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_1*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|1.1e+02|1.7e+02|2.2e+05| 1.000000e+01  0.000000e+00| 0:0:00| chol  1  1
 1|0.604|0.226|4.2e+01|1.3e+02|4.5e+04| 6.737516e+01 -2.135516e+01| 0:0:00| chol  1  1
 2|0.413|0.609|2.4e+01|5.1e+01|7.7e+03| 1.147756e+02  1.629012e+00| 0:0:00| chol  1  1
 3|0.862|0.838|3.4e+00|8.3e+00|1.0e+03| 2.057016e+02  5.478640e+01| 0:0:00| chol  1  1
 4|0.749|0.761|8.4e-01|2.0e+00|2.2e+02| 1.923480e+02  1.674200e+02| 0:0:00| chol  1  1
 5|0.838|0.551|1.4e-01|8.9e-01|8.8e+01| 2.172518e+02  1.999386e+02| 0:0:00| chol  1  1
 6|0.933|0.921|9.2e-03|7.1e-02|9.0e+00| 2.161303e+02  2.123786e+02| 0:0:00| chol  1  1
 7|0.973|0.958|2.6e-04|3.2e-03|3.9e-01| 2.149734e+02  2.148254e+02| 0:0:00| chol  1  1
 8|0.978|0.981|6.8e-06|6.6e-05|8.4e-03| 2.149428e+02  2.149407e+02| 0:0:00| chol  2  2
 9|0.955|0.976|3.3e-06|1.7e-06|2.6e-04| 2.149445e+02  2.149430e+02| 0:0:00| chol  3  3
10|0.937|0.962|1.1e-06|6.8e-06|1.6e-05| 2.149437e+02  2.149430e+02| 0:0:00|# chol  4  4
11|0.980|0.958|2.9e-07|4.1e-07|1.0e-06| 2.149432e+02  2.149430e+02| 0:0:00|# chol  8  8
12|0.603|0.987|2.1e-07|2.7e-08|1.2e-07| 2.149431e+02  2.149430e+02| 0:0:00|# chol
  linsysolve: Schur complement matrix not positive definite
  switch to LU factor. lu 30 ^12
13|0.182|0.727|6.5e-07|3.2e-09|2.6e-07| 2.149431e+02  2.149430e+02| 0:0:00|# lu 11 ^30
  stop: primal infeas has deteriorated too much, 3.5e-05
14|0.851|0.397|6.5e-07|3.2e-09|2.6e-07| 2.149431e+02  2.149430e+02| 0:0:01|
------------------------------------------------------------------
 number of iterations   = 14
 primal objective value =  2.14943133e+02
 dual   objective value =  2.14943031e+02
 gap := trace(XZ)       = 1.18e-07
 relative gap           = 2.75e-10
 actual relative gap    = 2.38e-07
 rel. primal infeas (scaled problem)   = 2.12e-07
 rel. dual     "        "       "      = 2.65e-08
 rel. primal infeas (unscaled problem) = 0.00e+00
 rel. dual     "        "       "      = 0.00e+00
 norm(X), norm(y), norm(Z) = 3.1e+02, 8.9e+02, 8.6e+02
 norm(A), norm(b), norm(C) = 5.8e+01, 3.2e+00, 2.0e+00
 Total CPU time (secs)  = 0.53
 CPU time per iteration = 0.04
 termination code       = -7
 DIMACS: 3.4e-07  0.0e+00  2.7e-08  0.0e+00  2.4e-07  2.7e-10
------------------------------------------------------------------

------------------------------------------------------------
Status: Inaccurate/Solved
Optimal value (cvx_optval): +214.943
```

```
m
```

```
m = 214.9431
```

И находим матриу реглятора K:

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

```
K = 1×4
    0.0000  -10.3333   -9.7937    7.3889
```

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

Далее определим корни матрицы A+BK:

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

```
BK = 4×1 complex
```

```
-7.0000 +16.1761i
-7.0000 -16.1761i
-7.0000 + 0.0000i
-7.0000 + 0.0000i
```