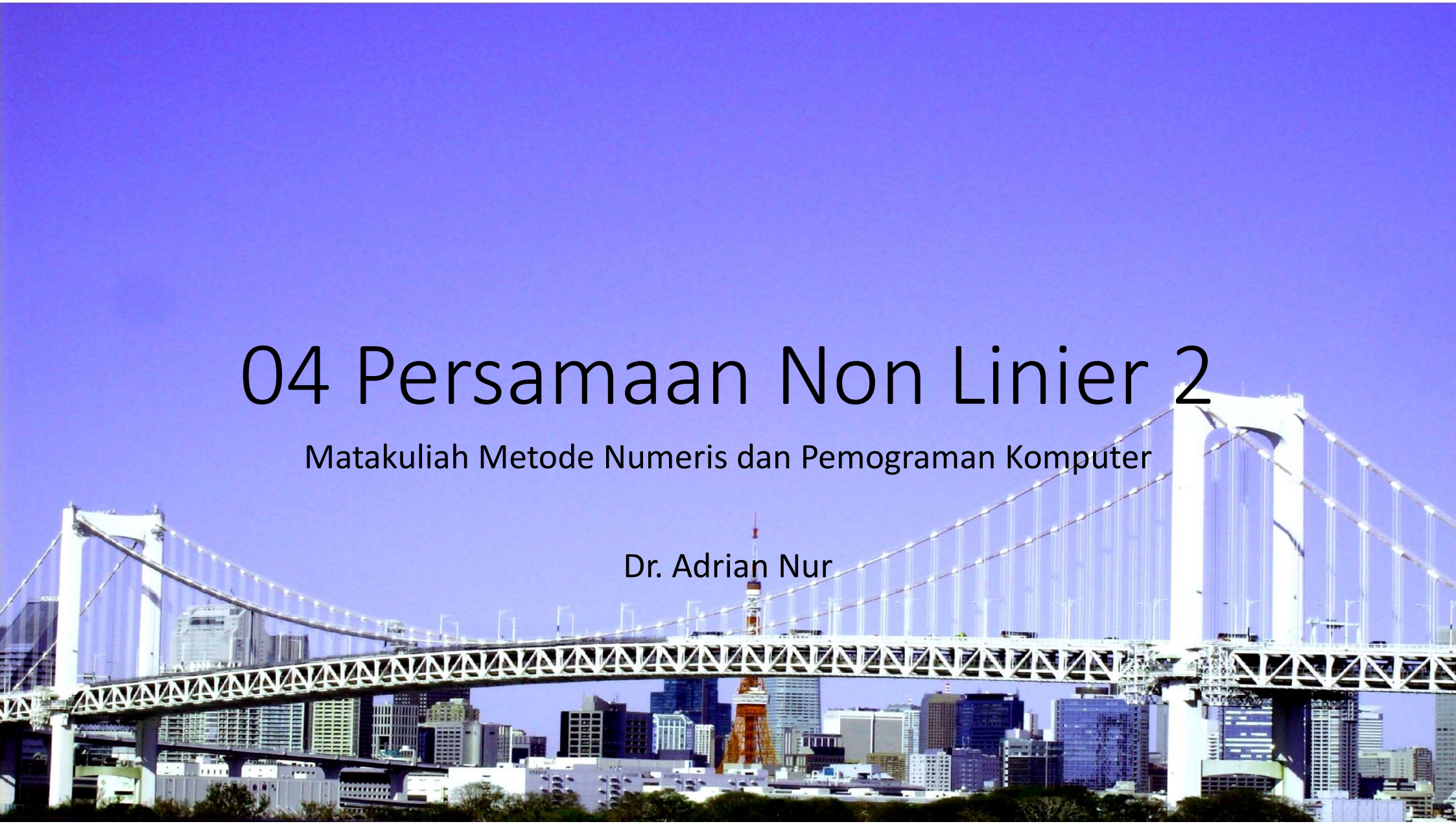


04 Persamaan Non Linier 2

Matakuliah Metode Numeris dan Pemograman Komputer

Dr. Adrian Nur

04 Persamaan Aljabar Non Linier

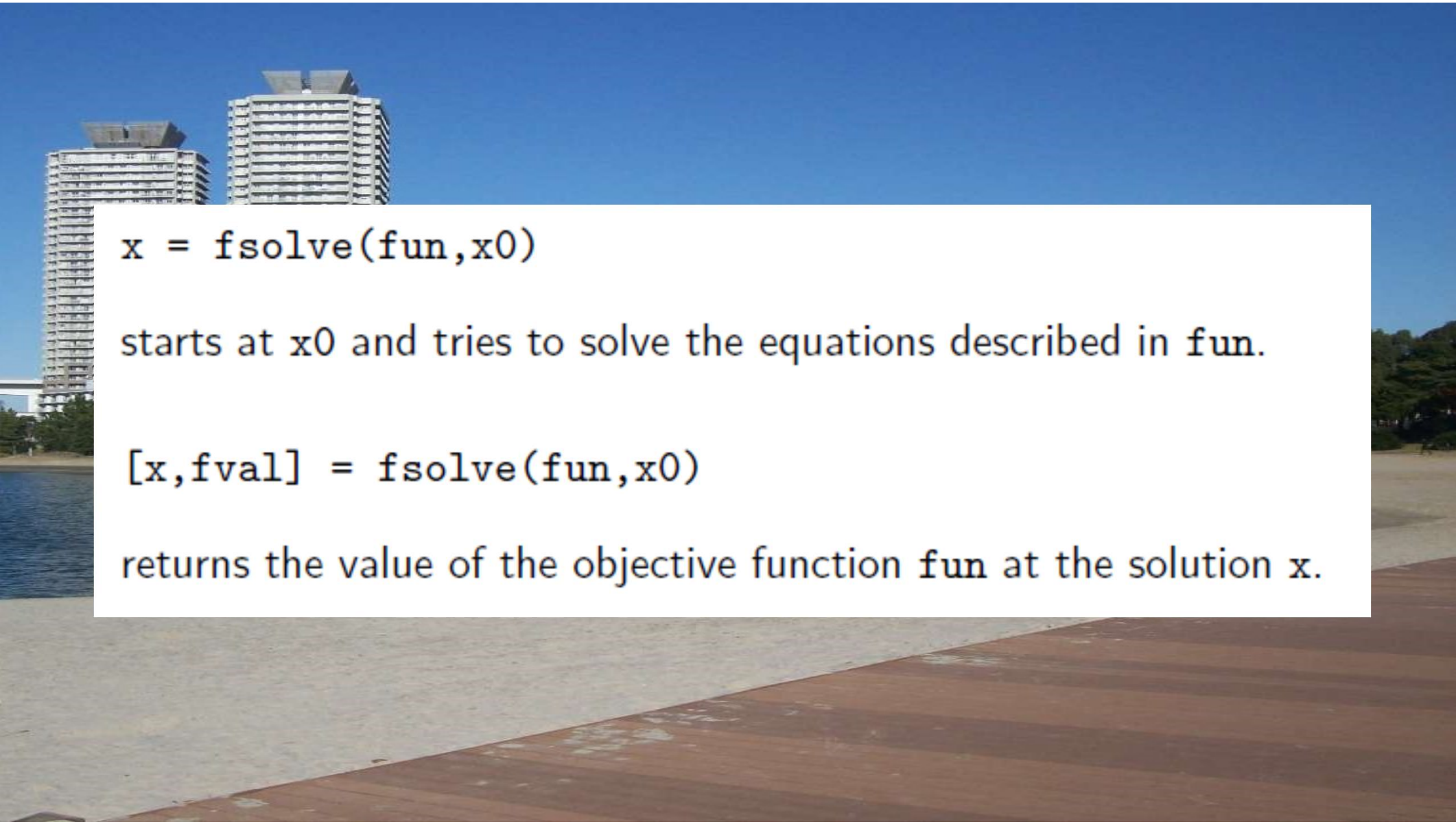
Persamaan Non Linier Simultan (Multivariabel)

fsolve

- Untuk menyelesaikan sistem persamaan non linear yang multivariabel maka digunakan “fsolve”

- Contoh penyelesaian persamaan berikut

$$\begin{aligned} x^2 - 3y + 2 &= 0 \\ x^3 - 4x^2 - xy + 1 &= 0 \end{aligned}$$



```
x = fsolve(fun,x0)
```

starts at `x0` and tries to solve the equations described in `fun`.

```
[x,fval] = fsolve(fun,x0)
```

returns the value of the objective function `fun` at the solution `x`.

contoh

Misalkan ada system non linier:

$f_1(x) = x_1 + x_2 - 1 = 0$

$f_2(x) = \sin(x_1^2 + x_2^2) - x_1 = 0$

Program MATLAB dalam bentuk M-file

```
function y=f2(x)
y(1)=x(1)+x(2)-1;
y(2)=sin(x(1).^2+x(2).^2)-x(1);
```

Jendela command atau program lain

```
x0=[0 1];
Akar=fsolve('f2', x0)
```

Hasil perhitungan adalah:

```
Akar =
    0.48012    0.51988
```

$$
\begin{aligned}
x^2 - 3y + 2 &= 0 \\
x^3 - 4x^2 - xy + 1 &= 0
\end{aligned}
$$

Dg initial guess x = 0; y = 0

Kunci

0.43711 0.73036

Solve the system of equations below using fsolve.

$$2a - b - e^{-a} = 0$$
$$2b - a - e^{-b} = 0$$

```
function f=example15(x)

f = [2*x(1)-x(2)-exp(-x(1)); -x(1)+2*x(2)-exp(-x(2))];
```

Initial guess a dan b = -5

```
ans =

    0.5671    0.5671
```

$$f_1(x_1, x_2) = x_1 - 4x_1^2 - x_1 x_2$$

$$f_2(x_1, x_2) = 2x_2 - x_2^2 - 3x_1 x_2$$

```
function   f = nle(x)
f(1) = x(1) - 4 * x(1)^2 - x(1) * x(2);
f(2) = 2 * x(2) - x(2)^2 + 3 * x(1) * x(2);
```

Initial guess = [1 1]

Contoh 6.3 Stoikiometri Reaksi Kesetimbangan

Reaksi reformasi steam (*steam reforming*) berlangsung menurut serangkaian reaksi kesetimbangan berikut:

$$CH_{4(g)} + H_2O_{(g)} \rightleftharpoons CO_{(g)} + H_{2\,(g)} \qquad \text{R-1}$$

$$CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2\,(g)} \qquad \text{R-2}$$

Pada suhu 2000 K harga konstanta kesetimbangan untuk masing-masing reaksi adalah $1{,}930 \times 10^{-4}$ dan 5,528. Tentukan komposisi kesetimbangan komponen-komponen apabila Gas umpan berkomposisi 20% $CH_{4(g)}$ dan 80% $H_2O_{(g)}$ berada pada kondisi suhu 2000 K dan tekanan 1 atm.

Misal ditetapkan basis perhitungan 10 mol gas umpan .

ε_1 = tingkat reaksi dari reaksi pertama

ε_2 = tingkat reaksi dari reaksi kedua

Jika dinyatakan sebagin tingkat reaksi:

$$K_1 = \frac{(\varepsilon_1 - \varepsilon_2)(3\varepsilon_1 - \varepsilon_2)^3}{(2-\varepsilon_1)(8-\varepsilon_1-\varepsilon_2)(10+2\varepsilon_1)^2}$$

$$K_2 = \frac{\varepsilon_2(3\varepsilon_1 + \varepsilon_2)}{(\varepsilon_1 - \varepsilon_2)(8-\varepsilon_1-\varepsilon_2)}$$

m.file ke 1

Nama fungsi persamaan

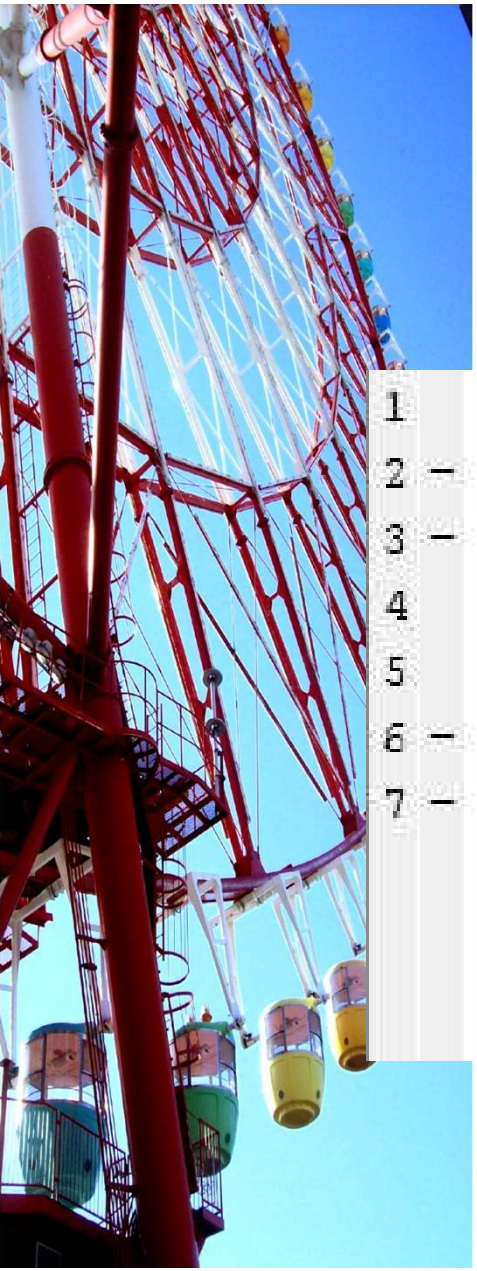
"function" adalah kata kunci yang digunakan untuk mendefinisikan prosedur pada matlab

```
1
2   function y=kst(E)
3
4 -   e1=E(1);
5 -   e2=E(2);
6
7 -   k1=0.0001934;
8 -   k2=5.528;
9
10 -  y=[-k1+((e1-e2)*(3*e1-e2)^3)/((2-e1)*(8-e1-e2)*(10+2*e1)^2)
11        -k2+(e2*(3*e1+e2))/((e1-e2)*(8-e1-e2))];
```

Variable yang di cari

Konstanta kecepatan reaksi

Persamaan untuk menyelesaikan permasalahan yang dicari



m.file ke 2

```
1
2 - clc
3 - clear
4
5
6 - e_tebak=[1 0.5];
7 - ehasil=fsolve('kst',e_tebak)
```

Untuk menghilangkan data sebelumnya pada command saat di run

Nilai tebakan untuk hasilnya

Fungsi fsolve itu untuk menyelesaikan sistem persamaan non linier simultan

HASIL

```
ehasil =

    0.7483    0.6922

>>
```

The functions f(1) through f(7) are defined by setting the given linear and nonlinear equations to zero:

$$f(1) = C_C\, C_D - K_{C1}\, C_A\, C_B$$

$$f(2) = C_X\, C_Y - K_{C2}\, C_B\, C_C$$

$$f(3) = C_Z - K_{C3}\, C_A\, C_X$$

$$f(4) = C_{A0} - C_A - C_D - C_Z$$

$$f(5) = C_{B0} - C_B - C_D - C_Y$$

$$f(6) = C_D - C_Y - C_C$$

$$f(7) = C_Y - C_X - C_Z$$

The equilibrium equations are rearranged so that division by the unknowns is avoided. Root finding techniques may have iterates that approach zero which can cause divergence.

```
%filename prob4.m
function f = prob4(cvector)
global Cao Cbo Kci Kcii Kciii
% cvector are the concentrations of the seven species. cvector(1) is the concentration of species a
% cvector(2) is the concentration of b etc.
f(1)= cvector(3)*cvector(4)-Kci*cvector(1)*cvector(2);
f(2)= cvector(6)*cvector(5)-Kcii*cvector(2)*cvector(3);
f(3)= cvector(7)- Kciii*cvector(1)*cvector(5);
f(4)= Cao - cvector(1) - cvector(4) - cvector(7);
f(5)= Cbo - cvector(2) - cvector(4) - cvector(6);
f(6)= cvector(4) - cvector(6) - cvector(3);
f(7)= cvector(6) - cvector(5)- cvector(7);
```

```
%filename Prob_4.m
global Cao Cbo Kci Kcii Kciii cvector
% define constants
Cao = 1.5; Cbo=1.5; Kci= 1.06; Kcii= 2.63; Kciii= 5;
%set initial conditions
% Initial guess and set tolerance
% remove the % in front of the desired initial guess
%cvector=[1.5 1.5 0 0 0 0 0]; %initial guess, part a
%cvector=[-.5 -1.5 -1 1 1 2 1]; %initial guess, part b
%cvector=[-18.5 -28.5 -10 10 10 20 10]; %initial guess, part c
guess=cvector;
%call fsolve
y = fsolve('prob4',guess)
```

The program gives the following solution.

guess = [1.5 1.5 0 0 0 0 0];

y = 0.4207 0.2429 0.1536 0.7053 0.1778 0.5518 0.3740

guess = [-0.5000 -1.5000 -1.0000 1.0000 1.0000 2.0000 1.0000]

y = 0.4207 0.2429 0.1536 0.7053 0.1778 0.5518 0.3740

guess = [-18.5 -28.5 -10 10 10 20 10]

y = 0.4207 0.2429 0.1536 0.7053 0.1778 0.5518 0.3740