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Department of Mathematical Sciences

MAJOR No. 2  
(MATH. 101-041 Sections 4 & 8)

**Name:**

**ID:**

**Prob. 1**

Sketch the graph of the derivative of the function whose graph is shown

**Prob. 2**

Find the  $x$ -coordinate of the point on the graph of  $y = x^2$  where the tangent line is parallel to the secant line that cuts the curve at  $x = -1$  and  $x = 3$ .

**Prob. 3**

Let

$$f(x) = \begin{cases} x^2 \sin \frac{1}{x}, & x \neq 0 \\ 0, & x = 0. \end{cases}$$

- (a) Show that  $f$  is continuous at 0.
- (b) Use the "**definition**" of the derivative to find  $f'(0)$ .
- (c) Find  $f'(x)$  for  $x \neq 0$ .
- (d) Show that  $f'$  is not continuous at  $x = 0$ .

**Prob. 4**

Use implicit differentiation to find the slope of the tangent line to the curve

$$x^{2/3} + y^{2/3} = 4$$

at the point  $(-1, 3\sqrt{3})$ .

**Prob. 5**

A police helicopter is flying due north at 100 mi/h and at a constant altitude of  $\frac{1}{2}$  mi. Below, a car is traveling west on a highway at 75 mi/h. At the moment the helicopter crosses over the highway the car is 2 mi east of the helicopter.

(a) How fast is the distance between the car and helicopter changing at the moment the helicopter crosses the highway?

(b) Is the distance between the car and helicopter increasing or decreasing at that moment?

**Prob. 6**

The time required for one complete oscillation of a pendulum is called its *period*. If  $L$  is the length of the pendulum, then the period is given by  $P = 2\pi\sqrt{L/g}$ , where  $g$  is a constant called the *acceleration due to gravity*. Use differentials to show that the percentage error in  $P$  is approximately half the percentage error in  $L$ .