

CEN236 Numerical Methods [1-6]

References:

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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 Fink 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, Pearson P. Hall, International Edition, 2008.
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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:
 $\varepsilon = 0.0015/1000$ $\rho = 1.23$ $v = 40$ $D = 0.005$ $\mu = 1.79 * [10]^{(-5)}$
 $Re = (\rho * V * D) / \mu$

```
>> 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, ϵ_a

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



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

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

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

The initial estimate of the root x_r

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

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

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

$$x_L = 4, \quad x_r = x_U = 6$$

$$x_r = \frac{4 + 6}{2} = 5$$

$$\varepsilon_a = \left| \frac{5 - 6}{5} \right| 100\% = 20$$

$$f(4) * f(5) = (2.3715) * (0.5124) = 1.2152 > 0$$

$$x_r = x_L = 5, \quad x_U = 6$$

$$x_r = \frac{5 + 6}{2} = 5.5$$

$$\varepsilon_a = \left| \frac{5.5 - 5}{5.5} \right| 100\% = 9.09$$

$$f(5) * f(5.5) = (0.5124) * (-0.3818) = -0.1956 < 0$$

$$x_L = 5, \quad x_r = x_U = 5.5$$

$$x_r = \frac{5 + 5.5}{2} = 5.25$$

$$\varepsilon_a = \left| \frac{5.25 - 5.5}{5.25} \right| 100\% = 4.76$$

$$f(5) * f(5.25) = (0.5124) * (0.0624) = 0.032 > 0$$

$$x_r = x_L = 5.25, \quad x_U = 5.5$$

$$x_r = \frac{5.25 + 5.5}{2} = 5.375$$

$$\varepsilon_a = \left| \frac{5.375 - 5.25}{5.375} \right| 100\% = 2.33$$

Iteration	x _L	x _U	x _r	ε _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

$$\mathbf{x = 5.375}$$

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

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

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

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

Iteration	x_i	ϵ_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	$[(8.8813 - 8.8824) / 8.8813] 100\% = 0.012$

$x = 8.8813$