# CHEN 320 Homework 1

By: Nathaniel Thomas

Date: 08/25/2022

**Problem 1 and 2 code:**

```
%% CHEN 320-202 Homework 1
% Questions 1 and 2
% Author: Nathaniel Thomas
% Date: 08/25/2022

%% Problem 1 (Part 1)
fprintf("Problem 1 (Part 1):\n");

% Given values
p = 1000; % kg/m^3

% Source: https://www.engineeringtoolbox.com/water-dynamic-kinematic-viscosity-
d_596.html
mu = 0.0008891; % N*s/m^2

d = 0.5; % m

% Get user input
u = input("Please enter a flow velocity (m/s): ");

% Calculate friction factor
re = reynolds_number(p, u, mu, d);
f = friction_factor(re);

fprintf("Friction factor: %.5f \n", f);
fprintf("\n")

%% Problem 1 (Part 2)
vel = (0.001:0.05:1);
re_mult = reynolds_number(p, vel, mu, d);
f_mult = friction_factor(re_mult);

% Plot the values
plot(vel, f_mult);
title("Friction factor vs Fluid velocity for water in a 0.5m pipe" + ...
    " at $25\ ^\circ C$", "Interpreter", "latex");
xlabel("Velocity $\frac{m}{s}$", "Interpreter", "latex");
ylabel("Friction factor", "Interpreter", "latex");

%% Problem 2
fprintf("Problem 2:\n");
pi = pi_sum();
fprintf("Value of pi: %.10f\n", pi);
fprintf("\n")

%% Functions for Homework 1

%% Question 1 functions

% Function for calculating Reynolds number
% Input parameters:
% p = density (kg/m^3)
```

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```
% u = flow velocity (m/s)
% mu = dynamic viscosity (N*s/m^2)
% d = inner diameter (m)
%
% Output:
% re = Reynolds number
function re = reynolds_number(p, u, mu, d)
    % Uses dot operators to allow use on arrays
    re = p .* u .* d ./ mu;
end

% Function for calculating friction factor
% Input parameters:
% re = Reynolds number
%
% Output:
% f = friction factor
function f = friction_factor(re)
    f = zeros(1, length(re));

    % Control flow is not elemental, hence the for-loop
    for i = (1:length(f))
        if re(i) <= 2100
            f(i) = 16./re(i);
        elseif re(i) < 1E5
            f(i) = 0.0791./(re(i).^0.25);
        else
            f(i) = 0.004;
        end
    end
end

%% Question 2 functions

% Function for calculating pi
%
% Output:
% pi = pi estimate, where
% (last term of the summation) / (pi estimate) < 10 ^ -8
function pi = pi_sum()
    k = 0;
    pi = 0;
    last = 1;

    % Dividing 1 / 0 gives "inf" value in MATLAB, first iteration OK
    while abs(last / pi) >= 1E-8
        last = sqrt(12) .* (-3).^-k / (2.*k + 1);
        pi = pi + last;
        k = k + 1;
    end
end
```

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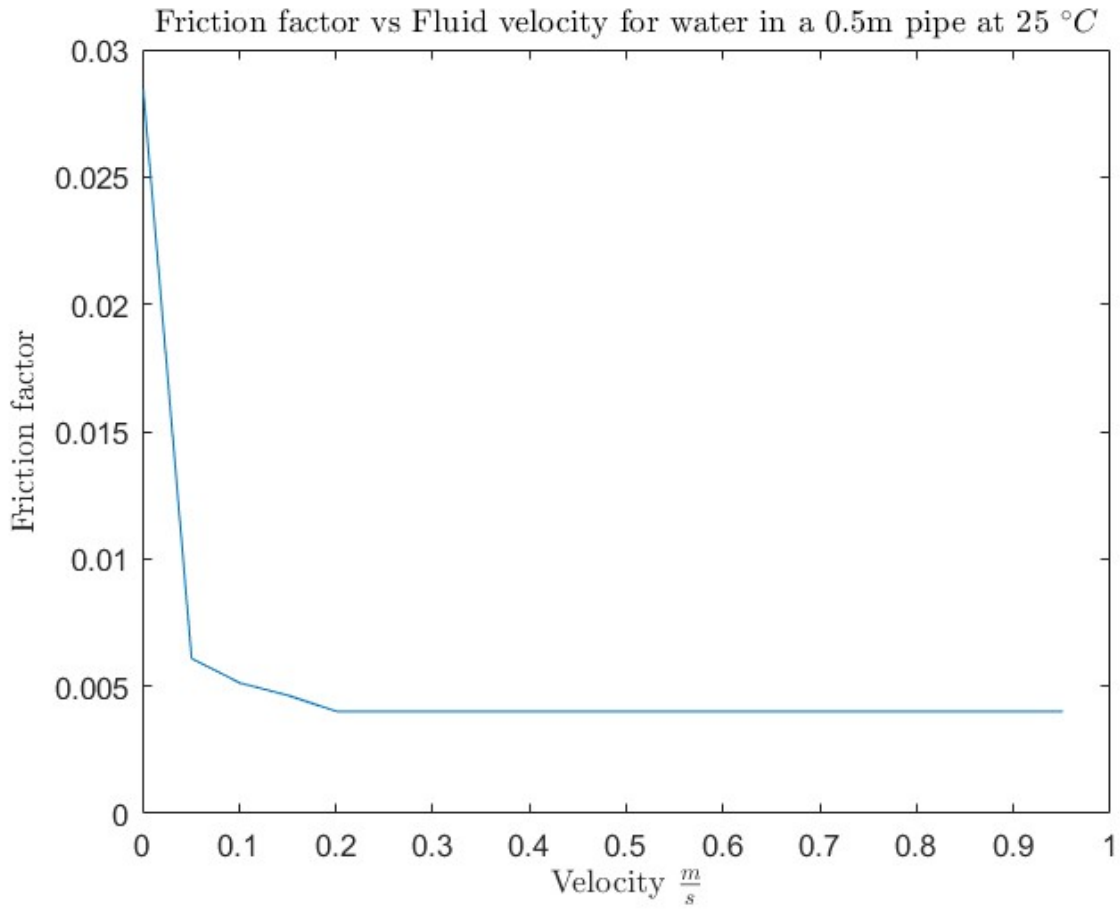
**Problem 1 ouput (Part 1):**

**Please enter a flow velocity (m/s): 0.01**

**Friction factor: 0.00913**

**Problem 1 (Part 2) graph:**




**Problem 2 output:**

**Value of pi: 3.1415926595**

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**Problem 3 code:**

```
%% CHEN 320-202 Homework 1
% Question 3
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% Date: 08/25/2022

%% Question 3 Plain Plot
x = (0:0.01:pi);
y = sin(x);
plot(x, y);
hold off

%% Question 3 Enhanced Plot
x = (0:0.01:pi);
y = sin(x);

% Plot
hold on
plot(x, y, "-k");

% Visual enhancements
grid on
xlim([0, pi]);
ylim([0, 1.01]);

title("Plot of sin(x), $0 < x < \pi$", "Interpreter", "latex");
xlabel("x");
ylabel("y");
```

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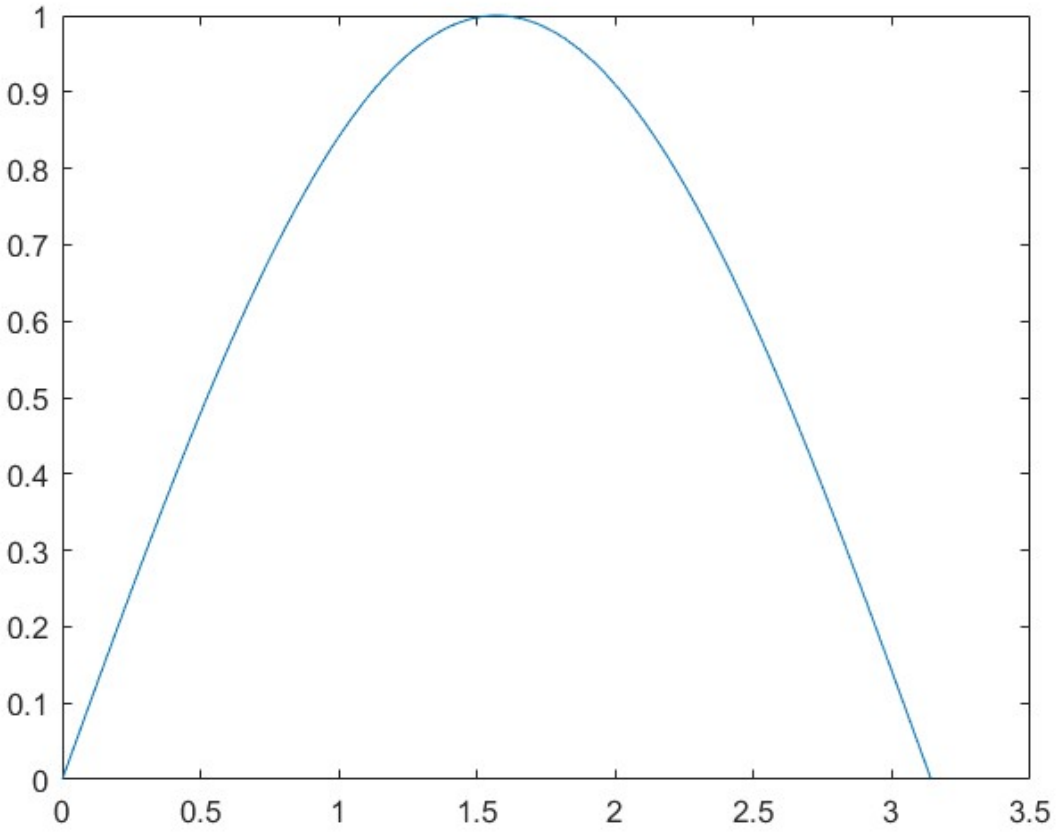
**Problem 3 (Plain Graph):**



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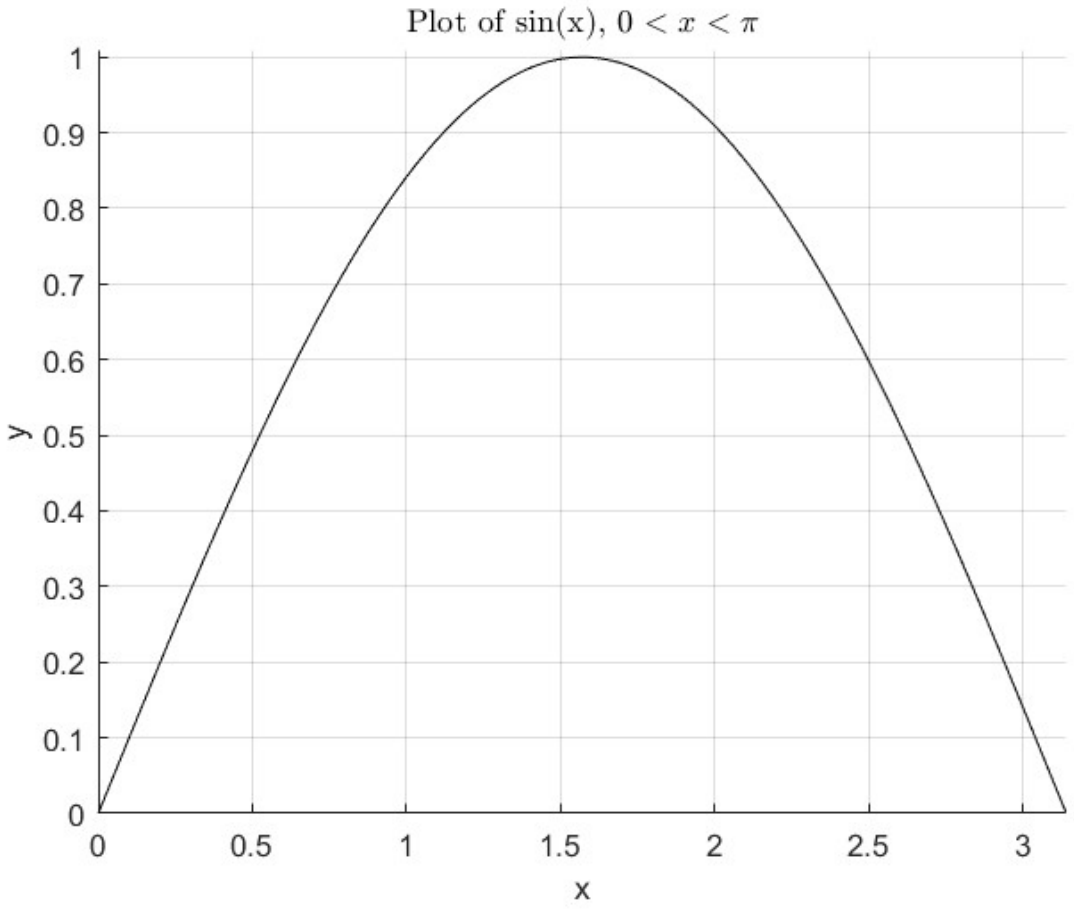
**Problem 3 (Enhanced Graph):**



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**Problem 4 code:**

```
%% CHEN 320-202 Homework 1
% Question 4
% Author: Nathaniel Thomas
% Date: 08/25/2022

%% Question 4

% Generate values to plot
x = (0:0.01:pi);
y1 = sin(x);
y2 = cos(x);

% Plot graphs
hold on
plot(x,  y1, "-r");
plot(x,  y2, "-b");

% Visual enhancements
grid on
xlim([0, pi]);
ylim([-1.01, 1.01]);
% Draw the x axis
line(xlim, [0, 0], 'Color', 'k', 'LineWidth', 2);

% Use LaTeX interpreter to print pi symbol
title("Plots of sin(x) and cos(x) from $0 < x < \pi$", "Interpreter", ...
    "latex");
xlabel("x");
ylabel("y");
legend(["sin(x)","cos(x)"]);
```

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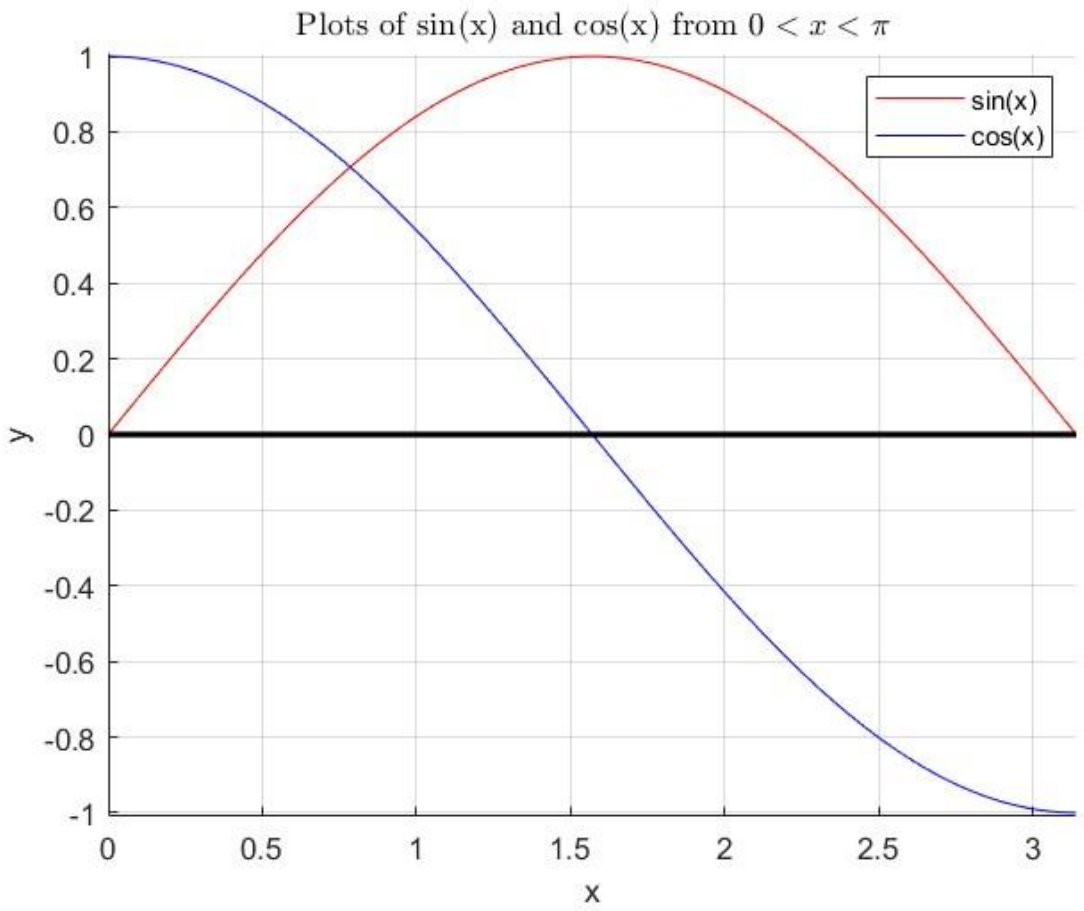
Problem 4 graph:



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**Problem 5 code:**

```
%% CHEN 320-202 Homework 1
% Question 5
% Author: Nathaniel Thomas
% Date: 08/25/2022

%% Question 5

syms x;
exp = x .^ 2 + 9 * x + 8;
result = factor(exp);
fprintf("Expression: %s\n", exp);
fprintf("Factor: %s\n", result);
```

**Problem 5 output:**

**Expression: 9*x + x^2 + 8**

**Factor: x + 8**

**Factor: x + 1**

**Problem 6 code:**

```
%% CHEN 320-202 Homework 1
% Question 6
% Author: Nathaniel Thomas
% Date: 08/25/2022

%% Question 6

syms a b x;
exp = 1 / (a.^2 + (b.^2).*(x.^2));
res = int(exp, x);
fprintf("Expression: %s\n", exp);
fprintf("Integral: %s\n", res);
```

**Problem 6 output:**

**Expression: 1/(a^2 + b^2*x^2)**

**Integral: atan((b*x)/a)/(a*b)**