Project_Code_2.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=0.8, 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];
```

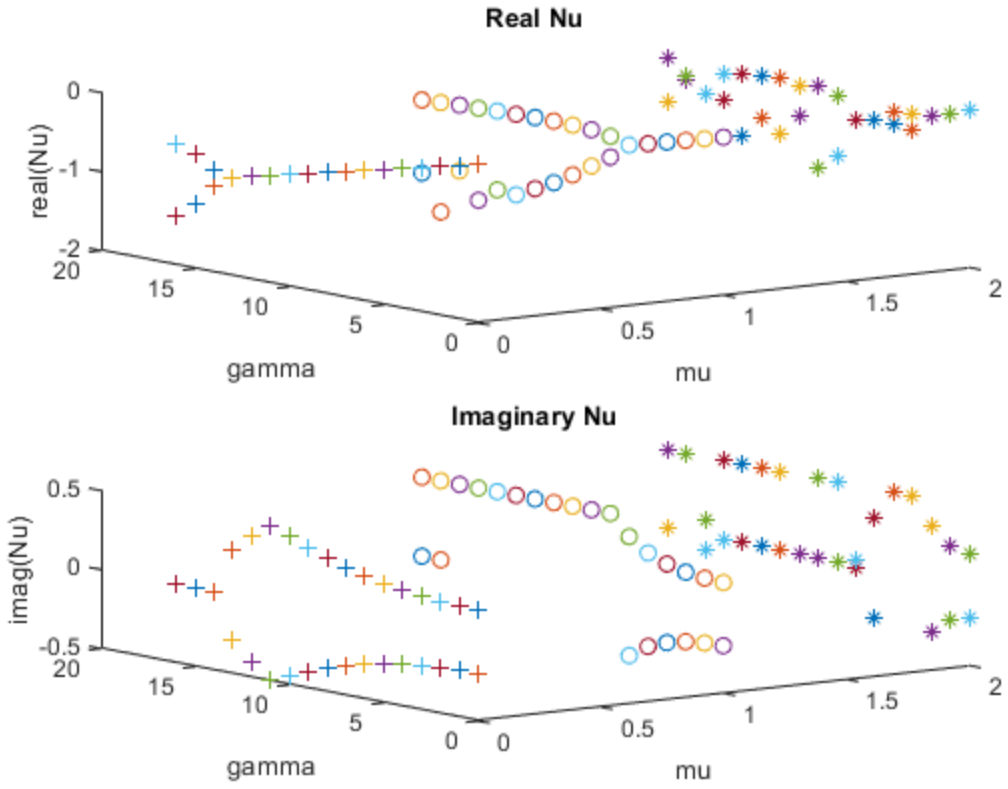
```
        Nu = [Nu nu];
    end
end
figure
hold on
mu = 0:2;
gamma = 0:16;
subplot(2,1,1)
for i = 1:length(gamma)
    plot3(mu(1),gamma(i),real(Nu(:,i)),'+')
    hold on
    plot3(mu(2),gamma(i),real(Nu(:,17+i)),'o')
    hold on
    plot3(mu(3),gamma(i),real(Nu(:,34+i)),'*')
    hold on
end
title('Real 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 = 0.8;
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 + 0.2000i  -0.0577 + 0.2021i  -0.1153 + 0.2084i  -0.1730 +
 0.2189i
  -0.0000 - 0.2000i  -0.0577 - 0.2021i  -0.1153 - 0.2084i  -0.1730 -
 0.2189i

  Columns 5 through 8

  -0.2306 + 0.2340i  -0.2882 + 0.2537i  -0.3459 + 0.2786i  -0.4035 +
 0.3092i
  -0.2306 - 0.2340i  -0.2882 - 0.2537i  -0.3459 - 0.2786i  -0.4035 -
 0.3092i

  Columns 9 through 12

  -0.4612 + 0.3463i  -0.5188 + 0.3911i  -0.5765 + 0.4453i  -0.6341 +
 0.4877i
  -0.4612 - 0.3463i  -0.5188 - 0.3911i  -0.5765 - 0.4453i  -0.6341 -
 0.4877i

  Columns 13 through 16

  -0.6918 + 0.4018i  -0.7494 + 0.2799i  -0.7005 + 0.0000i  -0.5365 +
 0.0000i
  -0.6918 - 0.4018i  -0.7494 - 0.2799i  -0.9137 + 0.0000i  -1.1928 +
 0.0000i

  Columns 17 through 20

  -0.4633 + 0.0000i  -0.0000 + 0.2000i  -0.0661 + 0.2053i  -0.1328 +
 0.2200i
  -1.3811 + 0.0000i  -0.0000 - 0.2000i  -0.0661 - 0.2053i  -0.1328 -
 0.2200i

  Columns 21 through 24

  -0.1993 + 0.2488i  -0.2660 + 0.2952i  -0.3288 + 0.3761i  -0.5284 +
 0.5000i
  -0.1993 - 0.2488i  -0.2660 - 0.2952i  -0.3288 - 0.3761i  -0.2646 +
 0.5000i

  Columns 25 through 28
```

```
  -0.6869 + 0.5000i  -0.8431 + 0.5000i  -0.9887 + 0.5000i  -1.1105 +
0.5000i
  -0.2272 + 0.5000i  -0.2144 + 0.5000i  -0.2096 + 0.5000i  -0.2099 +
0.5000i

  Columns 29 through 32

  -1.2340 + 0.5000i  -1.2174 + 0.5000i  -1.3936 + 0.5000i  -1.0683 +
0.5000i
  -0.2141 + 0.5000i  -0.2197 + 0.5000i  -0.2298 + 0.5000i  -0.2367 +
0.5000i

  Columns 33 through 36

  -1.6341 + 0.0000i  -1.1873 + 0.0000i  -0.0000 + 0.2000i  -0.0967 +
0.2348i
  -0.2497 + 0.5000i  -0.2626 + 0.5000i  -0.0000 - 0.2000i  -0.0967 -
0.2348i

  Columns 37 through 40

  -0.1856 + 0.3363i  -0.4062 + 0.5000i  -0.3751 + 0.5000i  -0.3730 +
0.3197i
  -0.1856 - 0.3363i  -0.1871 + 0.5000i  -0.2104 + 0.5000i  -0.3730 -
0.3197i

  Columns 41 through 44

  -0.4139 + 0.0259i  -0.1438 + 0.0000i  -0.0823 + 0.0000i  -0.1261 +
0.0000i
  -0.4139 - 0.0259i  -0.9073 + 0.5000i  -1.1089 + 0.5000i  -0.4889 +
0.0000i

  Columns 45 through 48

  -0.0483 + 0.0000i  -0.0799 + 0.0000i  -0.0963 + 0.0000i  -0.1402 +
0.0000i
  -0.7801 + 0.5000i  -0.6214 + 0.5000i  -0.8838 + 0.5000i  -0.4801 +
0.5000i

  Columns 49 through 51

  -0.4520 + 0.0953i  -0.3042 + 0.5000i  -0.6292 + 0.0000i
  -0.4520 - 0.0953i  -0.2537 + 0.5000i  -0.0951 + 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     1     1     1     1     1     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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