PRINT NAME:________________________________________________

PERM NUMBER:________________________________________________

DISCUSSION SECTION AND TA’S NAME:___________________________

(1) No books and notes are allowed.
(2) You may use a calculator and a notecard.
(3) Show your work in details.
(4) Be sure to spell your TA’s name correctly.
(5) Have a nice Thanksgiving.

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<th>Problem</th>
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(1) (15 points) Find the tangent line of the curve
\[2 \sin x \cos y = 1\]
at the point \(\left(\pi/4, \pi/4\right)\).
(2) (10 points) Let $f(x) = \cot x$. Find $f'''(\pi/4)$. 
(3) (30 points) Find the derivatives of the following functions.

(a) (10 points) \( f(x) = \frac{x}{\sin x} \).

(b) (10 points) \( f(x) = \sqrt{x \sqrt{x \sqrt{x}}} \).

(c) (10 points) \( f(x) = x^{\cos x} \).
(4) (15 points) Let \( f(x) \) be a function that is twice-differentiable at 0 and let \( F(x) = [f(x)]^2 \). Suppose that \( f(0) = 1, f'(0) = 2 \) and \( f''(0) = 3 \). Find \( F''(0) \).
(5) (10 points) Find the limit
\[
\lim_{x \to 0} \frac{\sin 2x}{\sin 3x}.
\]
(6) (20 points) Boyle’s Law states that when a sample of gas is compressed at a constant temperature, the pressure $P$ and volume $V$ satisfy the equation $PV = C$, where $C$ is a constant. Suppose that at a certain instant the volume is 600 cm$^3$, the pressure is 150 kPa, and the pressure is increasing at a rate of 20 kPa/min. At what rate is the volume decreasing at this instant?