MATHEMATICA LAB II

Lab report due: October 19th

First, read the following sections (pp 20 – 24) of Thomas' An Introduction to Mathematica.

- Built-in commands and constants
- Command options and additional plots

Submit a *printed version* of your Mathematica notebook. You may (*and are encouraged to*) work with other students and compare results, but ultimately you must submit *your own* lab results --- *not* a shared copy. On your front page (using *Mathematica*) state your name and "Mathematica Lab II" using an appropriate style, font, size, and color. *Number* each problem and *restate the problem* before giving the solution. Use *Mathematica* input, not free-form input!

1. Plot the curve $y = x^2 \sin(1/x^2)$. What happens near x = 0? What happens as $x \to \infty$? Justify your answers by referring to four or five versions of your graphs over different domains.

2. Let $f(x) = x^4 - \pi x^3 - 19 x^3 + 156.1 x^2 - 391 x + 303$

(a) Plot y = f(x) and, using the graph, determine the *number of roots* of this polynomial. Explain how you reached this conclusion.
You will need to examine the plot with several different domains!

(b) Using the NSolve command, find *all the real roots* of this polynomial.

3. Graph the curve $y = |x| \cos(1/x)$.

(a) Graph the two curves y = |x| cos(1/x) and y = x/2 for *several different domains*. (Use the built-in function Abs[ ])

(b) Viewing this graph, how many solutions do you think the equation |x| cos(1/x) = x/2 has?

(c) Using NSolve, can you find a solution? What happens?

(d) Using FindRoot, find 5 positive solutions.

4. Compare *logarithmic growth* with *linear growth* by plotting the two curves, $(\ln x)^7$ and x on the same set of axes.
Which function tends to infinity faster (as $x \to \infty$)? $(\ln x)^7$ or x? One way of achieving this is by exploring the quotients of these functions for large values of x. *Explain why your answer is correct by viewing the plot.*
(Careful, this problem is quite tricky if you are not careful.)

5. Let $g(x) = 2x + 7 \sin x$.

(a) Find equations of the *tangent and normal lines* to $y = g(x)$ at x = 4 (either by hand or using Mathematica).

(b) Graph *(on the same pair of axes)* the curve y = g(x) *together with* its *tangent and normal lines* at x = 4. (You may wish to use AspectRatio→Automatic to make sure that the tangent and normal lines actually *appear to be* perpendicular.)

6. (a) Plot the implicitly defined curve $2y^3 + y^2 - y^5 = x^4 - 2x^3 + x^2$ for each of x and y in the interval [-2, 3].

(b) Compute dy/dx for this curve.

7. Consider the *Folium of Descartes*: $x^3 + y^3 - 6xy = 0$.

Find the equations of the tangent and normal lines to this implicitly defined curve at the point $P = (4/3, 8/3)$. Plot the curve and the two lines on the same pair of axes.

I'm very well acquainted, too, with matters mathematical
I understand equations, both the simple and quadratical
About binomial theorem, I'm teeming with a lot o' news
With many cheerful facts about the square of the hypotenuse

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I'm very good at integral and differential calculus
I know the scientific names of beings animalculous
In short, in matters vegetable, animal, and mineral
I am the very model of a modern Major-General

- Gilbert and Sullivan: ***Pirates of Penzance***