Due: September 9, 2016

MATH 320: HOMEWORK 1

Please read through chapters 2 and 3 of the textbook. Obtain access to a copy of MATLAB or GNU Octave to answer the following questions. For all questions, please write a brief description of how your code works.

(1) Problem 2.9: The density of freshwater can be computed as a function of temperature with the following cubic equation:

$$\rho = 5.5289 \times 10^{-8} T_C^3 - 8.5016 \times 10^{-6} T_C^2 + 6.5622 \times 10^{-5} T_C + 0.99987$$

where ρ = density (g/cm^3) and T_C = temperature ($^\circ C$). Use MATLAB to generate a vector of temperatures ranging from $32^\circ F$ to $93.2^\circ F$ using increments of $3.6^\circ F$. Convert this vector to degrees Celsius and then compute a vector of densities based on the cubic formula. Create a plot of ρ versus T_C. Recall that $T_C = 5/9(T_F - 32)$.

(2) Problem 2.15: The Maclaurin series expansion for the cosine is

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \frac{x^8}{8!} - \cdots$$

Use MATLAB to create a plot of the cosine (solid line) along with a plot of the series expansion (black dashed line) up to and including the term $x^8/8!$. Use the built-in function `factorial` in computing the series expansion. Make the range of the abscissa from $x = 0$ to $3\pi/2$.

(3) Problem 3.6: Two distances are required to specify the location of a point relative to an origin in two-dimensional space:

- The horizontal and vertical distances (x, y) in Cartesian coordinates; or
- The radius and angle (r, θ) in polar coordinates.

It is relatively straightforward to compute Cartesian coordinates (x, y) on the basis of polar coordinates (r, θ). The reverse process is not so simple. The radius can be computed by the following formula: $r = \sqrt{x^2 + y^2}$.

If the coordinates lie within the first and fourth quadrants (i.e., $x > 0$), then a simple formula can be used to compute θ: $\theta = \tan^{-1}(y/x)$. The difficulty arises for the other cases. The following table summarizes the possibilities:

x	y	θ
< 0	> 0	$\tan^{-1}(y/x) + \pi$
< 0	< 0	$\tan^{-1}(y/x) - \pi$
< 0	$= 0$	π
$= 0$	> 0	$\pi/2$
$= 0$	< 0	$-\pi/2$
$= 0$	$= 0$	0

Write a well-structured M-file using `if...elseif` structures to calculate r and θ as a function of x and y. Express the final results for θ in degrees. Test your program by evaluating the following cases:

x	y	r	θ
2	0		
2	1		
0	3		
-3	1		
-2	0		
-1	-2		
0	0		
0	-2		
2	2		

(4) Problem 3.20: A Cartesian vector can be thought of as representing magnitudes along the $x-$, $y-$, and $z-$ axes multiplied by a unit vector (i, j, k). For such cases, the dot product of two of these vectors $\{a\}$ and $\{b\}$ corresponds to the product of their magnitudes and the cosine of the angle between their tails as in $\{a\} \cdot \{b\} = ab\cos\theta$.

The cross product yields another vector, $\{c\} = \{a\} \times \{b\}$, which is perpendicular to the plane defined by $\{a\}$ and $\{b\}$ such that its direction is specified by the right-hand rule. Develop an M-file function that is passed two such vectors and returns θ, $\{c\}$ and the magnitude of $\{c\}$ and generates a three-dimensional plot of the three vectors $\{a\}, \{b\}$ and $\{c\}$ with their origins at zero. Use dashed lines for $\{a\}$ and $\{b\}$ and a solid line for $\{c\}$. Test your function for the following cases:

(a) `a = [6 4 2]; b = [2 6 4];`
(b) `a = [3 2 -6]; b = [4 -3 1];`
(c) `a = [2 -2 1]; b = [4 2 -4];`
(d) `a = [-1 0 0]; b = [0 -1 0];`