SHOW ALL YOUR WORK. NO CREDITS FOR ANSWERES WITHOUT JUSTIFICATIONS

(1) (22 points) Where does the normal line to the parabola $y = x^2 - 4$ at the point $(-2,0)$ intersect the parabola a second time?

(2) If $f(x) = x^2 e^x$ find a formula for $f^{(n)}(x)$. Also find $f^{(10)}(0)$

(3) If $f(x) = \sin x \cos x$, find $f^{(61)}(x)$. (Hint use double angle identity)

(4) Use the definition of the derivative to evaluate the limit:

   a. $\lim\limits_{x \to 0} \dfrac{\ln(1+x)}{x}$

   b. $\lim\limits_{x \to \frac{\pi}{4}} \dfrac{\cot x - 1}{x - \dfrac{\pi}{4}}$

(5) If $f(x) = \sin^3(\cos^5(x^2))$, find $f'(0)$

(6) If $F(x) = f\left(3f\left(4f(x)\right)\right)$ where $f(0) = 0$ and $f'(0) = 2$, find $F'(0)$.

(7) If $y = (1 + \cos x)^{\ln x}$, find y'

(8) If $\tan^{-1} xy = x + y$, find y' at the point $(0,0)$

(9) If $x^y = y^x$, find y' at the point $(1,1)$