Problem 1

# **CODE:**

% PROBLEM 1

close all

clear

clc

% Define the system matrices

Ap = [0, 10, 2; -1, 1, 0; 0, 2, -5];

Ap\_bar = Ap + 0.2\*eye(3);

Bp = [0; 1; 0];

Cp = [1, 0, 0; 0, 0, 0];

Dp = [1; 0; 1];

By = [0; 1];

Dy = [0; 0];

Mp = [0, 1, 0];

Dz = 2;

% Convert to MATLAB notation

A = Ap\_bar;

B1 = Dp;

B2 = Bp;

C1 = Cp;

D11 = Dy;

D12 = By;

C2 = Mp;

D21 = Dz;

D22 = 0;

% LTI system

S = ltisys(A, [B1 B2], [C1; C2], [D11 D12; D21 D22]);

% H-infinity LMI

[gopt, G] = hinflmi(S,[1 1])

% Controller matrices

disp('H∞ controller:')

[Ac, Bc, Cc, Dc] = ltiss(G)

% Closed-loop system matrices

Acl = [Ap\_bar+Bp\*Dc\*Mp, Bp\*Cc; Bc\*Mp, Ac];

Bcl = [Dp+Bp\*Dc\*Dz; Bc\*Dz];

Ccl = [Cp+By\*Dc\*Mp, By\*Cc];

Dcl = Dy+By\*Dc\*Dz;

% Closed-loop system

Scl = ss(Acl, Bcl, Ccl, Dcl);

% Scl = slft(S, G);

% Verification

disp('H∞ norm:')

hinf\_norm = hinfnorm(Scl)

% hinf\_norm = norminf(Scl)

disp('Closed-loop poles:')

eig\_Acl = eig(Acl)

if((hinf\_norm < gopt) && all(real(eig\_Acl) < -0.2))

disp('Verification of H∞ norm and pole location constraints successful!')

else

disp('Verification of H∞ norm and pole location constraints failed!')

end

# **OUTPUT:**

Minimization of gamma:

Solver for linear objective minimization under LMI constraints

Iterations : Best objective value so far

1

2

3

4 21.011488

5 17.864947

6 15.385893

7 14.718282

8 14.718282

9 13.310861

10 13.310861

11 11.988542

12 11.988542

13 11.352617

14 11.352617

15 11.146445

16 11.125254

17 11.110262

18 11.110262

19 11.110262

\*\*\* new lower bound: 10.816366

20 11.081688

\*\*\* new lower bound: 11.010885

Result: feasible solution of required accuracy

best objective value: 11.081688

guaranteed relative accuracy: 6.39e-03

f-radius saturation: 0.188% of R = 1.00e+08

Optimal Hinf performance: 1.108e+01

gopt = 11.0815

G = 4×4

-4.9470 -6.4084 0.5375 2.0000

-0.5151 -33.3313 9.0153 0

-0.3907 -34.4295 5.4533 0

0 0 0 -Inf

H∞ controller:

Ac = 2×2

-4.9470 -6.4084

-0.5151 -33.3313

Bc = 2×1

0.5375

9.0153

Cc = 1×2

-0.3907 -34.4295

Dc = 5.4533

H∞ norm:

hinf\_norm = 11.0780

Closed-loop poles:

eig\_Acl = 5×1 complex

-23.2063 + 0.0000i

-1.6126 + 3.4277i

-1.6126 - 3.4277i

-4.9193 + 0.0000i

-4.8744 + 0.0000i

Verification of H∞ norm and pole location constraints successful!

# **SCREENSHOT:**

