# CHE236 Numerical Methods [1-6]

## References:


**1.** Chapra S.C. and Canale R.P. "Numerical Methods for Engineers", Sixth Edition,McGraw Hill, International Edition 2010.

**2.** Chapra S.C. and Canale R. P. "Yazılım ve programlama Uygulamalarıyla Mühendisler için Sayısal Yöntemler" 4.Basımdan Çevirenler: Hasan Heperkan ve Uğur Kesgin 2003.

**3.**Chapra S.C. "Applied Numerical Methods with MATLAB for engineers and Scientists" Third Edition, McGraw Hill, International Edition 2012.

**4.** Mathews J.H. and Fınk K.D. "Numerical Methods using MATLAB", Fourth Edition, Pearson P. Hall, International Edition 2004.

**5.** Fausett L.V. "Applied Numerical Analysis Using MATLAB, Second Edition, PearsonP. Hall, International Edition, 2008.

**6.** Gilat A. And Subramaniam V. "Numerical Methods, An introduction with Applications Using MATLAB", Second Edition,John Wiley and Sons. Inc. 2011.

# Numerical Methods in General

- **Programming**

**fzero, polyder, deconv, polyval, conv, roots**

to find the roots of the function **with the initial guesses of 0 and 1.**

$$f(x) = e^{-x} - x$$

```
>> x0=[0  1];
>> x=fzero(@(x) exp(-x)-x, x0)
        or
>> x=fzero('exp(-x)-x',x0)
```

**to evaluate the function given below at x = 2.5.**
**f(x)=x^2-2.71x+5**

```
>> a=[1   -2.71   5];
>> polyval(a,2.5)
```

to find the roots of the function, g(f),

with the initial guess of 0.08.

$$g(f) = \frac{1}{\sqrt{f}} + 2.0\,log\left(\frac{\varepsilon}{3.7 * D} + \frac{2.51}{Re\sqrt{f}}\right)$$

Data:

ε=0.0015/1000    ρ=1.23    v=40    D=0.005    μ=1.79*〖10〗^(-5)

Re=(ρ*V*D)/μ

```
>> rho=1.23; mu=1.79e-5; D=0.005; v=40; e=0.0015/1000;
>> Re=rho*v*D/mu;
>> g=@(f) 1/sqrt(f)+2*log10(e/(3.7*D)+2.51/(Re*sqrt(f)));
>> fzero(g,0.08)
```

MATLAB commands to solve the linear algebraic equation set given below.

$$5x_1 - 0.2x_2 - 0.8x_3 = 4.86$$
$$0.2x_1 + 9x_2 - 0.9x_3 = -58.02$$
$$0.4x_1 - 0.3x_2 + 12x_3 = 60$$

```
>> A=[5  -0.2  -0.8;0.2  9  -0.9;  0.4  -0.3  12];
>> B=[4.86; -58.02; 60];
>> x=A\B
or
>> x=inv(A)*B
```

MATLAB commands to find $[A]^{-1}$.

$$A = \begin{bmatrix} 4 & 2.6 & -0.9 \\ 0.5 & 1 & 5.2 \\ 7 & -3 & -8 \end{bmatrix}$$

- the absolute approximate relative percent error ,εa

$$v = \frac{g*m}{c}\left(1 - e^{-\left(\frac{c}{m}\right)*t}\right)$$

$$v - v = \frac{g*m}{c}\left(1 - e^{-\left(\frac{c}{m}\right)*t}\right) - v$$

$$f(c) = \frac{g*m}{c}\left(1 - e^{-\left(\frac{c}{m}\right)*t}\right) - v = \frac{9.81*75}{c}\left(1 - e^{-\left(\frac{c}{75}\right)*6}\right) - 48$$

$$f(c) = \frac{735.75}{c}\left(1 - e^{-0.08*c}\right) - 48$$

The initial estimate of the root xr

$$x_r = \frac{4+8}{2} = 6$$

Computing the product of the function value at the lower bound and at the midpoint:

f(4)*f(6)=(2.3715)*(-1.2533)=-2.9722

$$x_L = 4, \qquad x_r = x_U = 6$$
$$x_r = \frac{4+6}{2} = 5$$
$$\varepsilon_a = \left|\frac{5-6}{5}\right| 100\% = 20$$
$$f(4) * f(5) = (2.3715) * (0.5124) = 1.2152 > 0$$

$$x_r = x_L = 5, \qquad x_U = 6$$
$$x_r = \frac{5+6}{2} = 5.5$$
$$\varepsilon_a = \left|\frac{5.5-5}{5.5}\right| 100\% = 9.09$$
$$f(5) * f(5.5) = (0.5124) * (-0.3818) = -0.1956 < 0$$

$$x_L = 5, \qquad x_r = x_U = 5.5$$
$$x_r = \frac{5+5.5}{2} = 5.25$$
$$\varepsilon_a = \left|\frac{5.25-5.5}{5.25}\right| 100\% = 4.76$$
$$f(5) * f(5.25) = (0.5124) * (0.0624) = 0.032 > 0$$

$$x_r = x_L = 5.25, \qquad x_U = 5.5$$
$$x_r = \frac{5.25+5.5}{2} = 5.375$$
$$\varepsilon_a = \left|\frac{5.375-5.25}{5.375}\right| 100\% = 2.33$$

| Iteration | $x_L$ | $x_U$ | $x_r$ | $\varepsilon_a$ (%) |
|---|---|---|---|---|
| 1 | 4 | 8 | 6 | |
| 2 | 4 | 6 | 5 | 20 |
| 3 | 5 | 6 | 5.5 | 9.09 |
| 4 | 5 | 5.5 | 5.25 | 4.76 |
| 5 | 5.25 | 5.5 | 5.375 | 2.33 |

**x = 5.375**

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$$

$$f(x) = x^3 - 8.10x^2 - 9.35x + 21.41$$

$$f'(x) = 3x^2 - 16.2x - 9.35$$

$$x_{i+1} = x_i - \frac{x_i^3 - 8.10x_i^2 - 9.35x_i + 21.41}{3x_i^2 - 16.2x_i - 9.35}$$

| Iteration | $x_i$ | $\varepsilon_a$ (%) |
|---|---|---|
| 1 | 9.50 | |
| 2 | 8.9518 | [(8.9518 – 9.50) / 8.9518] 100% = 6.13 |
| 3 | 8.8824 | [(8.8824 – 8.9518) / 8.8824] 100% = 0.78 |
| 4 | 8.8813 | [(8.8813 – 8.8824) / 8.8813] 100% = 0.012 |

**x = 8.8813**