On the front of your bluebook write: (1) your name, (2) your student ID number, and (3) a grading table. You must work all of the problems on the exam. SHOW ALL YOUR WORK in your bluebook and $\boxed{\text{BOX}}$ in your final answers. A correct answer with no relevant work may receive no credit, while an incorrect answer accompanied by some correct work may receive partial credit. Text books, class notes, calculators and crib sheets are NOT permitted. **Please start each new problem on a new page of the bluebook.**

1. (25 points) Using the appropriate rules of differentiation, find the derivatives of the following functions. No simplification is necessary. Show all your work.

   (a) $g(y) = y \sin \dfrac{1}{y}$

   (b) $s(r) = \tan^2 r^3$

   (c) $f(x) = \sqrt{1 + \tan\left(x + \dfrac{1}{x}\right)}$

   (d) $p(t) = \left[\left(1 + \dfrac{2}{t}\right)^{-1} + 3t\right]^2$

   (e) $h(x) = \sin\left(\sec\left(\cos x\right)\right)$

2. (20 points) Evaluate each of the following limits, if it exists. If the limit does not exist, state this and state your justification. If the limit goes to $\pm\infty$, find the dominant terms as it does so. Show all your work.

   (a) $\lim\limits_{t\to\infty} \dfrac{3t^{3/4} + t^{5/6} + t^2}{4t^{7/3} + \frac{2}{5}\sqrt{t}}$

   (b) $\lim\limits_{x\to-\infty} \dfrac{|x+3|}{(x+3)}$

   (c) $\lim\limits_{r\to\infty} \sqrt{r^2+1} - r$

   (d) $\lim\limits_{y\to-\infty} \dfrac{y^3}{y^2+1}$

3. (15 points) Consider the curve called the *conchoid of Nicomedes* described by the equation $x^2y^2 = (y+1)^2(4-y^2)$

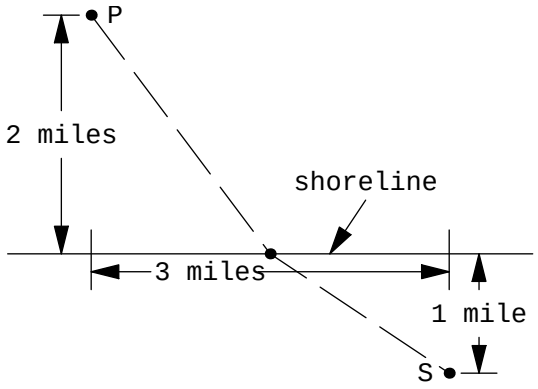
   (a) Find $\frac{dy}{dx}$.

   (b) Find the tangent to the conchoid at the point (0,-2).

4. (20 points) Plot the function $f(x) = 2\cos x + \sin 2x$ for $0 \le x \le 2\pi$. Find and label all critical points, local and absolute extrema, and inflection points.

THE EXAM IS CONTINUED ON THE BACK

5. (20 points)



A man is in a boat at point P, 2 miles from shore. He wants to get to point S, 3 miles down the coast and one mile inland. If he can row at 2 miles/hr and walk at 4 miles/hr, toward what point on the coast should he row in order to reach point S in the least amount of time?

Some Useful Information

$$\sin A \pm B = \sin A \cos B \pm \cos A \sin B$$
$$\cos A \pm B = \cos A \cos B \mp \sin A \sin B$$

$$\sin A \sin B = \frac{1}{2}\cos(A-B) - \frac{1}{2}\cos(A+B)$$
$$\cos A \cos B = \frac{1}{2}\cos(A-B) + \frac{1}{2}\cos(A+B)$$
$$\sin A \cos B = \frac{1}{2}\sin(A-B) + \frac{1}{2}\sin(A+B)$$

$$\sin A + \sin B = 2\sin\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right)$$
$$\sin A - \sin B = 2\cos\left(\frac{A+B}{2}\right)\sin\left(\frac{A-B}{2}\right)$$
$$\cos A + \cos B = 2\cos\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right)$$
$$\cos A - \cos B = -2\sin\left(\frac{A+B}{2}\right)\sin\left(\frac{A-B}{2}\right)$$

$$\sin 2\theta = 2\sin\theta\cos\theta$$
$$\cos 2\theta = \cos^2\theta - \sin^2\theta = 2\cos^2\theta - 1 = 1 - 2\sin^2\theta$$