Advanced Mathematics for Engineers, Laboratory Problems

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Problem 1.1

```
Matrix from file:
    1.0    -2.0     3.0    -4.0
    4.1     3.0     1.1     1.0
    2.0     4.0     1.0     4.0
    3.0     4.0     3.0     8.0

Vector from file:
    6.1
    5.2
    4.2
    3.1

a)
determinant:
169.2

inverse:
  -0.13    0.43   -0.53    0.15
   0.11   -0.17    0.71   -0.28
   0.29   -0.24     0.3    0.03
  -0.11    0.01   -0.26     0.2

rank:
4

eigenvalues:
8.25668694865
5.18909337619
-0.222890162424
-0.222890162424

eigenvectors:
[-0.31568286  0.44289131  0.61685718  0.61685718]
[ -7.86684467e-05   3.70103040e-01  -4.34768294e-01  -4.34768294e-01]
[ 0.38980754 -0.19285648 -0.40093074 -0.40093074]
[ 0.86509792 -0.79352215  0.10527324  0.10527324]

is symmetric:
False

is positive definite:
True
```

```
b)
x1 = -0.33829787234
x2 = 1.88156028369
x3 = 1.88794326241
x4 = -1.13439716312

c)
matrix after elimination:
    1.0    -2.0     3.0    -4.0
    0.0    11.2   -11.2    17.4
    0.0     0.0     3.0   -0.43
    0.0     0.0     0.0    5.04

vector after elimination:
    6.1
 -19.81
   6.15
  -5.71
```

Problem 1.2

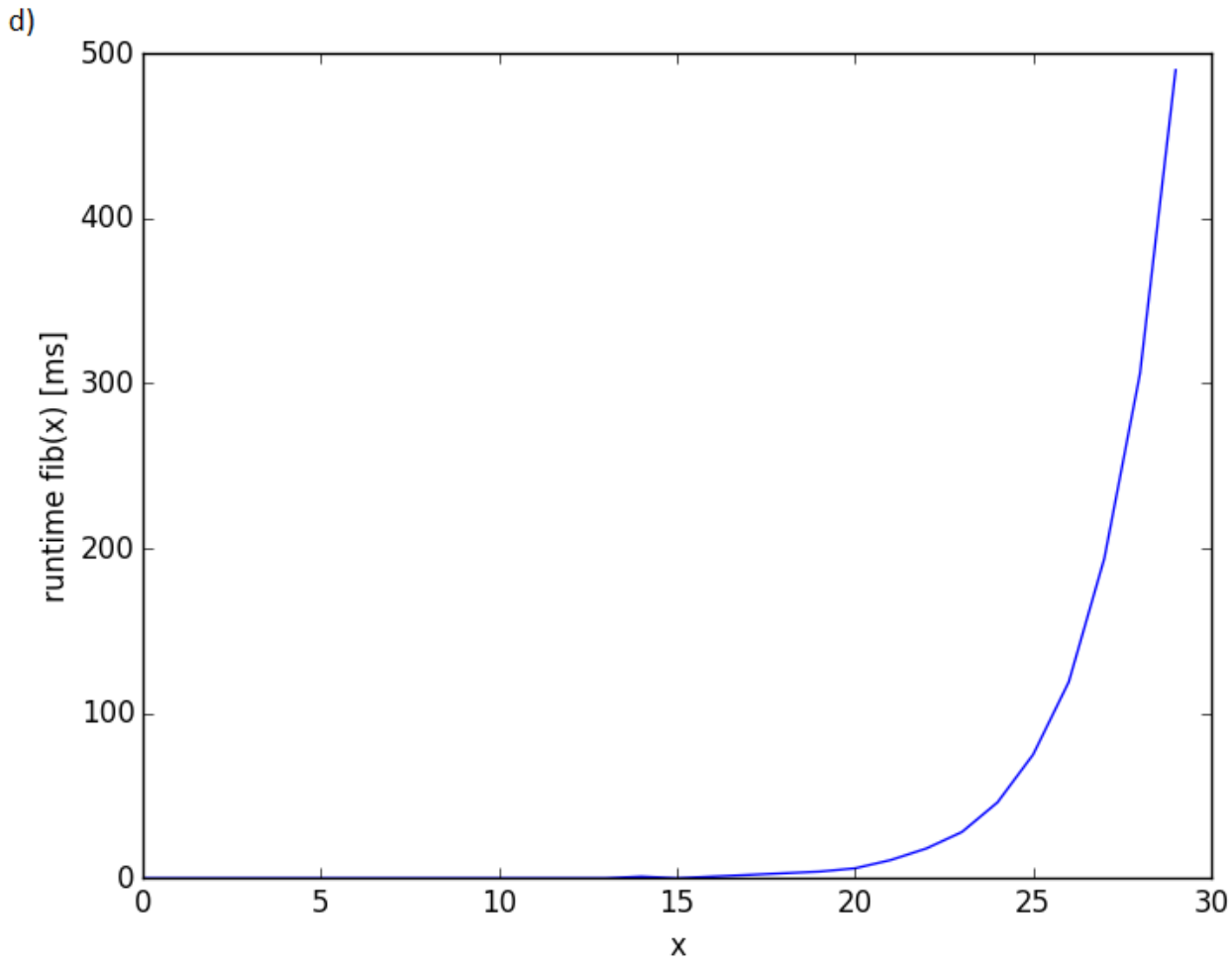
```
a)
matrix A:
     1.8     -2.0
     3.0     -4.1
     3.0      2.0

matrix B:
     1.0     -2.0     -3.0      4.0
    -5.0      4.0      1.0      1.0

A x B:
    11.8    -11.6     -7.4      5.2
    23.5    -22.4    -13.1      7.9
    -7.0      2.0     -7.0     14.0
```

```
b)
matrix C:
     1.0      2.4
     3.3     -4.0
    -5.0     -6.1

C transposed:
     1.0      3.3     -5.0
     2.4     -4.0     -6.1
```

Problem 2.3

a + b + c) (next page)

d)

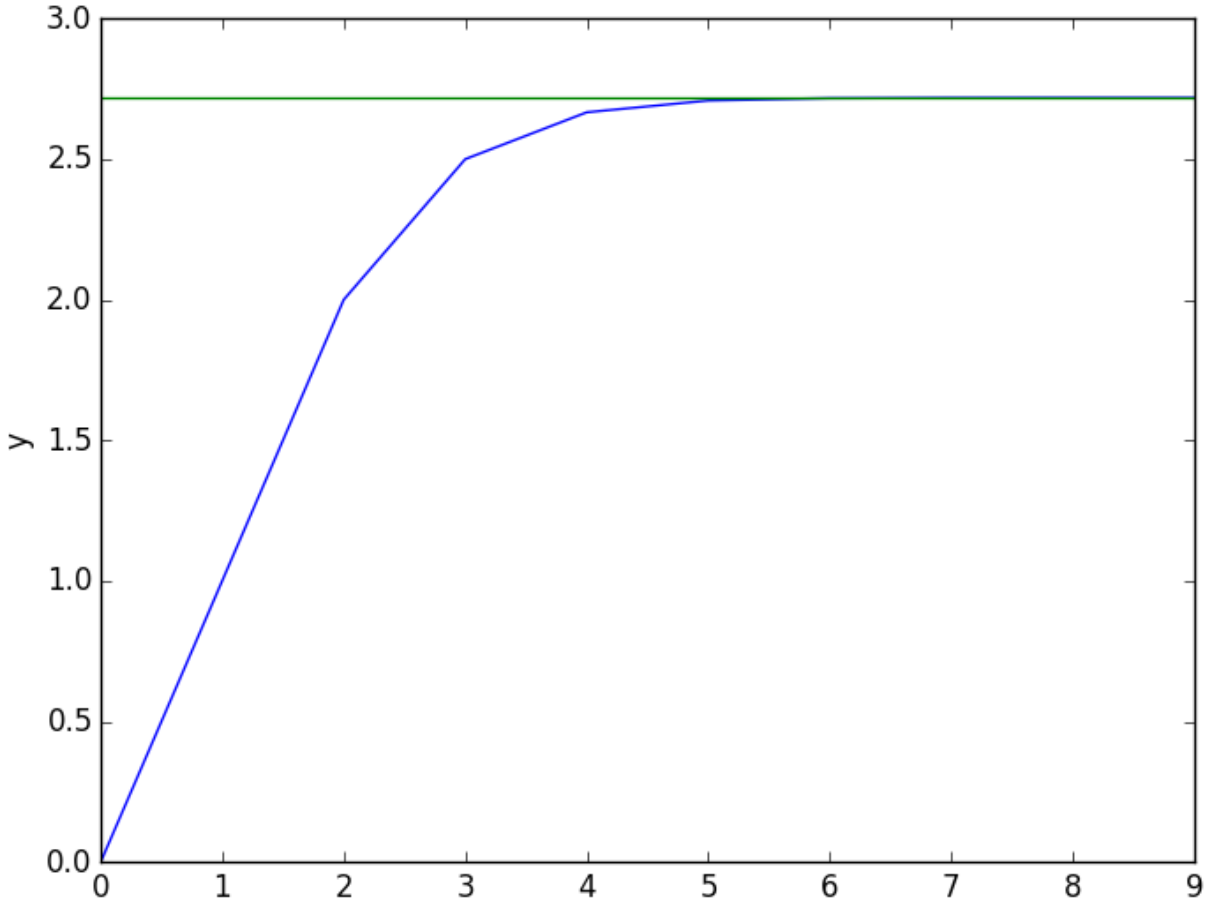


```
a)
n = 9
iterative result: 362880
recursive result: 362880

b)
n = 1
(n - 1)! = 1
Gamma(n) = (1.0, 1.1102230246251565e-14)

n = 2
(n - 1)! = 1
Gamma(n) = (1.0000000000000004, 1.6653345369377348e-15)

n = 3
(n - 1)! = 2
Gamma(n) = (2.0000000000000018, 1.687538997430238e-14)

n = 4
(n - 1)! = 6
Gamma(n) = (6.000000000000022, 2.9398705692074145e-13)

n = 5
(n - 1)! = 24
Gamma(n) = (24.00000000000007, 3.4425795547576854e-12)

n = 6
(n - 1)! = 120
Gamma(n) = (120.00000000002257, 2.0904167286062147e-10)

n = 7
(n - 1)! = 720
Gamma(n) = (719.9999999959593, 5.704745944967726e-06)

n = 8
(n - 1)! = 5040
Gamma(n) = (5040.00000041839, 2.7812626285594888e-05)

n = 9
(n - 1)! = 40320
Gamma(n) = (40320.00000350633, 6.723143451381475e-05)
```

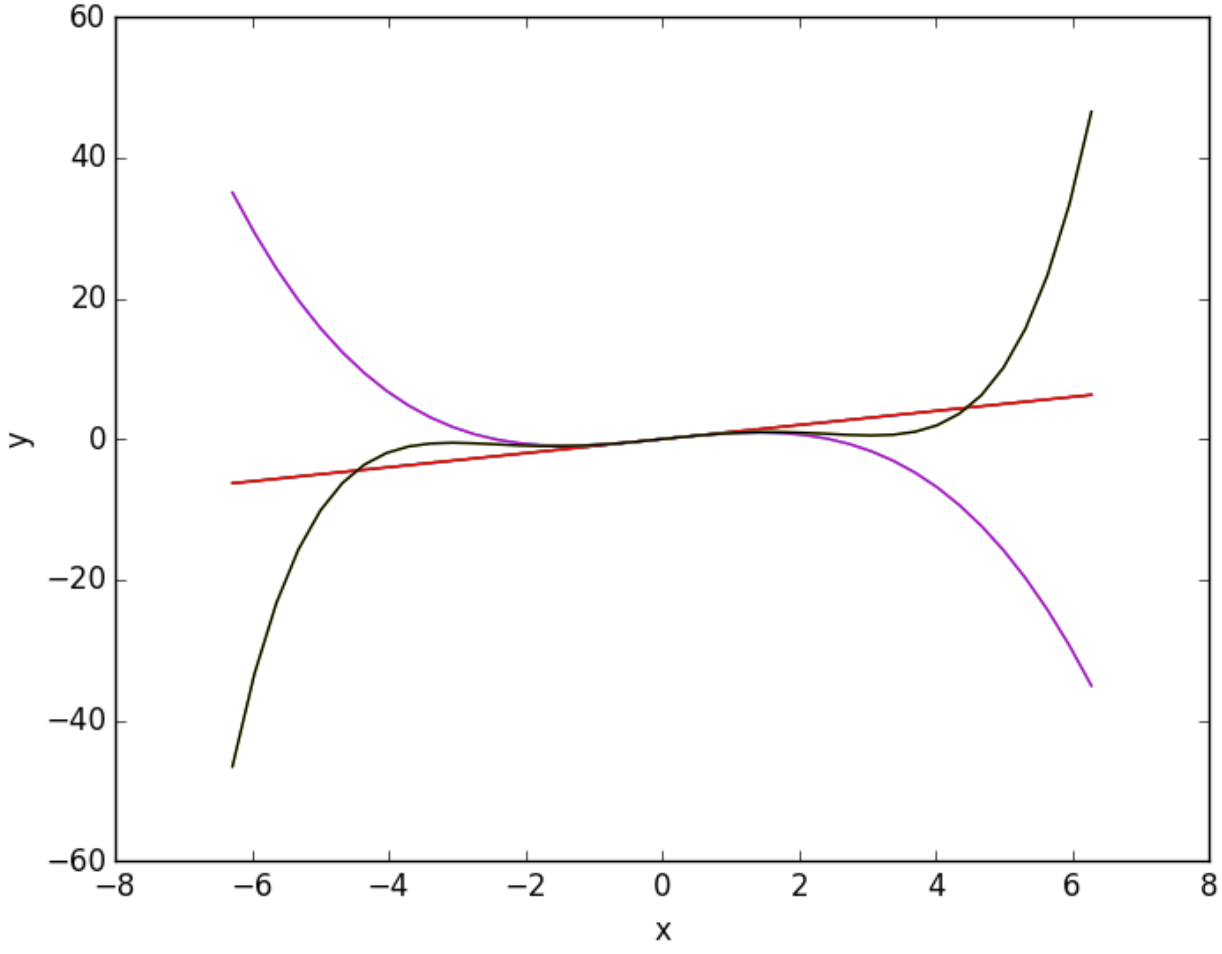
```
c)
fib(1) = 1
fib(2) = 1
fib(3) = 2
fib(4) = 3
fib(5) = 5
fib(6) = 8
fib(7) = 13
fib(8) = 21
fib(9) = 34
fib(10) = 55
fib(11) = 89
fib(12) = 144
fib(13) = 233
fib(14) = 377
fib(15) = 610
fib(16) = 987
fib(17) = 1597
fib(18) = 2584
fib(19) = 4181
fib(20) = 6765
```

Problem 2.4

a)



b)



```
c)
x = 1 | degree = 14 | e(1) = 2.71828182846
x = 2 | degree = 19 | e(2) = 7.38905609893
x = 3 | degree = 23 | e(3) = 20.0855369232
x = 4 | degree = 28 | e(4) = 54.5981500331
x = 5 | degree = 32 | e(5) = 148.413159103
```

Problem 2.5

```
a)
number of iterations: 5

b)
water used: 4.95 * v
```

c)
No it can't, the optimal β is the closest value to 1 – α.

d)

$$n = \lceil log_{(1+\alpha-\beta)}(\epsilon) \rceil$$

(n = number of iterations)

e)
It can be minimized by increasing the value of β.