# Week-in-Review 9: Exam 2 review
## (Ch 3.1 - 3.10, K1, K2: Derivatives and their Applications.)

**Problem 1.** Find the following derivatives:

a) $y = \sin^5(\sec(\sqrt{x^2+1}))$

b) $f(x) = x^2 \arcsin(x)$

c) $f(x) = 6^{2^x} + \sqrt[3]{3x^2}$

d) $y = \ln(x^2 e^{-3x})$

e) $f(x) = x^2 \ln(3 + 2x)$

f) $y = x^3 e^x \tan(x^2)$

g) $f(x) = e^{x^3 + \sin x}$

h) $f(x) = \dfrac{(2-x)^2}{\sin x}$

i) $y = \log(\sin^2(5x))$

j) $f(x) = \dfrac{7\pi}{\sqrt{5x + e^x}}$

**Problem 2.** If $f(x) = \sin^4(x)$, find $f'(\pi/3)$.

**Problem 3.** Find the $25^{th}$ derivative of $f(x) = xe^{-x}$.

**Problem 4.** For the parametric curve given by $x = t^3 - 3t^2 - 9t + 1,\ y = t^3 + 3t^2 - 9t + 1,$

a) Find the point(s) on the curve where the tangent lines are horizontal or vertical.

b) Find the equation of the tangent line when $t = 2$.

**Problem 5.** Find the slope of the tangent line to the curve $3y^3 - xy^2 + 3 = 0$ at the point $(0, -1)$.

**Problem 6.** For $f(x) = \dfrac{x^3 + 1}{x^2 + 1}$, find the equation of the tangent line at the point $x = -1$.

**Problem 7.** Find the velocity, speed and acceleration of each particle defined below: ($t$ is given in seconds and distance is in meters.)

a) At time $t = 2$ when its position is given by $\vec{r}(t) =< \sqrt{t^2 + 5}, t >$.

b) At time $t = \pi/3$ when its position is given by $\vec{r}(t) =< 4\cos(2t), 3\sin(2t) >$.

**Problem 8.** The population of a bacteria culture grows at a rate proportional to its size. After 2 hours the bacteria population was 1000 and after 5 hours, the bacteria population was 7000. After how long will the bacteria culture attain a population of $35,000$?

**Problem 9.** Find the half life of the radioactive isotope Strontium 90 if a sample decays to 95% of its original mass after 1 year.

**Problem 10.** Consider a right angled triangle. If the horizontal leg of the trangle is increasing at the rate of 5 m/s and the vertical leg of the triangle is decreasing at the rate of 6 m/s, at what rate is the hypotenuse changing when the horizontal leg is 12m and the vertical leg is 9m ?

**Problem 11.** A boat is being pulled into a dock by a pulley that is fixed 1m above the water level, at a rate of 1 m/s. How fast is the boat approaching the dock when the boat is 8 meters away from the dock?

**Problem 12.** A kite flying 100 ft above the ground moves horizontally at a speed of 8 ft/s. At what rate is the angle between the string and the horizon decreasing when the string is 200 ft long?

**Problem 13.** Find the linear approximation for $f(x) = \dfrac{1}{\sqrt{4+x}}$ at $a = 0$ . Use the linear approximation model to estimate the value of $\dfrac{1}{\sqrt{4.01}}$.

**Problem 14.** Use linear approximation to estimate the value of $\sqrt[3]{8.012}$.

**Problem 15.** The radius of a sphere was measured to be 5 cm with a maximum error in measurement of 0.1 cm. Use differentials to estimate the maximum error possible in the calculated volume of the sphere. What is the percentage relative error?