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);
```

```
%A'*Q + Q*A + 2*a_3*Q + C'*Y'+Y*C <= 0;
P*A' + A*P + 2*a_2*P + Y1'*B' + B*Y1 <= 0;
```

```
[P x_0;
    x_0' 1] > 0;
```

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

```
cvx_end
```

```
Calling SDPT3 4.0: 74 variables, 46 equality constraints
------------------------------------------------------------

 num. of constraints = 46
 dim. of sdp    var  = 18,   num. of sdp  blk  =  4
 dim. of free   var  = 24 *** convert ublk to lblk
 number of nearly dependent constraints = 4
 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|5.9e+01|1.7e+02|2.2e+05| 1.000000e+01  0.000000e+00| 0:0:00| chol  1  1
 1|0.624|0.178|2.2e+01|1.4e+02|4.6e+04| 5.982542e+01 -1.428100e+01| 0:0:00| chol  1  1
 2|0.502|0.641|1.1e+01|5.0e+01|6.0e+03| 9.492795e+01 -6.492749e+00| 0:0:00| chol  1  1
 3|1.000|0.909|9.3e-05|4.6e+00|4.2e+02| 1.202060e+02  9.435750e-01| 0:0:00| chol  1  1
 4|0.902|0.977|2.8e-05|1.0e-01|4.1e+01| 4.856559e+01  1.119819e+01| 0:0:00| chol  1  1
 5|0.559|0.687|1.4e-05|3.2e-02|1.9e+01| 3.315520e+01  1.646875e+01| 0:0:00| chol  1  1
 6|0.614|0.514|1.4e-05|1.6e-02|9.6e+00| 2.630348e+01  1.977192e+01| 0:0:00| chol  1  1
 7|0.727|0.785|5.3e-06|3.4e-03|2.8e+00| 2.390921e+01  2.187384e+01| 0:0:00| chol  1  1
 8|0.924|0.865|1.1e-06|4.6e-04|4.2e-01| 2.305371e+01  2.275730e+01| 0:0:00| chol  1  1
 9|0.904|0.868|4.1e-07|6.1e-05|4.6e-02| 2.295343e+01  2.292675e+01| 0:0:00| chol  1  2
10|0.693|0.713|2.3e-07|1.7e-05|1.6e-02| 2.294211e+01  2.293481e+01| 0:0:00| chol  2  2
11|0.628|0.578|1.6e-07|7.4e-06|8.0e-03| 2.293735e+01  2.293537e+01| 0:0:00| chol  2  2
12|0.482|0.533|1.3e-07|3.5e-06|4.7e-03| 2.293545e+01  2.293471e+01| 0:0:00| chol  2  2
13|0.443|0.518|9.9e-08|2.2e-05|4.5e-03| 2.293412e+01  2.293394e+01| 0:0:00| chol  2  2
14|0.477|0.512|7.6e-08|6.3e-05|3.6e-03| 2.293309e+01  2.293311e+01| 0:0:00| chol  2  2
15|0.544|0.514|1.1e-06|9.3e-05|2.2e-03| 2.293232e+01  2.293244e+01| 0:0:00| chol  3  3
16|0.619|0.517|4.4e-07|5.7e-05|1.1e-03| 2.293177e+01  2.293199e+01| 0:0:00| chol  3  4
17|0.605|0.507|3.5e-07|2.9e-05|6.5e-04| 2.293143e+01  2.293167e+01| 0:0:00| chol  5  6
18|0.583|0.501|3.7e-07|1.7e-05|4.1e-04| 2.293121e+01  2.293142e+01| 0:0:00| chol  9  8
19|0.567|0.497|1.9e-06|1.1e-05|2.7e-04| 2.293105e+01  2.293123e+01| 0:0:00| chol  8  9
20|0.550|0.493|1.5e-06|7.1e-06|1.8e-04| 2.293094e+01  2.293108e+01| 0:0:00| chol 11 10
21|0.531|0.488|4.5e-06|4.7e-06|1.2e-04| 2.293086e+01  2.293097e+01| 0:0:00| chol  9 11
22|0.510|0.482|5.7e-06|3.1e-06|8.2e-05| 2.293080e+01  2.293088e+01| 0:0:00| chol
  warning: symqmr failed: 0.3
  switch to LU factor. lu 30    1
23|0.491|0.477|2.9e-06|2.1e-06|5.7e-05| 2.293075e+01  2.293082e+01| 0:0:00| lu 30    1
24|0.473|0.472|1.5e-06|1.5e-06|4.0e-05| 2.293072e+01  2.293077e+01| 0:0:01| lu 28    1
25|0.363|0.460|9.7e-07|1.1e-06|3.1e-05| 2.293070e+01  2.293073e+01| 0:0:01| lu 13    1
  stop: progress in duality gap has deteriorated, 5.8e-05
26|0.045|0.133|9.7e-07|1.1e-06|3.1e-05| 2.293070e+01  2.293073e+01| 0:0:01|
-------------------------------------------------------------------
 number of iterations   = 26
 primal objective value =  2.29306980e+01
 dual   objective value =  2.29307325e+01
 gap := trace(XZ)        = 3.09e-05
 relative gap            = 6.59e-07
 actual relative gap     = -7.36e-07
 rel. primal infeas (scaled problem)   = 9.75e-07
 rel. dual     "          "         "  = 1.06e-06
 rel. primal infeas (unscaled problem) = 0.00e+00
 rel. dual     "          "         "  = 0.00e+00
 norm(X), norm(y), norm(Z) = 6.8e+05, 4.8e+01, 4.0e+01
 norm(A), norm(b), norm(C) = 3.9e+01, 3.2e+00, 2.0e+00
 Total CPU time (secs)  = 0.61
 CPU time per iteration = 0.02
 termination code       = -8
 DIMACS: 1.6e-06  0.0e+00  1.1e-06  0.0e+00  -7.4e-07  6.6e-07
-------------------------------------------------------------------

-------------------------------------------------------------
Status: Inaccurate/Solved
Optimal value (cvx_optval): +22.9307
```

```
m
```

```
m = 22.9307
```

И находим матрицу реглятора K:

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

```
K = 1×4
```

```
   0.0000   -1.6829   -2.2148   -0.2033
```

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

Далее определим корни матрицы A+BK:

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

```
BK = 4×1 complex
  -2.0000 + 9.6333i
  -2.0000 - 9.6333i
  -2.0000 + 0.0000i
  -7.0000 + 0.0000i
```

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