



Yıldız Teknik Üniversitesi
Elektrik-Elektronik Fakültesi
Bilgisayar Mühendisliği Bölümü

BLM2642 Bilgisayar Mühendisliği için Diferansiyel
Denklemler Dönem Projesi

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Raporda sadece örnekler ve çıktılar var. Kodun içinde yorum satırlarıyla ne yaptığımı ayrıntılı şekilde açıkladım.

Test 1:

$$y' + 2y = 4x, \quad y(x) = 2x - 1$$

$$x_0 \text{ (başlangıç } x \text{ değeri)} = 5, \quad y(5) = 9$$

$$x \text{ (hedef } x \text{ değeri)} = 2, \quad y(2) = 3$$

```
The order of the differantial equation: 1
the coefficient of 1.th order derivative: 1
the coefficient of 0.th order derivative: 2
how many elements are there in the polynomial: 1
the coefficient of 1.th value: 4
the degree of 1.th value: 1
Linear Differantial Equation...
(1.00)y(1) + (2.00)y(0) = (4.00)x^1
initial x value (x0): 5
what is the value of 0.th order derivative for 5.00 (x0): 9
target x value: 2
enter 1 if you have the real value of function for target x value: 1
real y value for target x: 3
```

Çıktı 1:

```
step size (it would be good to converge if you enter a value close to 0.1): 0.1
1. iteration x: 4.900000 - y: 8.800000
2. iteration x: 4.800000 - y: 8.600000
3. iteration x: 4.700000 - y: 8.400000
4. iteration x: 4.600000 - y: 8.200000
5. iteration x: 4.500000 - y: 8.000000
6. iteration x: 4.400000 - y: 7.800000
7. iteration x: 4.300000 - y: 7.600000
8. iteration x: 4.200000 - y: 7.400000
9. iteration x: 4.100000 - y: 7.200000
10. iteration x: 4.000000 - y: 7.000000
11. iteration x: 3.900000 - y: 6.800000
12. iteration x: 3.800000 - y: 6.600000
13. iteration x: 3.700000 - y: 6.400000
14. iteration x: 3.600000 - y: 6.200000
15. iteration x: 3.500000 - y: 6.000000
16. iteration x: 3.400000 - y: 5.800000
17. iteration x: 3.300000 - y: 5.600000
18. iteration x: 3.200000 - y: 5.400000
19. iteration x: 3.100000 - y: 5.200000
20. iteration x: 3.000000 - y: 5.000000
21. iteration x: 2.900000 - y: 4.800000
22. iteration x: 2.800000 - y: 4.600000
23. iteration x: 2.700000 - y: 4.400000
24. iteration x: 2.600000 - y: 4.200000
25. iteration x: 2.500000 - y: 4.000000
26. iteration x: 2.400000 - y: 3.800000
27. iteration x: 2.300000 - y: 3.600000
28. iteration x: 2.200000 - y: 3.400000
29. iteration x: 2.100000 - y: 3.200000
30. iteration x: 2.000000 - y: 3.000000

result for 2.00: 3.000000
absolute error: 0.000000
```

Test 2:

$$1.5y' - 3y = -9x^2 + 12x - 18.3, \quad y(x) = 3x^2 - x + 5.6$$

$$x_0 \text{ (başlangıç } x \text{ değeri)} = 4, \quad y(4) = 49.6$$

$$x \text{ (hedef } x \text{ değeri)} = 9, \quad y(9) = 239.6$$

```
The order of the differential equation: 1
the coefficient of 1.th order derivative: 1.5
the coefficient of 0.th order derivative: -3
how many elements are there in the polynomial: 3
the coefficient of 1.th value: -9
the degree of 1.th value: 2
the coefficient of 2.th value: 12
the degree of 2.th value: 1
the coefficient of 3.th value: -18.3
the degree of 3.th value: 0
Linear Differential Equation...
(1.50)y(1) + (-3.00)y(0) = (-9.00)x^2 + (12.00)x^1 + (-18.30)x^0
initial x value (x0): 4
what is the value of 0.th order derivative for 4.00 (x0): 49.6
target x value: 9
enter 1 if you have the real value of function for target x value: 1
real y value for target x: 239.6
```

Çıktı 2:

```
step size (it would be good to converge if you enter a value close to 0.1): 0.15
1. iteration x: 4.150000 - y: 53.117462
2. iteration x: 4.300000 - y: 56.769911
3. iteration x: 4.450000 - y: 60.557342
4. iteration x: 4.600000 - y: 64.479748
5. iteration x: 4.750000 - y: 68.537122
6. iteration x: 4.900000 - y: 72.729452
7. iteration x: 5.050000 - y: 77.056722
8. iteration x: 5.200000 - y: 81.518912
9. iteration x: 5.350000 - y: 86.115994
10. iteration x: 5.500000 - y: 90.847929
11. iteration x: 5.650000 - y: 95.714666
12. iteration x: 5.800000 - y: 100.716137
13. iteration x: 5.950000 - y: 105.852248
14. iteration x: 6.100000 - y: 111.122872
15. iteration x: 6.250000 - y: 116.527841
16. iteration x: 6.400000 - y: 122.066924
17. iteration x: 6.550000 - y: 127.739812
18. iteration x: 6.700000 - y: 133.546086
19. iteration x: 6.850000 - y: 139.485181
20. iteration x: 7.000000 - y: 145.556337
21. iteration x: 7.150000 - y: 151.758524
22. iteration x: 7.300000 - y: 158.090354
23. iteration x: 7.450000 - y: 164.549954
24. iteration x: 7.600000 - y: 171.134792
25. iteration x: 7.750000 - y: 177.841455
26. iteration x: 7.900000 - y: 184.665333
27. iteration x: 8.050000 - y: 191.600204
28. iteration x: 8.200000 - y: 198.637670
29. iteration x: 8.350000 - y: 205.766395
30. iteration x: 8.500000 - y: 212.971077
31. iteration x: 8.650000 - y: 220.231058
32. iteration x: 8.800000 - y: 227.518459
33. iteration x: 8.950000 - y: 234.795641

result for 9.00: 234.795641
absolute error: 4.804359
```

step size 0.1 için daha iyi yakınsadığından sonuç 239.102643 çıkmıştı.

Test 3:

$$4y'' - y' + y = 2x^2 - 4x - 9, \quad y(x) = 2x^2 + 4x - 17$$

$$x_0 \text{ (başlangıç } x \text{ değeri)} = 0, \quad y(0) = 4, \quad y'(0) = 4$$

$$x \text{ (hedef } x \text{ değeri)} = -5, \quad y(-5) = 13$$

```
The order of the differential equation: 2
the coefficient of 2.th order derivative: 4
the coefficient of 1.th order derivative: -2
the coefficient of 0.th order derivative: 1
how many elements are there in the polynomial: 3
the coefficient of 1.th value: 2
the degree of 1.th value: 2
the coefficient of 2.th value: -4
the degree of 2.th value: 1
the coefficient of 3.th value: -9
the degree of 3.th value: 0
Linear Differential Equation...
(4.00)y(2) + (-2.00)y(1) + (1.00)y(0) = (2.00)x^2 + (-4.00)x^1 + (-9.00)x^0
initial x value (x0): 0
what is the value of 0.th order derivative for 0.00 (x0): 4
what is the value of 1.th order derivative for 0.00 (x0): 4
target x value: -5
enter 1 if you have the real value of function for target x value: 1
real y value for target x: 13
```

Çıktı 3:

```
step size (it would be good to converge if you enter a value close to 0.1): 0.1
1. iteration x: -0.100000 - y: 3.594187
2. iteration x: -0.200000 - y: 3.178498
3. iteration x: -0.300000 - y: 2.755550
4. iteration x: -0.400000 - y: 2.327946
5. iteration x: -0.500000 - y: 1.898274
6. iteration x: -0.600000 - y: 1.469096
7. iteration x: -0.700000 - y: 1.042947
8. iteration x: -0.800000 - y: 0.622327
9. iteration x: -0.900000 - y: 0.209699
10. iteration x: -1.000000 - y: -0.192515
11. iteration x: -1.100000 - y: -0.581942
12. iteration x: -1.200000 - y: -0.956256
13. iteration x: -1.300000 - y: -1.313184
14. iteration x: -1.400000 - y: -1.650509
15. iteration x: -1.500000 - y: -1.966073
16. iteration x: -1.600000 - y: -2.257778
17. iteration x: -1.700000 - y: -2.523590
18. iteration x: -1.800000 - y: -2.761538
19. iteration x: -1.900000 - y: -2.969719
20. iteration x: -2.000000 - y: -3.146298
21. iteration x: -2.100000 - y: -3.289507
22. iteration x: -2.200000 - y: -3.397651
23. iteration x: -2.300000 - y: -3.469104
24. iteration x: -2.400000 - y: -3.502310
25. iteration x: -2.500000 - y: -3.495788
26. iteration x: -2.600000 - y: -3.448125
27. iteration x: -2.700000 - y: -3.357983
28. iteration x: -2.800000 - y: -3.224091
29. iteration x: -2.900000 - y: -3.045254
30. iteration x: -3.000000 - y: -2.820345
31. iteration x: -3.100000 - y: -2.548305
32. iteration x: -3.200000 - y: -2.228147
33. iteration x: -3.300000 - y: -1.858951
34. iteration x: -3.400000 - y: -1.439863
35. iteration x: -3.500000 - y: -0.970096
36. iteration x: -3.600000 - y: -0.448927
37. iteration x: -3.700000 - y: 0.124304
38. iteration x: -3.800000 - y: 0.750197
```

```
38. iteration x: -3.800000 - y: 0.750197
39. iteration x: -3.900000 - y: 1.429289
40. iteration x: -4.000000 - y: 2.162060
41. iteration x: -4.100000 - y: 2.948933
42. iteration x: -4.200000 - y: 3.790277
43. iteration x: -4.300000 - y: 4.686407
44. iteration x: -4.400000 - y: 5.637586
45. iteration x: -4.500000 - y: 6.644028
46. iteration x: -4.600000 - y: 7.705899
47. iteration x: -4.700000 - y: 8.823321
48. iteration x: -4.800000 - y: 9.996369
49. iteration x: -4.900000 - y: 11.225079
50. iteration x: -5.000000 - y: 12.509447
```

```
result for -5.00: 12.509447
absolute error: 0.490553
enter 1 if you want to continue
enter 0 to exit
```

Örnek 4:

$$-2y' + 5y = 5x^3 - 6x^2 - 50x + 20$$

$$y(x) = x^3 - 10x$$

$$x_0 \text{ (başlangıç } x \text{ değeri)} = -1, y(-1) = 9,$$

$$x \text{ (hedef } x \text{ değeri)} = 2, y(2) = -12$$

Çıktı 4:

```
step size (it would be good to converge if you enter a value close to 0.1): 0.1
1. iteration x: -0.900000 - y: 8.271011
2. iteration x: -0.800000 - y: 7.488024
3. iteration x: -0.700000 - y: 6.657040
4. iteration x: -0.600000 - y: 5.784059
5. iteration x: -0.500000 - y: 4.875083
6. iteration x: -0.400000 - y: 3.936112
7. iteration x: -0.300000 - y: 2.973149
8. iteration x: -0.200000 - y: 1.992195
9. iteration x: -0.100000 - y: 0.999254
10. iteration x: -0.000000 - y: 0.000328
11. iteration x: 0.100000 - y: -0.998577
12. iteration x: 0.200000 - y: -1.991457
13. iteration x: 0.300000 - y: -2.972304
14. iteration x: 0.400000 - y: -3.935108
15. iteration x: 0.500000 - y: -4.873857
16. iteration x: 0.600000 - y: -5.782536
17. iteration x: 0.700000 - y: -6.655125
18. iteration x: 0.800000 - y: -7.485598
19. iteration x: 0.900000 - y: -8.267923
20. iteration x: 1.000000 - y: -8.996056
21. iteration x: 1.100000 - y: -9.663945
22. iteration x: 1.200000 - y: -10.265519
23. iteration x: 1.300000 - y: -10.794689
24. iteration x: 1.400000 - y: -11.245340
25. iteration x: 1.500000 - y: -11.611324
26. iteration x: 1.600000 - y: -11.886454
27. iteration x: 1.700000 - y: -12.064485
28. iteration x: 1.800000 - y: -12.139106
29. iteration x: 1.900000 - y: -12.103916
30. iteration x: 2.000000 - y: -11.952401

result for 2.00: -11.952401
absolute error: 0.047599
```


Örnek 5:

$$y'' + y' - 6y = 0, \quad y(x) = e^{-3x} + 2e^{2x}$$

$$x_0 \text{ (başlangıç } x \text{ değeri)} = 0, \quad y(0) = 3, \quad y'(0) = 1$$

$$x \text{ (hedef } x \text{ değeri)} = 1, \quad y(1) = 14.827899$$

```
The order of the differential equation: 2
the coefficient of 2.th order derivative: 1
the coefficient of 1.th order derivative: 1
the coefficient of 0.th order derivative: -6
how many elements are there in the polynomial: 1
the coefficient of 1.th value: 0
the degree of 1.th value: 0
Linear Differential Equation...
(1.00)y(2) + (1.00)y(1) + (-6.00)y(0) = (0.00)x^0
initial x value (x0): 0
what is the value of 0.th order derivative for 0.00 (x0): 3
what is the value of 1.th order derivative for 0.00 (x0): 1
target x value: 1
enter 1 if you have the real value of function for target x value: 1
real y value for target x: 14.827899
```

Çıktı 5:

```
step size (it would be good to converge if you enter a value close to 0.1): 0.1
1. iteration x: 0.100000 - y: 3.183638
2. iteration x: 0.200000 - y: 3.532476
3. iteration x: 0.300000 - y: 4.050814
4. iteration x: 0.400000 - y: 4.752267
5. iteration x: 0.500000 - y: 5.659661
6. iteration x: 0.600000 - y: 6.805469
7. iteration x: 0.700000 - y: 8.232750
8. iteration x: 0.800000 - y: 9.996623
9. iteration x: 0.900000 - y: 12.166270
10. iteration x: 1.000000 - y: 14.827579

result for 1.00: 14.827579
absolute error: 0.000320
```

Örnek 6:

$$4y' - y = -2x^2 + 12x + 33$$

$$y(x) = 2x^2 + 4x - 17$$

$$x_0 \text{ (başlangıç } x \text{ değeri)} = 1, y(1) = -11$$

$$x \text{ (hedef } x \text{ değeri)} = 27, y(27) = 1549$$

Çıktı 6:

```
step size (it would be good to converge if you enter a value close to 0.1): 0.5
1. iteration x: 1.500000 - y: -6.500020
2. iteration x: 2.000000 - y: -1.000043
3. iteration x: 2.500000 - y: 5.499930
4. iteration x: 3.000000 - y: 12.999901
5. iteration x: 3.500000 - y: 21.499867
6. iteration x: 4.000000 - y: 30.999829
7. iteration x: 4.500000 - y: 41.499786
8. iteration x: 5.000000 - y: 52.999737
9. iteration x: 5.500000 - y: 65.499682
10. iteration x: 6.000000 - y: 78.999619
11. iteration x: 6.500000 - y: 93.499548
12. iteration x: 7.000000 - y: 108.999468
13. iteration x: 7.500000 - y: 125.499377
14. iteration x: 8.000000 - y: 142.999273
15. iteration x: 8.500000 - y: 161.499156
16. iteration x: 9.000000 - y: 180.999024
17. iteration x: 9.500000 - y: 201.498873
18. iteration x: 10.000000 - y: 222.998703
19. iteration x: 10.500000 - y: 245.498510
20. iteration x: 11.000000 - y: 268.998291
21. iteration x: 11.500000 - y: 293.498043
22. iteration x: 12.000000 - y: 318.997763
23. iteration x: 12.500000 - y: 345.497444
24. iteration x: 13.000000 - y: 372.997084
25. iteration x: 13.500000 - y: 401.496675
26. iteration x: 14.000000 - y: 430.996212
27. iteration x: 14.500000 - y: 461.495687
28. iteration x: 15.000000 - y: 492.995093
29. iteration x: 15.500000 - y: 525.494419
30. iteration x: 16.000000 - y: 558.993656
31. iteration x: 16.500000 - y: 593.492791
32. iteration x: 17.000000 - y: 628.991810
33. iteration x: 17.500000 - y: 665.490699
34. iteration x: 18.000000 - y: 702.989441
35. iteration x: 18.500000 - y: 741.488014
36. iteration x: 19.000000 - y: 780.986398
37. iteration x: 19.500000 - y: 821.484567
38. iteration x: 20.000000 - y: 862.982492
```

```

38. iteration x: 20.000000 - y: 862.982492
39. iteration x: 20.500000 - y: 905.480140
40. iteration x: 21.000000 - y: 948.977475
41. iteration x: 21.500000 - y: 993.474456
42. iteration x: 22.000000 - y: 1038.971035
43. iteration x: 22.500000 - y: 1085.467157
44. iteration x: 23.000000 - y: 1132.962764
45. iteration x: 23.500000 - y: 1181.457786
46. iteration x: 24.000000 - y: 1230.952145
47. iteration x: 24.500000 - y: 1281.445753
48. iteration x: 25.000000 - y: 1332.938510
49. iteration x: 25.500000 - y: 1385.430302
50. iteration x: 26.000000 - y: 1438.921001
51. iteration x: 26.500000 - y: 1493.410462
52. iteration x: 27.000000 - y: 1548.898520

```

```

result for 27.00: 1548.898520
absolute error: 0.101480

```

Örnek 7:

$$-3y'''' + 2y'' - y' + 5y = 5x^5 - 5x^4 + 40x^3 - 15x^2 - 354x - 42$$

$$y(x) = x^5 - 3x^2 - 6$$

$$x_0 \text{ (başlangıç } x \text{ değeri)} = 1, y(1) = -8, y'(1) = -1, \\ y''(1) = 14, y'''(1) = 60, y''''(1) = 120$$

$$x \text{ (hedef } x \text{ değeri)} = -2.4, y(27) = -102.90624$$

Linear Differential Equation...

$$(-3.00)y(4) + (0.00)y(3) + (2.00)y(2) + (-1.00)y(1) + (5.00)y(0) = (5.00)x^5 + (-5.00)x^4 + (40.00)x^3 + (-15.00)x^2 + (-354.00)x^1 + (-42.00)x^0$$

```

initial x value (x0): 1

what is the value of 0.th order derivative for 1.00 (x0): -8

what is the value of 1.th order derivative for 1.00 (x0): -1

what is the value of 2.th order derivative for 1.00 (x0): 14

what is the value of 3.th order derivative for 1.00 (x0): 60

target x value: -2.4

enter 1 if you have the real value of function for target x value: 1

real y value for target x: -102.90624

```

Çıktı 7:

```

real y value for target x: -102.90624

step size (it would be good to converge if you enter a value close to 0.1): 0.1
1. iteration x: 0.900000 - y: -7.839500
2. iteration x: 0.800000 - y: -7.592301
3. iteration x: 0.700000 - y: -7.301902
4. iteration x: 0.600000 - y: -7.002204
5. iteration x: 0.500000 - y: -6.718706
6. iteration x: 0.400000 - y: -6.469708
7. iteration x: 0.300000 - y: -6.267511
8. iteration x: 0.200000 - y: -6.119613
9. iteration x: 0.100000 - y: -6.029915
10. iteration x: 0.000000 - y: -5.999917
11. iteration x: -0.100000 - y: -6.029919
12. iteration x: -0.200000 - y: -6.120220
13. iteration x: -0.300000 - y: -6.272320
14. iteration x: -0.400000 - y: -6.490120
15. iteration x: -0.500000 - y: -6.781118
16. iteration x: -0.600000 - y: -7.157615
17. iteration x: -0.700000 - y: -7.637911
18. iteration x: -0.800000 - y: -8.247504
19. iteration x: -0.900000 - y: -9.020295
20. iteration x: -1.000000 - y: -9.999782
21. iteration x: -1.100000 - y: -11.240265
22. iteration x: -1.200000 - y: -12.808043
23. iteration x: -1.300000 - y: -14.782616
24. iteration x: -1.400000 - y: -17.257881
25. iteration x: -1.500000 - y: -20.343338
26. iteration x: -1.600000 - y: -24.165285
27. iteration x: -1.700000 - y: -28.868021
28. iteration x: -1.800000 - y: -34.615043
29. iteration x: -1.900000 - y: -41.590248
30. iteration x: -2.000000 - y: -49.999135
31. iteration x: -2.100000 - y: -60.070000
32. iteration x: -2.200000 - y: -72.055139
33. iteration x: -2.300000 - y: -86.232050
34. iteration x: -2.400000 - y: -102.904626

result for -2.40: -102.904626
absolute error: 0.001614

```