Лабораторная работа №9

Задание 4

```
A = [2 0 -4 2;
0 2 -2 4;
-4 -2 2 0;
2 4 0 2]
```

```
A = 4×4
     2     0    -4     2
     0     2    -2     4
    -4    -2     2     0
     2     4     0     2
```

```
B = [2; 4; 6; 8]
```

```
B = 4×1
     2
     4
     6
     8
```

```
C = [-2 2 2 2;
2 0 0 2]
```

```
C = 2×4
    -2     2     2     2
     2     0     0     2
```

Определяем собственные числа

```
eig(A)
```

```
ans = 4×1
   -4.0000
   -0.0000
    4.0000
    8.0000
```

Выберем различные значения желаемой степени устойчивости α

```
a_1 = 4
```

```
a_1 = 4
```

```
a_2 = 2
```

```
a_2 = 2
```

```
a_3 = 0.05
```

```
a_3 = 0.0500
```

Далее решаем неравенства Ляпунова

```
x_0 = [1; 1; 1; 1]
```

```
x_0 = 4×1
```

```
     1
     1
     1
     1
```

```
%m = 25

cvx_begin sdp
variable Q(4, 4)
variable Y(4, 2)
variable P(4, 4)
variable Y1(1, 4)
variable m
minimize m
Q > 0.00001*eye(4);
```

```
Warning: The use of strict inequalities in CVX is strongly discouraged,
    because solvers treat them as non-strict inequalities. Please
    consider using ">=" instead.
Warning: This linear matrix inequality appears to be unsymmetric. This is
very likely an error that will produce unexpected results. Please check
the LMI; and, if necessary, re-enter the model.
```

```
P > 0.00001*eye(4);
```

```
Warning: The use of strict inequalities in CVX is strongly discouraged,
    because solvers treat them as non-strict inequalities. Please
    consider using ">=" instead.
Warning: This linear matrix inequality appears to be unsymmetric. This is
very likely an error that will produce unexpected results. Please check
the LMI; and, if necessary, re-enter the model.
```

```
A'*Q + Q*A + 2*a_2*Q + C'*Y'+Y*C <= 0;
```

```
Warning: This linear matrix inequality appears to be unsymmetric. This is
very likely an error that will produce unexpected results. Please check
the LMI; and, if necessary, re-enter the model.
```

```
P*A' + A*P + 2*a_2*P + Y1'*B' + B*Y1 <= 0;
```

```
Warning: This linear matrix inequality appears to be unsymmetric. This is
very likely an error that will produce unexpected results. Please check
the LMI; and, if necessary, re-enter the model.
```

```
%[P x_0;
%    x_0' 1] > 0;
%[P Y1';
%    Y1 m] > 0;
cvx_end
```

```
Calling SDPT3 4.0: 49 variables, 16 equality constraints
------------------------------------------------------------

 num. of constraints = 16
 dim. of sdp    var  = 16,   num. of sdp  blk  =  4
 dim. of free   var  =  9 *** convert ublk to lblk
*****************************************************************
   SDPT3: Infeasible path-following algorithms
*****************************************************************
```

```
 version  predcorr  gam  expon  scale_data
   HKM      1      0.000   1        0
it pstep dstep pinfeas dinfeas  gap      prim-obj      dual-obj    cputime
-----------------------------------------------------------------
 0|0.000|0.000|3.0e+02|1.8e+02|3.4e+04| 7.518963e-11  0.000000e+00| 0:0:00| chol  1  1
 1|0.892|0.793|3.2e+01|3.7e+01|2.1e+03|-6.404007e-01  6.562413e-04| 0:0:00| chol  1  1
 2|0.729|0.751|8.7e+00|9.2e+00|3.5e+02|-1.243253e+00  8.605831e-04| 0:0:00| chol  1  1
 3|0.981|0.785|1.7e-01|2.0e+00|6.2e+01|-2.570474e+00  6.478593e-04| 0:0:00| chol  1  1
 4|1.000|0.102|4.9e-05|2.3e+00|1.7e+02|-2.286626e+02  7.139492e-04| 0:0:00| chol  1  1
 5|1.000|0.218|1.0e-06|1.8e+00|2.3e+02|-4.067786e+03  9.083476e-04| 0:0:00| chol  1  1
 6|1.000|0.022|4.2e-07|2.3e+00|2.1e+06|-6.793025e+06  9.191008e-04| 0:0:00| chol  1  1
 7|1.000|0.001|1.5e-03|2.8e+00|7.6e+07|-1.260413e+08  3.141123e-03| 0:0:00| chol  1  1
 8|1.000|0.156|1.6e-06|2.9e+00|6.0e+08|-8.944614e+08  1.690421e-03| 0:0:00| chol  1  1
 9|1.000|0.132|9.2e-05|3.0e+00|4.3e+09|-5.749871e+09  2.717818e-03| 0:0:00| chol  2  1
10|1.000|0.110|4.4e-05|3.2e+00|2.8e+10|-3.217112e+10  2.430946e-03| 0:0:00| chol  2  2
11|1.000|0.140|1.5e-04|3.3e+00|1.4e+11|-1.540270e+11  2.937557e-03| 0:0:00| chol  2  2
12|1.000|0.203|3.7e-04|2.6e+00|3.7e+11|-6.991469e+11  2.583101e-03| 0:0:00| chol  2  2
13|0.974|0.129|2.1e-03|2.8e+00|3.8e+12|-6.125586e+12  2.667331e-03| 0:0:00| chol  2  2
14|1.000|0.148|9.2e-03|2.9e+00|2.9e+13|-4.292315e+13  2.426577e-03| 0:0:00| chol  2  2
15|1.000|0.128|2.6e-01|3.1e+00|2.1e+14|-2.670695e+14  2.789406e-03| 0:0:00| chol  2  2
16|1.000|0.150|2.7e+00|3.1e+00|1.2e+15|-1.443499e+15  2.362089e-03| 0:0:00| chol  2  2
17|1.000|0.158|4.1e+01|3.2e+00|6.2e+15|-7.399245e+15  2.947057e-03| 0:0:00| chol  2  2
18|1.000|0.198|1.5e+02|3.1e+00|2.9e+16|-3.705957e+16  2.351783e-03| 0:0:00| chol  2  2
19|1.000|0.193|1.6e+03|3.0e+00|1.5e+17|-2.017684e+17  2.830020e-03| 0:0:00|
  sqlp stop: dual problem is suspected of being infeasible
-----------------------------------------------------------------
 number of iterations   = 19
 residual of dual infeasibility
 certificate X          = 8.03e-15
 reldist to infeas.    <= 1.32e-16
 Total CPU time (secs)  = 0.32
 CPU time per iteration = 0.02
 termination code       =  2
 DIMACS: 1.6e+03  0.0e+00  3.6e+00  0.0e+00  -1.0e+00  7.3e-01
-----------------------------------------------------------------

------------------------------------------------------------
Status: Unbounded
Optimal value (cvx_optval): -Inf
```

```
%m
```

И находим матриу реглятора K:

```
K = Y1*inv(P)
```

```
K = 1×4
  -37.8666   -9.9563   33.0091  -14.8600
```

```
L = inv(Q)*Y
```

```
L = 4×2
    1.4598   -3.9007
   -1.4598   -9.1913
   -1.4598    9.1913
   -1.4598   -3.9007
```

Далее определим корни матрицы A+BK:

```
LC = eig(A+L*C)
```

```
LC = 4×1 complex
  -3.8014 + 8.3785i
  -3.8014 - 8.3785i
  -7.6783 + 0.0000i
  -4.0000 + 0.0000i
```

```
BK = eig(A+B*K)
```

```
BK = 4×1 complex
 -10.7745 +14.5756i
 -10.7745 -14.5756i
  -2.8974 + 0.0000i
  -3.9376 + 0.0000i
```