ME 352 Problem Set 1 due 7 October 2008

Quick Questions

Use MATLAB to evaluate the following formulas. Show the results of executing the formulas in a MATLAB session. For each formula *use variables, not numerical values* for the constants given at the start of the problem statement. Pure numbers in the formulas can be entered directly.

Example:

Given $m = 3$ gm, $v = 30$ m/s, compute the kinetic energy $\text{KE} = \frac{1}{2}mv^2$

Solution

```
>> m = 3e-3;
>> v = 30;
>> KE = 0.5*m*v^2
KE =
    1.3500
```

1. **(5 points)**

   Given $\rho = 1.2\,\text{kg/m}^3$, $V_0 = 5\,\text{m/s}$, $\epsilon = 0.4$ $\Phi_s = 0.83$, and $D_p = 0.2\,\text{mm}$, compute $\Delta p/L$

   $$\frac{\Delta p}{L} = \frac{1.75 \rho V_0^2}{\Phi_s D_p} \frac{1-\epsilon}{\epsilon^3}$$

   Make sure the units of $\Delta p/L$ are Pa/m.

2. **(5 points)** Given $p_a = 6.5 \times 10^5$, $p_b = 1.42 \times 10^5$, $\gamma = 1.4$, and $\beta = 0.75$ compute Y where

   $$Y = \left(\frac{p_b}{p_a}\right)^{1/\gamma} \left\{ \frac{\gamma(1-\beta^4)\left[1-(p_b/p_a)^{(\gamma-1)/\gamma}\right]}{(\gamma-1)(1-p_b/p_a)\left[1-\beta^4(p_b/p_a)^{2/\gamma}\right]} \right\}^{1/2}$$

Comprehensive Questions

3. **(15 points)** The Michaelis-Mentel model for the consumption of a substrate by an enzymatic reaction is

$$K_m \ln\left(\frac{s_0}{s}\right) + s_0 - s = V_{\max} t$$

where K_m is the concentration of the substrate at the so-called *half-maximal consumption rate*, s is the substrate concentration, s_0 is the initial value of s, $V_{\max}$ is the maximum substrate consumption rate, and t is time.

Make a plot of s versus t for $0 \leq t \leq 200$ minutes for the following parameter values: $K_m = 0.5$ mM (milli-mole), $s_0 = 1$ mM and $V_{\max} = 5$ mM/min. *Hint*: Since you cannot solve for s as a function of t, compute t as a function of s and reverse the meaning of the abscissa and ordinate. t should still be the abscissa in your plot.

4. **(15 points)** Given the following astronomical data

Diameter of the earth:	$d_e = 12,600$ km
Diameter of the sun:	$d_s = 1,390,000$ km
Orbit of the earth:	$d_o = 150,000,000$ km

use the `draw_circle` and `fill_circle` functions to make two plots. Assume that the sun, the earth, and the earth's orbits are circular. The first plot shows (1) the sun as a solid yellow circle centered at the origin, (2) the orbit of the earth as a dashed line, and (3) the earth as a solid blue circle located on its orbit (choose one point).

The second plot is a zoomed-in view that shows the eart at the center of the plot and the roughly the size of one fifth of the x and y axes.

Be sure that the scale of the x and y axes are equal so that the sun, earth and earth orbits are circular.

Do not alter the code in `draw_circle` and `fill_circle` and *do not* copy the code from `draw_circle` and `fill_circle` into an m-file. Instead, write one m-file that calls `draw_circle` and `fill_circle` as needed.

Is there anything odd about the appearance of the dashed line representing the earth's orbit. How would you fix the plot of the orbit to make it appear smooth?

```
function draw_circle(r,x0,y0,line_style)
% draw_circle  Draw a circle in the (x,y) plane
%
% Synopsis:  draw_circle(r)
%            draw_circle(r,x0)
%            draw_circle(r,x0,y0)
%
% Input:  r = radius of the circle
%         x0,y0 = x and y coordinates of the center of the circle
%                 Default:  x0 = 0,  y0 = 0;

if nargin<2, x0 = 0;  end
if nargin<3, y0 = 0;  end
if nargin<4, line_style = '-';  end

t = linspace(0,2*pi);
x = x0 + r*cos(t);
y = y0 + r*sin(t);
plot(x,y,line_style)
```

```
function fill_circle(r,x0,y0,fill_style)
% fill_circle  Draw a solid circle (a solid disk) in the (x,y) plane
%
% Synopsis:  fill_circle(r)
%            fill_circle(r,x0)
%            fill_circle(r,x0,y0)
%
% Input:  r = radius of the circle
%         x0,y0 = x and y coordinates of the center of the circle
%                 Default:  x0 = 0,  y0 = 0;

if nargin<2, x0 = 0;  end
if nargin<3, y0 = 0;  end
if nargin<4, fill_style = 'b';  end

t = linspace(0,2*pi);
x = x0 + r*cos(t);
y = y0 + r*sin(t);
fill(x,y,fill_style)
```