ENVE404

Homework 2

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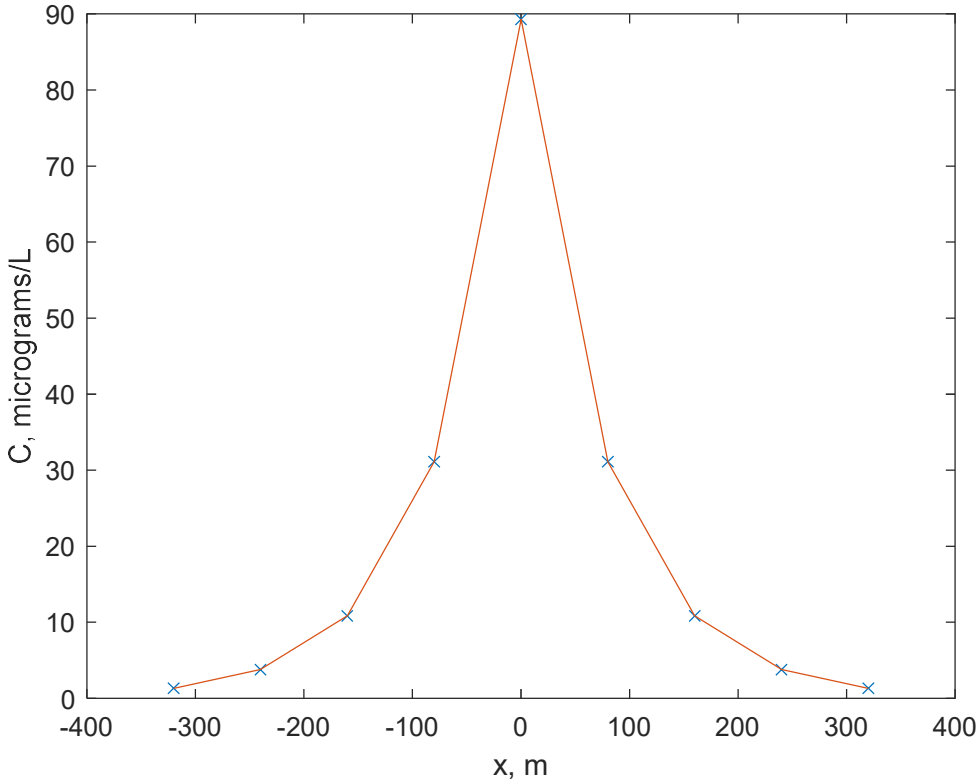
Question 1

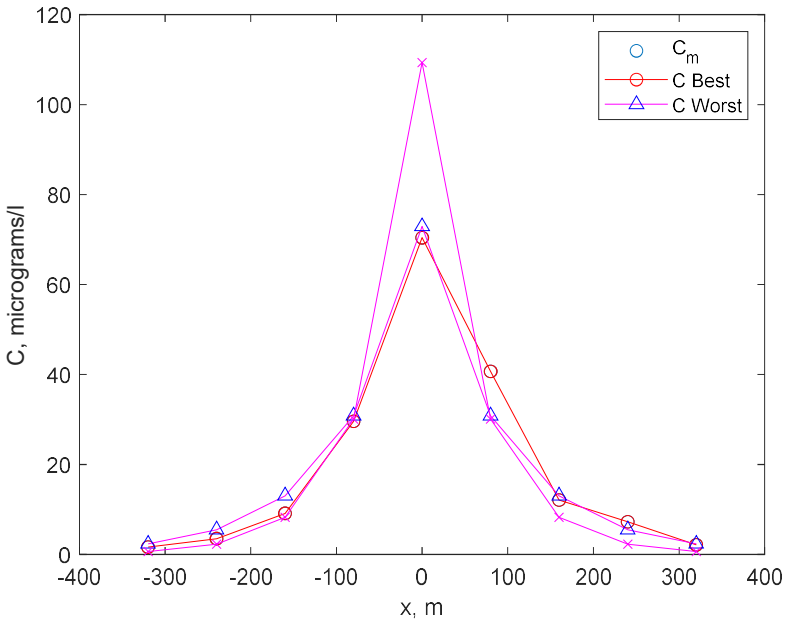
A)


C, micrograms/L
x, m
0
10
20
30
40
50
60
70
80
90
-400
-300
-200
-100
0
100
200
300
400

```
close all
clc

W = 246;    % mass discharge rate into the surface water(in kg/day)
k_1 = 0.25;  % first order decay coefficient(in day^-1)
Q = 3.13;       % river flow rate(in m^3/s)
A = 72600;      % cross sectional area of river(in m^2)
D =60*24;  % dispersion coefficient(converted from m^2/h to m^2/day)
x = -320:80:320;        % distances

v = Q/A;        % flow velocity
m = sqrt(1+((4*k_1*D)/(v^2)));  % given in the question statement
C_0 = W/(m*Q);  % concentration at x=0(in g/L)
r_1 = v*(1+m)./(2*D);
r_2 = v*(1-m)./(2*D);

for i = 1:length(x) % loop for the range of distances

    if x(i) <= 0
        C_x(i) = C_0*exp(r_1*x(i)); %calculation of C_x if x<=0
    elseif x(i) >= 0
        C_x(i) = C_0*exp(r_2*x(i)); %calculation of C_x if x>0
    end

    C_x(i) = C_x(i)*10.^6   %convertion from g/L to micrograms/L

end

plot (x,C_x,'x')
hold all
plot (x,C_x)
xlabel('x, m');
ylabel('C, micrograms/L');
```

B)

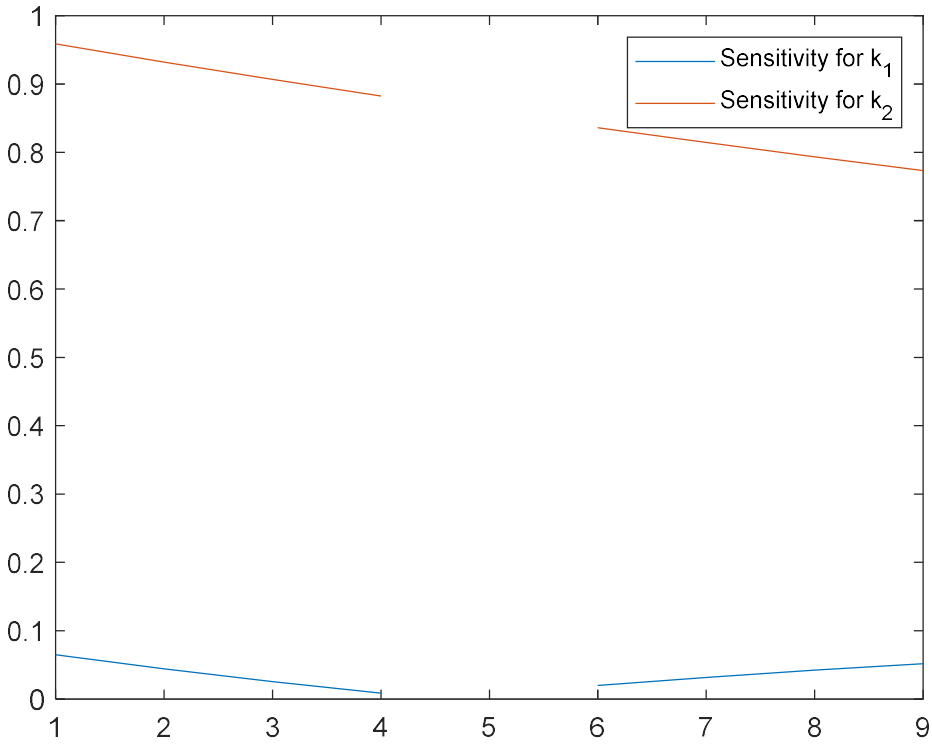
```
If D= 40
RMSE= 13.6468
CE= 19.8441

If D= 50
RMSE= 9.867
CE= 14.3478

If D= 60
RMSE= 7.2149
CE= 10.4913

If D= 70
RMSE= 5.376
CE= 7.8174

If D= 80
RMSE= 4.2447
CE= 6.1724

If D= 90
RMSE= 3.7858
CE= 5.505

If D= 100
RMSE= 3.8777
CE= 5.6386

Min CE= 5.505
Max CE= 19.8441
```



```
clear all
close all
clc

W = 246;    % mass discharge rate into the surface water(in kg/day)
k_1 = 0.25; % first order decay coefficient(in day^-1)
Q = 3.13;       % river flow rate(in m^3/s)
A = 72600;      % cross sectional area of river(in m^2)
D = 40*24:240:100*24; % range of dispersion coefficient
C_m = [1.63 3.5 9.13 29.6 70.4 40.7 12.1 7.26 2.12];    %measured concentr
%-ation values
x = -320:80:320;    % distances

v = Q/A;    % flow velocity

for j = 1:length(D) % loop for the range of D values

    m = sqrt(1+((4*k_1*D(j))/(v^2)));
    C_0 = W/(m*Q);      % concentration at x=0(in g/L)
    r_1 = v*(1+m)./(2*D(j));
    r_2 = v*(1-m)./(2*D(j));

    for i = 1:length(x)

        if x(i) <= 0
            C_x(j,i) = C_0*exp(r_1*x(i)); %calculation of C_x if x<=0
        elseif x(i) >= 0
            C_x(j,i) = C_0*exp(r_2*x(i)); %calculation of C_x if x>0
        end

        C_x(j,i) = C_x(j,i)*10.^6;   %convertion from g/L to micrograms/L

    end

    RMSE(j) = sqrt(mean((C_x(j,:) - C_m).^2)); %RMSE calculation formula
    deltaC=max(C_m)-min(C_m); %difference between max and min measured conc.
    CE=RMSE/deltaC*100;
    SSE=sum((C_m-C_x).^2); %SSE calculation
    SSyy=sum((C_m-mean(C_m)).^2); %SSY calculation
    R2=1-SSE/SSyy; %calculation of R^2
    disp(['If D= ' num2str(D(j)/24)])
    disp(['RMSE= ' num2str(RMSE(j))])
    disp(['CE= ' num2str(CE(j))])
    fprintf('\n')

end

disp(['Min CE= ' num2str(min(CE))])
disp(['Max CE= ' num2str(max(CE))])
plot (x,C_m,'o')
hold all
plot (x,C_m,'-or','markeredgecolor','red')
plot(x,C_x(6,:),'-^m','markeredgecolor','blue')
plot(x,C_x(1,:),'-xm','markeredgecolor','magenta')
hold all
xlabel('x, m');
ylabel('C, micrograms/l');
legend('C_m','C Best','C Worst')
```

Question 2)

```
K2(0.0020) is more sensitive.
K2(0.0021) is more sensitive.
K2(0.0022) is more sensitive.
K2(0.0024) is more sensitive.
Error, this is the base case.
K2(0.0026) is more sensitive.
K2(0.0027) is more sensitive.
K2(0.0029) is more sensitive.
K2(0.0030) is more sensitive.

Percent change in NO2 values for each k_1 value

    0.8k1      0.85k1      0.9k1       0.95k1       k1     1.05k1      1.1k1       1.15k1      1.2k1
    ______    ________    ________    _________    __    ________    ________    ________    ______

    -1.3005    -0.66148    -0.25366    -0.043058    0     -0.09858    -0.31621    -0.63322    -1.0325


Percent change in NO2 values for each k_2 value

    0.8k2     0.85k2    0.9k2     0.95k2    k2    1.05k2     1.1k2     1.15k2     1.2k2
    ______    ______    ______    ______    __    _______    _______    _______    _______

    19.175    13.983    9.0673    4.4112    0     -4.1804    -8.1432    -11.901    -15.465
```



```
clear all
close all
clc

CT=10.15*60;    %cycle time(in minutes)
C0i=133.26;     %Initial concentration of NH3-N
k1b=0.00381;    %base rate constant
k2b=0.00249;    %base rate constant

delta=(0.8:0.05:1.2);
k1vals=delta*k1b;   %k1 values
k2vals=delta*k2b;   %k2 values

C1b=C0i*k1b*((exp(-k1b*CT)/(k2b-k1b))+((exp(-k2b*CT)/(k1b-k2b))));  %base
%concentration for NO2_N

for i=1:length(delta)

    C1i_k1(i)=C0i*k1vals(i)*((exp(-k1vals(i)*CT)/(k2b-k1vals(i)))+((exp(-k2b*CT)/(k1vals(i)-k2b
    %concentration for new k1 value
    changeC1_k1(i)=(C1i_k1(i)-C1b)/(C1b)*100;   %percent change in NO2
    %values for each k1 value
    Sens_k1(i)=(abs(C1b-C1i_k1(i))/C1b)*(k1b/abs(k1b-k1vals(i)));   %sensit
    %ivity for each k1 value

    C1i_k2(i)=C0i*k1b*((exp(-k1b*CT)/(k2vals(i)-k1b))+((exp(-k2vals(i)*CT)/(k1b-k2vals(i)))));
    %concentration for new k1 value
    changeC1_k2(i)=(C1i_k2(i)-C1b)/(C1b)*100;   %percent change in NO2
    %values for each k2 value
    Sens_k2(i)=(abs(C1b-C1i_k2(i))/C1b)*(k2b/abs(k2b-k2vals(i)));   %sensit
    %ivity for each k2 value

    if Sens_k1(i)>Sens_k2(i)
        fprintf('K1(%.4f) is more sensitive.\n',k1vals(i))
    elseif Sens_k1(i)<Sens_k2(i)
        fprintf('K2(%.4f) is more sensitive.\n', k2vals(i))
    else
        fprintf('Error, this is the base case.\n')
    end

end

hold off
plot(Sens_k1)
hold on
plot(Sens_k2)
legend('Sensitivity for k_1','Sensitivity for k_2')
fprintf('\n')
disp('Percent change in NO2 values for each k_1 value')
fprintf('\n')
VarNames1 = {'0.8k1', '0.85k1', '0.9k1', '0.95k1', 'k1', '1.05k1','1.1k1','1.15k1','1.2k1'};
T1 = array2table(changeC1_k1,'VariableNames',VarNames1); %creating table for k1 values
disp(T1)
fprintf('\n')
disp('Percent change in NO2 values for each k_2 value')
fprintf('\n')
VarNames2 = {'0.8k2', '0.85k2', '0.9k2', '0.95k2', 'k2', '1.05k2','1.1k2','1.15k2','1.2k2'};
T2 = array2table(changeC1_k2,'VariableNames',VarNames2); %creating table for k2 values
disp(T2)
```