Question 1. Find the following limits: (32 Points)

a) \( \lim_{{x \to 0}} \sqrt{\frac{\tan 3x}{x}} \)

b) \( \lim_{{x \to -\frac{1}{2}}} \frac{2x^2 - 2x - 4}{x^2 + 3x + 2} \)

c) \( \lim_{{x \to 0}} \frac{3^x - 1}{x} \)

i. Is it 1, more than 1, or less than 1? Justify your answer.

ii. Use your calculator to find the (approximate) answer.

d) \( \lim_{{x \to a}} \tan 3x = -\infty \), what is \( a \)?

e) \( \lim_{{x \to \infty}} \sqrt{x(x^2 + \frac{2}{x})} \)

f) \( \lim_{{x \to \infty}} \frac{\sin 2x}{x} \)

g) \( \lim_{{x \to \infty}} \left( \sqrt{3x^2 + 8x + 6} - \sqrt{3x^2 + 3x + 1} \right) \)
Question 2. Let $f(x)$ is given as follows: (20 Points)

$$F(x) = \begin{cases} 
mx - 2 & \text{if } x < -0.1 \\
(x - 1)^2 - b & \text{if } x \geq \frac{0.7}{\pi} \\
3\sin(2\pi x - 1.4) + 1 & \text{if } -0.1 \leq x \leq \frac{0.7}{\pi}
\end{cases}$$

For which values of $b$ and $m$ is $f$ continuous? Use your calculator to write the values up to two decimal places.
Question 3. Use the definition of derivative to calculate $f'$: (18 Points)

a) $f(x) = \frac{1}{x^3}$

b) $f(x) = \sqrt{x}$
Question 4. (30 Points)

a) Differentiate $f(x) = (ln(1 + e^x))^2$

b) Differentiate $f(x) = x^x$

c) Differentiate $f(x) = \sec\left(\frac{x^2 - 1}{x}\right)$

d) Find an equation of the tangent line to the curve $y = 3\cos(x/2)$ at the point $(\pi, 0)$.

e) Suppose $f$ is a one-to-one differentiable function and $f^{-1}$ is also differentiable. If $f(4) = 5$ and $f'(4) = \frac{2}{3}$, find $(f^{-1})'(5)$. 