## MATHEMATICS: ASSIGNMENT 2

Instructions: No hand-written work. Submit using the assignment box in IBLC 361. Indicate subject (mathematics), assignment number, name and student ID\# at the top of the front page. Multiple pages should be stapled; no folded-corner tricks, no paper clips.

Due: Before 10 am, Monday, Sept 28.

1. Determine where each of the following functions is differentiable. In (a), show non-differentiability (if applicable) by using the definition of the derivative. For (b), your answer can be entirely conceptual and should address the possibilities for the kinds of behaviour you might get in such a function. You do not need to mess around with formulae for ellipses or worry about the details of the planets' actual paths.
(a) $f(x)=\left|1-x^{2}\right|-\left(2-x^{2}\right)$,
(b) the distance between Saturn and the planet closest to Saturn, as a function of time.
2. For each of the following curves, find $y^{\prime}$ (in terms of $x$ ). Simplify as much as possible.
(a) $y=x^{4} /\left(k^{4}+x^{4}\right)$,
(b) $x=4 \sin (2 y+6)$.
3. Find the equation of the line(s) tangent to the curve $y=x+3 / \log x$, with $y$-intercept 6 .
4. The perceived frequency of a sound emitted by a source is determined by the emitted frequency $f_{0}$, the "velocity" of the source relative to the medium $v_{s}$, the velocity of sound in the medium $v_{m}$ and the "velocity" of the receiver relative to the medium $v_{r} . v_{s}$ and $v_{r}$ are not the full velocities but rather the component of the velocities parallel to the line between source and receiver. The sign convention for each one is such that it is positive when the distance between source and receiver is increasing and negative when decreasing. The perceived frequency is given by

$$
f_{r}=\frac{v_{m}-v_{r}}{v_{m}+v_{s}} f_{s} .
$$

Calculate the perceived frequency as a function of time if the source is moving in a straight line with constant velocity $v$ and is a distance $\delta$ away from the receiver when at its closest point to the receiver. The moment at which source and receiver are closest occurs at $t=0$. The receiver is not moving.

5. Can a function be continuous everywhere on a real interval $(a, b)$, but differentiable nowhere on $(a, b)$ ? Justify your answer. This is a relatively open ended question - we are looking for some evidence of deep thought.

