Contents


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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%   Project #1
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%       Marlon Coates
%   ME 2543--Simulations Methods
%   Spring 2023
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

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```

QUESTION 1

```
clear all; close all; clc

Qtot = 1.671;                       % Cubic Feet per Second
L = [10 10 10];                     % Feet
D = [1/6 1/6 1/6];                  % Feet
e = [0.00085 0.00085 0.00085];      % Feet
p = 1.94;                           % Slugs per Cubic Foot
m = 2.05*(10^-5);                   % Pound-Force-Seconds per Square Foot
A = pi*(D./2).^2;                    % ft^2

Guess = [0.5 0.5 0.5 70];
% Our initial guess for Q1, Q2, Q3, and DeltaP, respectively.

saveGuess = Guess;
% Set up initial guesses to print

oldGuess = zeros(1,4);
% Initialize previous guesses

while abs(Guess(1)-oldGuess(1)) > 0.001

    Re = (p.*Guess(1:end-1).*D)./(A.*m);

    oldGuess = Guess;

    if Re(1) <= 2300
        f =  64./Re;
    else
        f = 0.25.*(log10(((e./D)/3.7)+5.74./(Re.^(0.9)))).^-2;
    end
    func = @(Q)equations(Q,Qtot,p,f,L,D,A);
    Guess = fsolve(func,Guess);
```

```
end

clc

disp('Question 1')

sprintf(['The three flow rates are %.2f, %.2f, and %.2f GPM, respectively.\n' ...
    'The total change in pressure through the network is %.2f PSI.'], ...
    Guess(1,1)*(448.831),Guess(1,2)*(448.831),Guess(1,3)*(448.831),Guess(1,4)/144)

sprintf(['Our initial guesses for the three flow rates are %.2f, %.2f, and ' ...
    '%.2f cubic feet per second, respectively.\nOur initial guess for the ' ...
    'total change in pressure through the network is %.2f Pounds per ' ...
    'square foot.'],saveGuess(1),saveGuess(2),saveGuess(3),saveGuess(4))

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

QUESTION 2

```
clear all; close all; clc

Qtot = 1.671;                       % Cubic Feet per Second
L = [20 10 30];                     % Feet
D = [2/12 2.5/12 1.5/12];                 % Feet
e = [0.00085 0.00085 0.00085];      % Feet
p = 1.94;                           % Slugs per Cubic Foot
m = 2.05*(10^-5);                   % Pound-Force-Seconds per Square Foot
A = pi*(D./2).^2;                    % ft^2

Guess = [0.5 0.5 0.5 70];
% Our initial guess for Q1, Q2, Q3, and DeltaP, respectively.

saveGuess = Guess;
% Set up initial guesses to print

oldGuess = zeros(1,4);
% Initialize previous guesses

while abs(Guess(1)-oldGuess(1)) > 0.001

    Re = (p.*Guess(1:end-1).*D)./(A.*m);

    oldGuess = Guess;

    if Re(1) <= 2300
        f =  64./Re;
    else
        f = 0.25.*(log10(((e./D)/3.7)+5.74./(Re.^(0.9)))).^-2;
    end
    func = @(Q)equations(Q,Qtot,p,f,L,D,A);
    Guess = fsolve(func,Guess);

end

clc

disp('Question 2')
```

```
sprintf(['The three flow rates are %.2f, %.2f, and %.2f GPM, respectively.\n' ...
    'The total change in pressure through the network is %.2f PSI.'], ...
    Guess(1,1)*(448.831),Guess(1,2)*(448.831),Guess(1,3)*(448.831),Guess(1,4)/144)

sprintf(['Our initial guesses for the three flow rates are %.2f, %.2f, and ' ...
    '%.2f cubic feet per second, respectively.\nOur initial guess for the ' ...
    'total change in pressure through the network is %.2f Pounds per ' ...
    'square foot.'],saveGuess(1),saveGuess(2),saveGuess(3),saveGuess(4))

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
Equation solved.

fsolve completed because the vector of function values is near zero
as measured by the value of the function tolerance, and
the problem appears regular as measured by the gradient.


Equation solved.

fsolve completed because the vector of function values is near zero
as measured by the value of the function tolerance, and
the problem appears regular as measured by the gradient.


Equation solved.

fsolve completed because the vector of function values is near zero
as measured by the value of the function tolerance, and
the problem appears regular as measured by the gradient.

Question 2

ans =

    'The three flow rates are 190.35, 487.46, and 72.18 GPM, respectively.
     The total change in pressure through the network is 9.47 PSI.'


ans =

    'Our initial guesses for the three flow rates are 0.50, 0.50, and 0.50 cubic feet per second, respectively.
     Our initial guess for the total change in pressure through the network is 70.00 Pounds per square foot.'
```

QUESTIONS 3-4

```
% Question 3

clear all; close all; clc

L = [20 10 30];                     % Feet
D = [2/12 2.5/12 1.5/12];           % Feet
e = [0.00085 0.00085 0.00085];      % Feet
p = 1.94;                           % Slugs per Cubic Foot
m = 2.05*(10^-5);                   % Pound-Force-Seconds per Square Foot
A = pi*(D./2).^2;                   % ft^2
```

```
cleanFoP = zeros(2,26);

for i = 1:26
Qtot = 100/448.831 + (i-1)*((1400/25)/448.831);   % Cubic Feet per Second

Guess = [0.5 0.5 0.5 70];
% Our initial guess for Q1, Q2, Q3, and DeltaP, respectively.

oldGuess = zeros(1,4);
% Initialize previous guesses

while abs(Guess(1)-oldGuess(1)) > 0.001

    Re = (p.*Guess(1:end-1).*D)./(A.*m);

    oldGuess = Guess;

    if Re(1) <= 2300
        f =  64./Re;
    else
        f = 0.25.*(log10(((e./D)/3.7)+5.74./(Re.^(0.9)))).^-2;
    end
    func = @(Q)equations(Q,Qtot,p,f,L,D,A);
    Guess = fsolve(func,Guess);

end
    cleanFoP(1,i) = Guess(4)/144;
    cleanFoP(2,i) = Qtot*(448.831);
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Question 4.a

fouledFoP_A = zeros(2,26);

for i = 1:26
Qtot = 100/448.831 + (i-1)*((1400/25)/448.831);   % Cubic Feet per Second

Guess = [0.5 0.5 0.5 70];
% Our initial guess for Q1, Q2, Q3, and DeltaP, respectively.

oldGuess = zeros(1,4);
% Initialize previous guesses

while abs(Guess(1)-oldGuess(1)) > 0.001

    Re = (p.*Guess(1:end-1).*D)./(A.*m);

    oldGuess = Guess;

    if Re(1) <= 2300
        f =  64./Re;
    else
        f = 0.25.*(log10((((e.*1.25)/D)/3.7)+5.74./(Re.^(0.9)))).^-2;
    end
    func = @(Q)equations(Q,Qtot,p,f,L,D,A);
    Guess = fsolve(func,Guess);

end
```

```
    fouledFoP_A(1,i) = Guess(4)/144;
    fouledFoP_A(2,i) = Qtot*(448.831);
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Question 4.b

fouledFoP_B = zeros(2,26);

for i = 1:26
Qtot = 100/448.831 + (i-1)*((1400/25)/448.831);   % Cubic Feet per Second

Guess = [0.5 0.5 0.5 70];
% Our initial guess for Q1, Q2, Q3, and DeltaP, respectively.

oldGuess = zeros(1,4);
% Initialize previous guesses

while abs(Guess(1)-oldGuess(1)) > 0.001

    Re = (p.*Guess(1:end-1).*D)./(A.*m);

    oldGuess = Guess;

    if Re(1) <= 2300
        f =  64./Re;
    else
        f = 0.25.*(log10((((e.*1.35)/D)/3.7)+5.74./(Re.^(0.9)))).^-2;
    end
    func = @(Q)equations(Q,Qtot,p,f,L,D,A);
    Guess = fsolve(func,Guess);

end
    fouledFoP_B(1,i) = Guess(4)/144;
    fouledFoP_B(2,i) = Qtot*(448.831);
end

clc

hold on
grid on
CleanGraph = plot(cleanFoP(1,1:end),cleanFoP(2,1:end),"Black", ...
    fouledFoP_A(1,1:end),fouledFoP_A(2,1:end),"R", ...
    fouledFoP_B(1,1:end),fouledFoP_B(2,1:end),"B");
xlabel('Pressure(psi)')
ylabel('Total Flow Rate (gpm)')
title('Total Flow Rate vs Pressure')
legend("Clean Pipes","Fouled A","Fouled B")

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```

Functions

```
function F = equations(Q,Qtot,p,f,L,D,A)
    F(1) = Q(1) + Q(2) + Q(3) - Qtot;
    F(2) = p*f(1)*(L(1)/D(1))*((Q(1)^2)/(2*(A(1)^2))) - Q(4);
    F(3) = p*f(2)*(L(2)/D(2))*((Q(2)^2)/(2*(A(2)^2))) - Q(4);
```

```
    F(4) = p*f(3)*(L(3)/D(3))*((Q(3)^2)/(2*(A(3)^2))) - Q(4);
end
```

```
Solver stopped prematurely.

fsolve stopped because it exceeded the function evaluation limit,
options.MaxFunctionEvaluations = 4.000000e+02.


Equation solved.

fsolve completed because the vector of function values is near zero
as measured by the value of the function tolerance, and
the problem appears regular as measured by the gradient.


Equation solved.

fsolve completed because the vector of function values is near zero
as measured by the value of the function tolerance, and
the problem appears regular as measured by the gradient.

Question 1

ans =

    'The three flow rates are 250.00, 250.00, and 250.00 GPM, respectively.
     The total change in pressure through the network is 8.14 PSI.'


ans =

    'Our initial guesses for the three flow rates are 0.50, 0.50, and 0.50 cubic feet per second, respectively.
     Our initial guess for the total change in pressure through the network is 70.00 Pounds per square foot.'
```

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