Лабораторная работа №9

Задание 2

```
A = [-7 0 0 0;
0 3 0 0;
0 0 2 7;
0 0 -7 2]
```

```
A = 4×4
    -7     0     0     0
     0     3     0     0
     0     0     2     7
     0     0    -7     2
```

```
B = [0; 7; 0; 6]
```

```
B = 4×1
     0
     7
     0
     6
```

Определяем собственные числа

```
eig(A)
```

```
ans = 4×1 complex
   2.0000 + 7.0000i
   2.0000 - 7.0000i
  -7.0000 + 0.0000i
   3.0000 + 0.0000i
```

Выберем различные значения желаемой степени устойчивости α

```
a_1 = 7
```

```
a_1 = 7
```

```
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);
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_3*Q + C'*Y'+Y*C <= 0;
P*A' + A*P + 2*a_3*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;
```

```
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 Y1';
    Y1 m] > 0;
```

```
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.
```

```
cvx_end
```

```
Calling SDPT3 4.0: 74 variables, 45 equality constraints
------------------------------------------------------------

 num. of constraints = 45
 dim. of sdp    var  = 18,   num. of sdp  blk  =  4
 dim. of free   var  = 24 *** convert ublk to lblk
 number of nearly dependent constraints = 5
 To remove these constraints, re-run sqlp.m with OPTIONS.rmdepconstr = 1.
*****************************************************************
   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|5.1e+01|1.7e+02|2.2e+05| 1.000000e+01  0.000000e+00| 0:0:00| chol  1  1
 1|0.994|0.169|3.3e-01|1.4e+02|5.3e+04| 1.003081e+02 -1.574210e+01| 0:0:00| chol  1  1
 2|1.000|0.958|2.1e-05|6.0e+00|8.3e+02| 8.938900e+01 -1.039059e+00| 0:0:00| chol  1  1
 3|0.917|0.976|1.0e-05|1.5e-01|5.2e+01| 4.314055e+01  1.960938e-01| 0:0:00| chol  1  1
 4|0.702|0.768|4.8e-06|3.5e-02|1.7e+01| 1.547115e+01  2.618079e-01| 0:0:00| chol  1  1
 5|0.586|0.712|3.4e-06|1.0e-02|7.6e+00| 8.106405e+00  1.059198e+00| 0:0:00| chol  1  1
 6|0.728|0.554|3.9e-06|4.5e-03|3.7e+00| 5.921135e+00  2.762234e+00| 0:0:00| chol  1  1
 7|1.000|0.749|1.8e-06|1.1e-03|8.0e-01| 4.443450e+00  3.813536e+00| 0:0:00| chol  1  1
 8|0.972|0.865|3.6e-07|1.5e-04|7.2e-02| 4.238524e+00  4.186303e+00| 0:0:00| chol  1  1
 9|0.582|0.590|1.9e-07|6.3e-05|3.6e-02| 4.227989e+00  4.206262e+00| 0:0:00| chol  1  1
10|0.571|0.620|2.7e-07|2.4e-05|1.7e-02| 4.224382e+00  4.214873e+00| 0:0:00| chol  2  2
11|0.558|0.568|1.2e-07|1.0e-05|9.0e-03| 4.221689e+00  4.217461e+00| 0:0:00| chol  2  2
12|0.655|0.519|4.4e-08|5.0e-06|5.0e-03| 4.219553e+00  4.218100e+00| 0:0:00| chol  2  2
13|0.641|0.504|1.8e-08|2.4e-05|4.5e-03| 4.218488e+00  4.218062e+00| 0:0:00| chol  2  2
14|0.640|0.519|2.7e-08|6.1e-05|3.4e-03| 4.217826e+00  4.217696e+00| 0:0:00| chol  2  2
15|0.636|0.532|4.7e-07|8.8e-05|1.9e-03| 4.217347e+00  4.217323e+00| 0:0:00| chol  3  3
16|0.722|0.544|1.3e-07|5.0e-05|8.5e-04| 4.216964e+00  4.217072e+00| 0:0:00| chol  3  3
17|0.704|0.611|8.3e-07|2.2e-05|3.6e-04| 4.216741e+00  4.216875e+00| 0:0:00| chol  5  5
18|0.631|0.557|4.8e-07|9.5e-06|1.9e-04| 4.216589e+00  4.216717e+00| 0:0:00| chol 10  9
19|0.527|0.517|7.3e-07|5.0e-06|1.2e-04| 4.216494e+00  4.216597e+00| 0:0:00| chol 12 11
20|0.474|0.490|3.5e-06|3.1e-06|7.9e-05| 4.216425e+00  4.216507e+00| 0:0:00| chol 13 10
21|0.444|0.469|3.9e-06|2.1e-06|5.7e-05| 4.216374e+00  4.216440e+00| 0:0:00| chol 10 16
22|0.424|0.461|9.0e-06|1.5e-06|4.2e-05| 4.216338e+00  4.216388e+00| 0:0:00| chol 17 10
23|0.419|0.461|9.4e-06|1.1e-06|3.2e-05| 4.216311e+00  4.216349e+00| 0:0:00| chol 11 10
24|0.419|0.463|1.1e-05|8.4e-07|2.4e-05| 4.216291e+00  4.216320e+00| 0:0:00|
  lack of progress in infeas
------------------------------------------------------------------
 number of iterations   = 24
 primal objective value =  4.21637414e+00
 dual   objective value =  4.21643958e+00
 gap := trace(XZ)       = 5.66e-05
 relative gap           = 6.00e-06
 actual relative gap    = -6.94e-06
 rel. primal infeas (scaled problem)   = 3.88e-06
 rel. dual     "        "       "      = 2.07e-06
 rel. primal infeas (unscaled problem) = 0.00e+00
 rel. dual     "        "       "      = 0.00e+00
 norm(X), norm(y), norm(Z) = 1.6e+05, 8.2e+00, 6.4e+00
 norm(A), norm(b), norm(C) = 3.7e+01, 3.2e+00, 2.0e+00
 Total CPU time (secs)  = 0.35
 CPU time per iteration = 0.01
 termination code       =  0
 DIMACS: 6.3e-06  0.0e+00  2.1e-06  0.0e+00  -6.9e-06  6.0e-06
------------------------------------------------------------------

------------------------------------------------------------
Status: Solved
Optimal value (cvx_optval): +4.21637
```

```
m
```

```
m = 4.2164
```

И находим матриу реглятора K:

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

```
K = 1×4
    0.0000   -0.6181   -0.6679   -0.4706
```

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

Далее определим корни матрицы A+BK:

```
%LC = eig(A+L*C)
BK = eig(A+B*K)
```

```
BK = 4×1 complex
  -0.0500 + 7.8497i
  -0.0500 - 7.8497i
  -0.0501 + 0.0000i
  -7.0000 + 0.0000i
```