Midterm Exam 2 is scheduled for Monday, February 15th, at 3:00pm (in class). Remember that calculators are not allowed for this exam. The following exercises are just a sample of what may be on the exam. Do not restrict your studying to this review, and it is no guarantee that everything on this review will be on the midterm. These exercises are all examples of what knowledge/skills you should have gotten from the material covered so far. Other very important resources for studying include the WebWork assignments, lecture guides and exercises in the text.

1. The Concept Check, True-False Quiz, and Exercises in the Chapter 3 Review of the textbook (except Exercises 43,44,76).

2. Compute the indicated derivative.

   (a) $v'(\frac{\pi}{4})$, where $v(t) = \tan(t) - 2\csc(t)$

   (b) $\frac{d}{dx}\left[\frac{e^x \sin(x)}{x^2+1}\right]\Big|_{x=0}$

   (c) $j''(x)$ for $j(x) = x^4 - \frac{5}{\sqrt[5]{x}}$

   (d) $\frac{dy}{dx}$ for $y = \frac{3x^2}{\sin(x)}$

   (e) $\frac{d^2y}{dx^2}$ for $y = 2^x\sqrt{x}$

   (f) $f''(x)$ with $f(x) = \sin(\cos(x))$.

   (g) $\frac{dy}{dx}$ for $x^2y^2 + x^4 = e^{y^2} - 1$

   (h) $\frac{dx}{dy}$ at the point when $x = 2$, $y = 1$, given $x\arctan(y) = y\ln(0.5x)$

   (i) $g'(0)$, given $g(t) = \frac{(t+1)^2\ln(t+1)}{e^t}$

   (j) $h'(x)$, with $h(x) = \log_2(\csc(\sqrt{x^2-1}))$

3. Use implicit differentiation to calculate the derivative of $y = \tan^{-1}(x)$.

4. For what values of x is the tangent line to $f(x) = x^2e^x$ horizontal?

5. Write the equation of the tangent line to $y = e^x - 3x^2 + \sin(x)$ at $x = 0$.

6. Suppose that $f(2) = -3$, $g(2) = 2$, $f'(2) = 5$, and $g'(2) = -2$. Find $h'(2)$ if...

   (a) $h(x) = f(x)g(x)$

   (b) $h(x) = \frac{f(x)}{g(x)}$

   (c) $h(x) = 3f(x) - 2x + 3 - g(x)$

7. Use linear approximation of $f(x) = \sqrt{x}$ at $x = 100$ to estimate $\sqrt{99.8}$. Is this an overestimate or underestimate?

8. For each of the following functions, on what interval(s) is the function increasing? Decreasing? Concave up? Concave down?

   (a) $f(x) = \ln\left(\cos\left(\frac{\pi}{2}x\right)\right)$ with $-1 < x < 1$

   (b) $g(x) = \ln(x^2 + 1)$

9. When the brightness x of a light source is increased, the eye reacts by decreasing the area R of the pupil. The experimental formula

$$R = \frac{40 + 24x^{0.4}}{1 + 4x^{0.4}}$$

   has been used to model the dependence of R on x when R is measured in square millimeters and x is measured in appropriate units of brightness. Find the rate of change of the reaction with respect to x, called the sensitivity.

10. Decide whether each of the following statements is true or false.

    (a) It is impossible to find y' from an equation in which it is impossible to isolate y.

    (b) The acceleration of an object is the instantaneous rate of change in its velocity.

    (c) If $r(x) = \frac{p(x)}{q(x)}$, then $r'(x) = \frac{p'(x)}{q'(x)}$.

11. Suppose that an ant is walking around on the edge of a yardstick for eight seconds. Its position (in inches) after t seconds ($0 \leq t \leq 8$) is given by $s = \frac{1}{3}t^3 - 3t^2 + 5t + 10$.

    (a) Find the ant's velocity (including units) after t seconds.

    (b) Find the ant's acceleration (including units) after t seconds.

    (c) When is the ant moving in the positive direction?

    (d) When is the ant speeding up?

    (e) What is the total distance traveled by the ant during the first two seconds?

12. An oscillating lemming population is modeled by the function

$$P(t) = 200\cos\left(\frac{\pi}{10}t\right) + 60t$$

    where t is measured in *hours* from now. Use linear approximation to estimate the population 5 *minutes* from now.