

   (e) $f(x) = \begin{cases} x \cos \frac{1}{x}, & x \neq 0 \\ 0, & x = 0. \end{cases}$

   (f) $f(x) = e^{-|x|}$.

2. Determine if f' is continuous at 0 for the following functions:

   (a) $f(x) = \begin{cases} x^3 \sin \frac{1}{x}, & x \neq 0 \\ 0, & x = 0. \end{cases}$

   (b) $f(x) = \begin{cases} x^2 \cos \frac{1}{x}, & x \neq 0 \\ 0, & x = 0. \end{cases}$

   (c) $f(x) = \begin{cases} x^2 \ln \frac{1}{|x|}, & x \neq 0 \\ 0, & x = 0. \end{cases}$

3. When a circular plate of metal is heated in an oven, its radius increases at the rate of 0.01cm/min. At what rate the plate's area increasing when the radius is 50 cm?

4. Evaluate the following limits:

   $(a)\ \lim_{x \to 0} \frac{e^x - (1 + x)}{x^2}, \quad (b)\ \lim_{t \to 0} \frac{1 - \cos t - (t^2/2)}{t^4}, \quad (c)\ \lim_{x \to \infty} x^2 (e^{-1/x^2} - 1).$