Semester: Summer 2008

EML3041 Affidavit Sheet

Important: Each student is expected to work independently on the computer program. Offenders will be assigned a grade of *FF* for the whole course and brought to the attention of the Dean of academic affairs for further process. Check 2007-08 undergraduate catalog on academic dishonesty and disruption of academic process. I attest to the following.

I have

1. worked independently,
2. received no help on this programming assignment from anybody (other than instructor or TA), and
3. given no help in completing the programming assignment

during Summer 2008 for the course - EML 3041- Computational Methods.

If I am found to be giving or receiving help, I will be assigned a grade of 'FF' for the whole course and brought to the attention of the Dean of Academic Affairs for further process. Check 2007-08 undergraduate catalog on academic dishonesty and disruption of academic process. You always have the right to appeal the decision of the instructor.

Name of the Project: Flow rate in pipe

Dated June 02, 2008

Signature AKK

Name AUTAR K KAW

SUMMER 2008 AUTAR KAW 06/02/08 GROUP 5

Velocity vs. radius data

r	$v(r)$
ft	ft/s
0	10.0
0.083	9.72
0.17	8.88
0.25	7.50
0.33	5.60
0.42	3.10
0.50	0.00

Contents


```
% Revised:
%       August 25, 2015

% Purpose
%       This program will demonstrate the appropriate format to be
%       used for submissions. This is not a MATLAB tutorial. In addition,
%       it demonstrates finding the flow rate in a pipe when
%       the velocity vs radius data is given.

% Keyword
%       Sample
%       Format

% Author
%       Autar Kaw
%       Semester: Fall 2015

clc
clf
clear all
disp ('Computational Methods')
disp ('EML3041')
disp ('Fall 2015')
disp ('Autar Kaw')
disp('Project Name: Flow rate in a pipe')
disp('**********************************************************************')
disp('  ')
```

```
Computational Methods
EML3041
Fall 2015
Autar Kaw
Project Name: Flow rate in a pipe
**********************************************************************
```

General Guidelines

```
%1) publish the m file in HTML format
```

```
%2) sufficient comments should be used so someone else can
%   understand your program
```

Problem 1

```
%EXAMPLE OF PROPER TABLE FORMAT

%>> each problem should be separated by this divider.
%HINT: Don't forget the space after the %%!

%INPUTS
% Attached is the handwritten data taken in the lab
% radial location data
radial =   [0  0.083  0.17  0.25  0.33  0.42  0.5];
% velocity data
velocity= [10  9.72   8.88  7.5     5.6      3.1    0];
%>> for tables, you only need to display the problem number as shown below

%CODE
disp ('Problem 1')
disp('_________________________________')
disp('   Radius (in)    Velocity (ft/s)' )
disp('_________________________________')
dataval=[radial;velocity]';
disp(dataval)
disp('_________________________________')
disp ('  ')

%OUTPUTS
%See table

%for problems not requiring clearly defined outputs (e.g. displaying data
%in a table), make a note similar to the one seen above.
```

```
Problem 1
_________________________________
   Radius (in)    Velocity (ft/s)
_________________________________
         0   10.0000
    0.0830    9.7200
    0.1700    8.8800
    0.2500    7.5000
    0.3300    5.6000
    0.4200    3.1000
    0.5000         0

_________________________________
```

Problem 2

```
%EXAMPLE OF A CALCULATION PROBLEM
```

```
%>> each problem should be divided with comments as follows:
%   INPUTS, CODE, and OUTPUTS. You should NOT use %% for these
%   divisions.

%>> if you have already entered the INPUT data for a previous problem,
%   reference the variable names as a comment here. Example is as follows.

%INPUTS (from Problem 1)
%radial
%velocity

%CODE
% Length of radial location array
n=length(radial);
% Fitting a polynomial of degree 2 to the data
p=polyfit(radial,velocity,2);
syms r %>> DO NOT put comments here
%>> put comments above or below your line of code to get a cleaner
%   look

%OUTPUTS
% Outputting the velocity profile
disp('Problem 2')
%>> the only ways anything should be output to the Command Window
%   is by using 'disp' or 'fprint' commands
fprintf('The velocity profile is %gr^2 + %gr +%g', p(1),p(2),p(3))
disp('   ')
disp('********************************************************************')
disp ('  ')
```

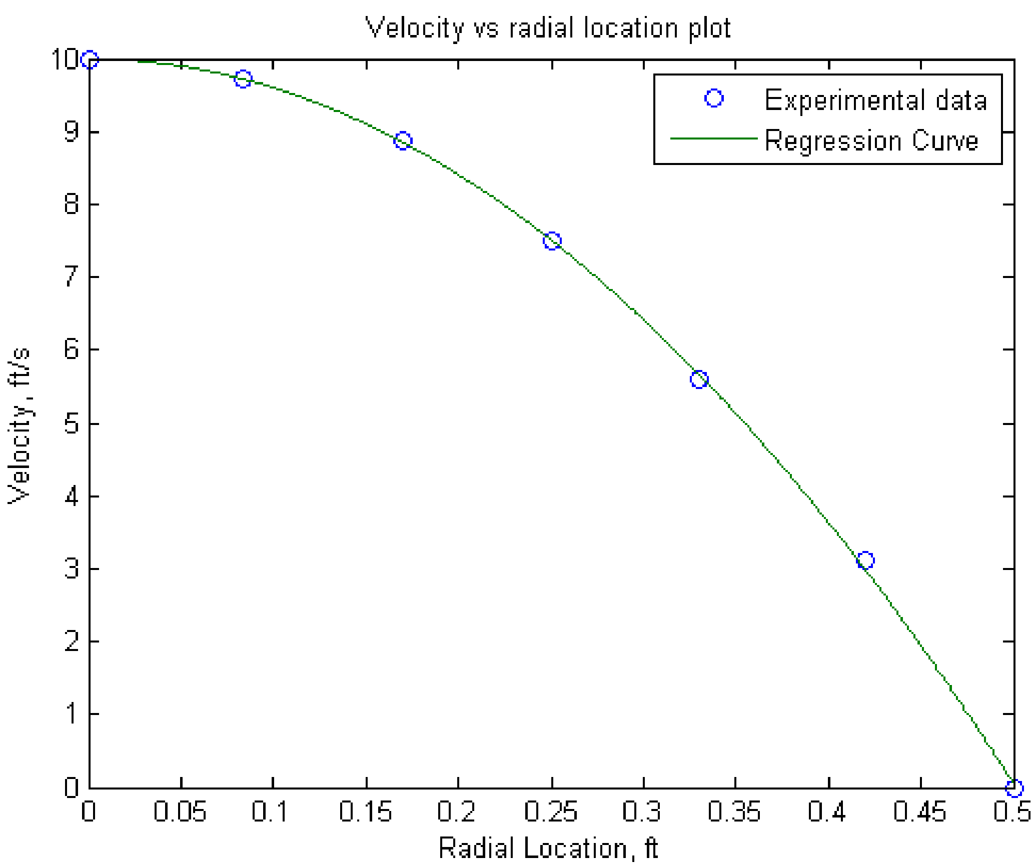
```
Problem 2
The velocity profile is -39.9209r^2 + 0.067263r +9.9965
********************************************************************
```

Problem 3

```
%EXAMPLE OF PROPER FIGURE FORMAT

%INPUTS (from Problem 1)
%radial
%velocity

%CODE
% Plotting velocity vs radial location
r_val=radial(1):(radial(n)-radial(1))/1000:radial(n);
v_val=polyval(p,r_val);

%OUTPUTS
%plotting radial location vs velocity
plot(radial,velocity,'o',r_val,v_val,'-');
%>> if there is more than one plot on the same figure, the plots
%   must have different colors and/or symbols
xlabel('Radial Location, ft')
```

```
ylabel('Velocity, ft/s')
title ('Velocity vs radial location plot')
legend('Experimental data','Regression Curve')
%>> you must use all of the previous figure format elements
disp ('Problem 3')
%>> refer the reader to the appropriate figure for plot problems
disp('See Figure 1')
disp('*********************************************************************')
disp ('  ')
```

```
Problem 3
See Figure 1
*********************************************************************
```



Problem 4

```
%INPUTS
%radial (from Problem 1)
%p (from Problem 2)

%CODE
% Finding the flow rate from the regression curve
% Velocity profile
vel_profile=p(1)*r^2+p(2)*r+p(3);
% Integrating to find the flow rate
flow_rate=int(2*pi*r*vel_profile,r,radial(1),radial(n));
```

```
flow_rate=double(flow_rate);

%OUTPUTS
disp('Problem 4')
%>> Use '...' to avoid cut off errors
fprintf ('The flow rate from the regression curve is=  %g  ft^3/s',...
    flow_rate)
disp('  ')
disp('********************************************************************')
disp ('  ')
```

```
Problem 4
The flow rate from the regression curve is=  3.94962  ft^3/s
********************************************************************
```

Problem 5

```
%EXAMPLE OF A CALCULATION PROBLEM

%INPUTS (from Problem 1)
%velocity
%radial

%CODE
% Finding the flow rate from the average velocity x Area method
% Average Velocity
avg_vel=mean(velocity);
% Integrating to find the flow rate
flow_rate=avg_vel*pi*radial(n)^2;
flow_rate=double(flow_rate);

%OUTPUTS
disp('Problem 5')
fprintf('The flow rate from the average velocity method is=  %g  ft^3/s',...
    flow_rate)
disp('  ')
disp('********************************************************************')
disp ('  ')
```

```
Problem 5
The flow rate from the average velocity method is=  5.02655  ft^3/s
********************************************************************
```

Problem 6

```
%EXAMPLE OF A CALCULATION PROBLEM

%INPUTS (from Problem 1)
%velocity
```

```
%radial

%CODE
% Using trapezoidal rule with unequal segments to find flow rate
flow_rate_alt=0;
for i=1:1:n-1
    fun_up=2*pi*radial(i+1)*velocity(i+1);
    fun_low=2*pi*radial(i)*velocity(i);
    flow_annulus=(radial(i+1)-radial(i))/2*(fun_up+fun_low);
    flow_rate_alt=flow_rate_alt+flow_annulus;
end

%OUTPUTS
disp('Problem 6')
disp('Using trapezoidal rule with unequal segments to find flow rate')
fprintf ('The flow rate from an alternative method is=  %g  ft^3/s',...
    flow_rate_alt)
disp('  ')
disp('*******************************************************************')
disp ('  ')
```

```
Problem 6
Using trapezoidal rule with unequal segments to find flow rate
The flow rate from an alternative method is=  3.84767  ft^3/s
*******************************************************************
```

Published with MATLAB® R2013b

Conclusions

Autar Kaw
Group 5
Summer 2008
Flow Rate Project

The flow rate Q in a pipe is given by

$$Q = \int_0^a v(r)dA = \int_0^a 2\pi r v(r)dr \quad (1)$$

where

$v(r)$= velocity along the radial location, r

a = radius of the pipe.

I used three methods of finding the flow rate.

1. In the first case, the velocity vs radial location data was regressed to a second order polynomial and then substituted in equation (1).
2. In the second method, the average velocity $\overline{V}$ was found and the flow rate was simply given by

   $$Q = \overline{V} \times A$$

   where A is the cross-sectional area of the pipe.
3. In the method of my choice, I chose the Trapezoidal rule with unequal segments.

So why are the results from methods (1) and (3) so different from method (2)? This is because the integrand in equation (1) is $2\pi r v(r)$ and not $v(r)$. If I had averaged $2\pi r v(r)$ instead, I would get a better estimate of the flow rate just like obtained in Methods (1) and (3). I would have tried this method also as a learning experience, but I had ICE and HVAC tests to study for and I promised my BFF that I will go to see *Sex and the City* with her.