**Math 229 Calculus Computer Lab Spring 15 Sample Midterm 2**

- You may only use `julia` during this exam. No calculators or cell phones.

(1) Convert the following `julia` expressions to standard mathematical expressions. Use parentheses to clearly indicate the order of operations:

    (a) `a+b/(b-1)`

    (b) `cos(1/2x)^2/2*x`

    (c) `(y-x)/2z+3`

(2) Write `julia` commands to find the zeros of $f(x) = x^2 - 4x + 4$ using

    (a) `roots`

    (b) `fzeros`

    (c) The bisection method `fzero`

        The last one doesn't work - explain why.

(3) Consider the equation $e^{x/2} = 3/x$.

    (a) Show there is a solution by plotting the graphs of these functions.

    (b) Write `julia` commands to find a numerical approximation to the solution, and find the solution.

(4) You wish to estimate

$$\lim_{x \to 0} \frac{\cos(3x) - e^{x^2/2}}{x^2}.$$

Write `julia` commands to generate a list of numbers $\{10^{-1}, 10^{-2}, \ldots, 10^{-10}\}$. Evaluate the function when $x$ takes these values, and write down your results. What do you think the limit is? Explain `julia`'s output.

(5) Let $f(x) = \sin(1/x)$.

(a) Write `julia` commands to define an approximate derivate $\dfrac{f(x+h)-f(x)}{h}$ with $h = 0.01$.

(b) Use symbolic differentiation in `julia` to find $f'(x)$.

(c) Write `julia` commands to plot both functions on the same graph. What do you notice?

(6) Use symbolic differentiation in `julia` to find the second derivative of $f(x) = e^{1/x^2}$. Write `julia` commands to find $\lim\limits_{x\to 0} f''(x)$ by any method, and find the limit.