Project_Code_2a.m

By Joshua Norlin This project code calculates the characteristic exponents of the rotor system with reversed flow for values B=0.98 and p=1, determines the stability of the system, and plots the results. Stable1 and Stable2 contain a true/false analysis for each characteristic exponent's stability, and Nu contains the characteristic exponent pairs. For gamma=0:16, values 1:17 correspond with mu=0, values 18:34 correspond with mu=1, and values 35:51 correspond with mu=2.

```
t = 0:pi/8:2*pi;
conditions1 = [1 0];
conditions2 = [0 1];
Q = []; % Matrix of transition matricies; Values 1:34 are for mu=0,
 35:69
% are for mu=1, 70:102 are for mu=2.
Lambda = []; % Eigenvalues of transition matricies
Nu = []; % Natural logarithms of transition matricies
Stable1 = []; % Values of stability for Nu, 1=stable, 0=unstable
Stable2 = []; % Values of stability for Nu, 1=stable, 0=unstable
% Values 1:17 are for mu=0, gamma=0:16, 18:34 are for mu=1, and 35:51
 are
% for mu=2.
for mu = 0:2
    for gamma = 0:16
        [t,beta2] =
 ode45(@(t,beta)rhs(t,beta,mu,gamma),t,conditions2);
        [t,beta1] =
 ode45(@(t,beta)rhs(t,beta,mu,gamma),t,conditions1);
        Beta1 = beta1(:,1);
        Beta2 = beta2(:,1);
        dBeta1dt = beta1(:,2);
        dBeta2dt = beta2(:,2);
        period1a = Beta1(length(t));
        period1b = dBeta1dt(length(t));
        period2a = Beta2(length(t));
        period2b = dBeta2dt(length(t));
        q = [period1a period2a; period1b period2b];
        lambda = eig(q);
        nu = (1/(2*pi))*log(lambda);
        if real(nu(1)) <= 0
            stable1 = 1;
        elseif real(nu(1)) > 0
            stable1 = 0;
        end
        Stable1 = [Stable1 stable1];
        if real(nu(2)) <= 0
            stable2 = 1;
        elseif real(nu(2)) > 0
            stable2 = 0;
        end
        Stable2 = [Stable2 stable2];
        Q = [Q q];
        Lambda = [Lambda lambda];
```

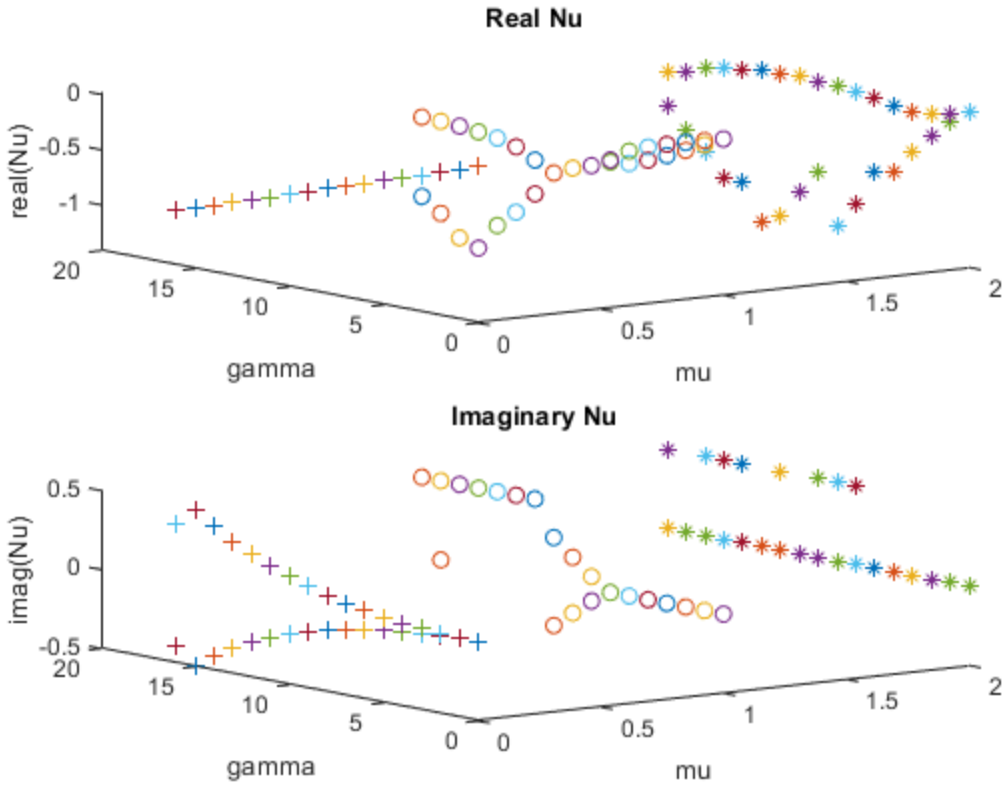
```
        Nu = [Nu nu];
    end
end
figure
hold on
mu = 0:2;
gamma = 0:16;
subplot(2,1,1)
for i = 1:length(gamma)
    plot3(mu(1),gamma(i),real(Nu(:,i)),'+')
    hold on
    plot3(mu(2),gamma(i),real(Nu(:,17+i)),'o')
    hold on
    plot3(mu(3),gamma(i),real(Nu(:,34+i)),'*')
    hold on
end
title('Real Nu')
xlabel('mu')
ylabel('gamma')
zlabel('real(Nu)')
subplot(2,1,2)
for i = 1:length(gamma)
     plot3(mu(1),gamma(i),imag(Nu(:,i)),'+')
    hold on
    plot3(mu(2),gamma(i),imag(Nu(:,17+i)),'o')
    hold on
    plot3(mu(3),gamma(i),imag(Nu(:,34+i)),'*')
    hold on
end
title('Imaginary Nu')
xlabel('mu')
ylabel('gamma')
zlabel('imag(Nu)')
Nu
Stable1
Stable2


function dbetadt = rhs(t,beta,mu,gamma)
B = 0.98;
p = 1;
K1 = gamma.*((B.^3).*mu.*cos(t)/6 + (B.^2).*(mu.^2).*sin(2.*t)/8);
K2 = K1 + gamma.*(mu.^4)*(-sin(2.*t)/24 + sin(4.*t)/48);
K3 = -K1;
C1 = gamma.*((B.^4)/8 + (B.^3).*mu.*sin(t)/6);
C2 = C1 + gamma.*(mu.^4).*(1/32 - cos(2.*t)/24 - cos(4.*t)/96);
C3 = -C1;
if mu*sin(t) > -B && mu*sin(t) < 0
    K = K2;
    C = C2;
elseif mu*sin(t) <= -B
    K = K3;
    C = C3;
else
```

```
    K = K1;
    C = C1;
end
dbetadt_1 = beta(2);
dbetadt_2 = -(p.^2 + K).*beta(1) - C.*beta(2);
dbetadt = [dbetadt_1; dbetadt_2];
end
```

```
Nu =

  Columns 1 through 4

  -0.0000 + 0.0000i  -0.0577 + 0.0016i  -0.1153 + 0.0067i  -0.1730 +
 0.0151i
  -0.0000 - 0.0000i  -0.0577 - 0.0016i  -0.1153 - 0.0067i  -0.1730 -
 0.0151i

  Columns 5 through 8

  -0.2306 + 0.0270i  -0.2883 + 0.0425i  -0.3459 + 0.0618i  -0.4035 +
 0.0851i
  -0.2306 - 0.0270i  -0.2883 - 0.0425i  -0.3459 - 0.0618i  -0.4035 -
 0.0851i

  Columns 9 through 12

  -0.4612 + 0.1127i  -0.5188 + 0.1452i  -0.5764 + 0.1829i  -0.6341 +
 0.2268i
  -0.4612 - 0.1127i  -0.5188 - 0.1452i  -0.5764 - 0.1829i  -0.6341 -
 0.2268i

  Columns 13 through 16

  -0.6917 + 0.2779i  -0.7494 + 0.3379i  -0.8071 + 0.4095i  -0.8648 +
 0.4977i
  -0.6917 - 0.2779i  -0.7494 - 0.3379i  -0.8071 - 0.4095i  -0.8648 -
 0.4977i

  Columns 17 through 20

  -0.9224 + 0.3863i  -0.0000 + 0.0000i  -0.0470 + 0.0000i  -0.0971 +
 0.0000i
  -0.9224 - 0.3863i  -0.0000 - 0.0000i  -0.0848 + 0.0000i  -0.1686 +
 0.0000i

  Columns 21 through 24

  -0.1472 + 0.0000i  -0.2039 + 0.0000i  -0.2737 + 0.0000i  -0.3861 +
 0.0000i
  -0.2483 + 0.0000i  -0.3226 + 0.0000i  -0.3852 + 0.0000i  -0.4050 +
 0.0000i

  Columns 25 through 28
```

```
  -0.4702 + 0.0772i  -0.5251 + 0.1761i  -0.6016 + 0.2781i  -0.8242 +
0.5000i
  -0.4702 - 0.0772i  -0.5251 - 0.1761i  -0.6016 - 0.2781i  -0.5184 +
0.5000i

  Columns 29 through 32

  -1.0221 + 0.5000i  -1.1758 + 0.5000i  -1.4131 + 0.5000i  -1.3522 +
0.5000i
  -0.4316 + 0.5000i  -0.3853 + 0.5000i  -0.3613 + 0.5000i  -0.3417 +
0.5000i

  Columns 33 through 36

  -1.1650 + 0.0000i  -1.0437 + 0.5000i  -0.0000 + 0.0000i  -0.0646 +
0.0000i
  -0.3323 + 0.5000i  -0.3258 + 0.5000i  -0.0000 - 0.0000i  -0.1240 +
0.0000i

  Columns 37 through 40

  -0.0975 + 0.0000i  -0.0978 + 0.0000i  -0.0808 + 0.0000i  -0.0481 +
0.0000i
  -0.2807 + 0.0000i  -0.4735 + 0.0000i  -0.6737 + 0.0000i  -0.7207 +
0.0000i

  Columns 41 through 44

  -0.0198 + 0.0000i   0.0021 + 0.0000i   0.0036 + 0.0000i   0.0167 +
0.0000i
  -1.0432 + 0.5000i  -1.2732 + 0.5000i  -0.8111 + 0.5000i  -1.0306 +
0.0000i

  Columns 45 through 48

   0.0139 + 0.0000i   0.0134 + 0.0000i  -0.0173 + 0.0000i  -0.0405 +
0.0000i
  -1.2666 + 0.5000i  -1.3624 + 0.0000i  -1.0386 + 0.5000i  -1.0320 +
0.5000i

  Columns 49 through 51

  -0.0709 + 0.0000i  -0.1383 + 0.0000i  -0.1663 + 0.0000i
  -0.8255 + 0.5000i  -0.6533 + 0.0000i  -0.4841 + 0.5000i


Stable1 =

  Columns 1 through 13

     1     1     1     1     1     1     1     1     1     1     1
 1     1
```

```
  Columns 14 through 26

     1     1     1     1     1     1     1     1     1     1     1
 1     1

  Columns 27 through 39

     1     1     1     1     1     1     1     1     1     1     1
 1     1

  Columns 40 through 51

     1     1     0     0     0     0     0     1     1     1     1
 1


Stable2 =

  Columns 1 through 13

     1     1     1     1     1     1     1     1     1     1     1
 1     1

  Columns 14 through 26

     1     1     1     1     1     1     1     1     1     1     1
 1     1

  Columns 27 through 39

     1     1     1     1     1     1     1     1     1     1     1
 1     1

  Columns 40 through 51

     1     1     1     1     1     1     1     1     1     1     1
 1
```



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