1. (a) (8pts) Find $\dfrac{d^2y}{dx^2}$ for the function $y = 3\sin(x) + \sqrt{x}$.

   (b) (8pts) Find $f'\left(\frac{\pi}{4}\right)$ where $f(x) = \frac{2}{\pi}x^2 + \cos(2x)$.

   (c) (8pts) Find the derivative of the function $y = \sqrt[4]{x} \cdot \ln(x)$

2. (12 pts) Use implicit differentiation to find an equation for $\dfrac{dy}{dx}$:

$$3xy - x = x^2 + y^2$$

3. (12 pts) Find the equation for the tangent line to the below function at the point $(1, 1)$:

$$y = \ln(x) + e^{2x-2}$$

4. (16 pts) Consider the function $f(x) = \sin^2(x) - \cos^2(x)$, defined on the interval $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$
   (a) Find the x- and y-value of the critical point of $f(x)$ on the given domain.
   (b) Use the first or second derivative test to determine whether this point corresponds to a local maximum, a local minimum, or neither.

5. (15 pts) A coffee stain has formed a perfect circle which is slowly expanding in size while maintaining its shape. If the radius is expanding at a constant rate of 2 centimeters per second, at what rate is the area expanding when the radius is 7 centimeters? [*N.B.* The area of a circle with radius r is $A = \pi r^2$.]

6. (18 pts) A home gardening enthusiast would like to make a small rectangular fence enclosure for a garden in her front yard; the fence will have three compartments in order to keep three types of plant separated. As such she will use the same fencing to make the rectangular border and two separate dividers inside the fence which are each parallel to one of the outer walls (as well as each other). If she has 400 feet of fencing, what dimensions will give her the largest possible fenced-in area?

7. (36 pts) Integrate the following (no need to simplify):

   (a) $\displaystyle\int_1^2 3t - t^2 + \frac{3}{t}\, dt$ (b) $\displaystyle\int \frac{-\sin\left(e^{-x}\right)}{e^x}\, dx$ (c) $\displaystyle\int_0^2 x^2 e^{x^3}\, dx$

8. (7 pts) Find the domain and range of the function $f(x) = \dfrac{1}{\sqrt{x^3 - 1}}$

9. (21 pts) A miscreant drops a penny off of a tall building onto the street. After t seconds, the height of the penny in feet above the ground is given by the equation $s(t) = 3200 - 16t^2$.
   (a) How tall is the building, in feet?
   (b) How long does the penny take to reach the ground?
   (c) What is the velocity of the penny after it has been in the air for 5 seconds?

10. (14 pts) Find the limits:

    (a) $\displaystyle\lim_{x\to 2} \frac{x^2 - 4}{x - 2}$ (b) $\displaystyle\lim_{h\to 0} \frac{(5+h)^2 - 5^2}{h}$

11. (14 pts) Find the function $f(x)$ which satisfies the initial value problem $f'(x) = 1 - x - x^2$ and $f(0) = 3$.

12. (21 pts) Sketch the graph of the function $y = x^3 - 3x + 3$, including the y-intercept, local maximum and minimum points, intervals of increasing/decreasing and concavity, and inflection points.