ELEC 7500

Project 3

Xing Wang

**%% Problem 1**

**>> A1 = [0 1 0;**

**0 0 1;**

**-15 -23 -9];**

**>> eig(A1)**

**ans =**

**-1.0000**

**-3.0000**

**-5.0000**

**% Since all 3 eigenvalues have negative real part, the system is asymptotically stable.**

**>> A2 = [-7 1 0;**

**-7 0 1;**

**15 0 0];**

**>> eig(A2)**

**ans =**

**-5.0000**

**-3.0000**

**1.0000**

**% Since one of the 3 eigenvalues has positive real part, the system is NOT stable.**

**>> A3 = [0 1 0;**

**0 0 1;**

**0 -15 -8];**

**>> eig(A3)**

**ans =**

**0**

**-3**

**-5**

**% Since all 3 eigenvalues have negative semidefinite real part, the system is stable; but one of them is 0, the system is not asymptotically stable.**

**>> A4 = [0 0 0;**

**0 0 0;**

**0 0 -1];**

**>> [M, S] = eig(A4)**

**M =**

**0 0 1**

**0 1 0**

**1 0 0**

**S =**

**-1 0 0**

**0 0 0**

**0 0 0**

**% The 3 eigenvalues are -1, 0, and 0, on the diagonal of S. All have negative semidefinite real part, and the two zero eigenvalues have distinct eigenvectors, thus the system is stable (but not asymptotically stable).**

**>> A5 = [0 1 0;**

**0 0 0;**

**0 0 -1];**

**>> [M, S] = eig(A5)**

**M =**

**1.0000 -1.0000 0**

**0 0.0000 0**

**0 0 1.0000**

**S =**

**0 0 0**

**0 0 0**

**0 0 -1**

**% The 3 eigenvalues are 0, 0, and -1. The two 0 eigenvalues have the same eigenvector . Therefore, this system is NOT stable.**

**>> A6 = [0 1 0;**

**1 0 0;**

**0 0 -1];**

**>> [M6, S6] = eig(A6)**

**M6 =**

**-0.7071 0 0.7071**

**0.7071 0 0.7071**

**0 1.0000 0**

**S6 =**

**-1 0 0**

**0 -1 0**

**0 0 1**

**% The eigenvalues are -1, -1, and 1. Since one of the 3 eigenvalues has positive real part, the system is NOT stable.**

**%% Problem 6(b)**

**% We verify the solution by simulating the state dynamics in MATLAB.**

**>> u = exp(1)/(1-exp(1)) \* ones(size(t));**

**>> A = [-1 0;**

**0 1];**

**>> B = [0 1]';**

**>> C = [0 1];**

**>> x0 = [0 1];**

**>> t = 0:0.01:1;**

**>> sys = ss(A, B, C, 0)**

**>> [y, t, x] = lsim(sys, u, t, x0);**

**>> xx1 = x(:, 1);**

**>> xx2 = x(:, 2);**

**>> plot(t, xx1, t, xx2)**

**>> legend('x[1]', 'x[2]')**

**>> xlabel('t')**

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**% From the above plot, we see that with the constant impulse between time 0 and 1, the first coordinate of x always stays at 0, while the second coordinate of x gradually decreases to 0 at time 1, starting from 1 at time 0.**