Project_Code_4.m

By Joshua Norlin This project code calculates the characteristic exponents of the rotor system with reversed flow stalling for values B=1 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];
```

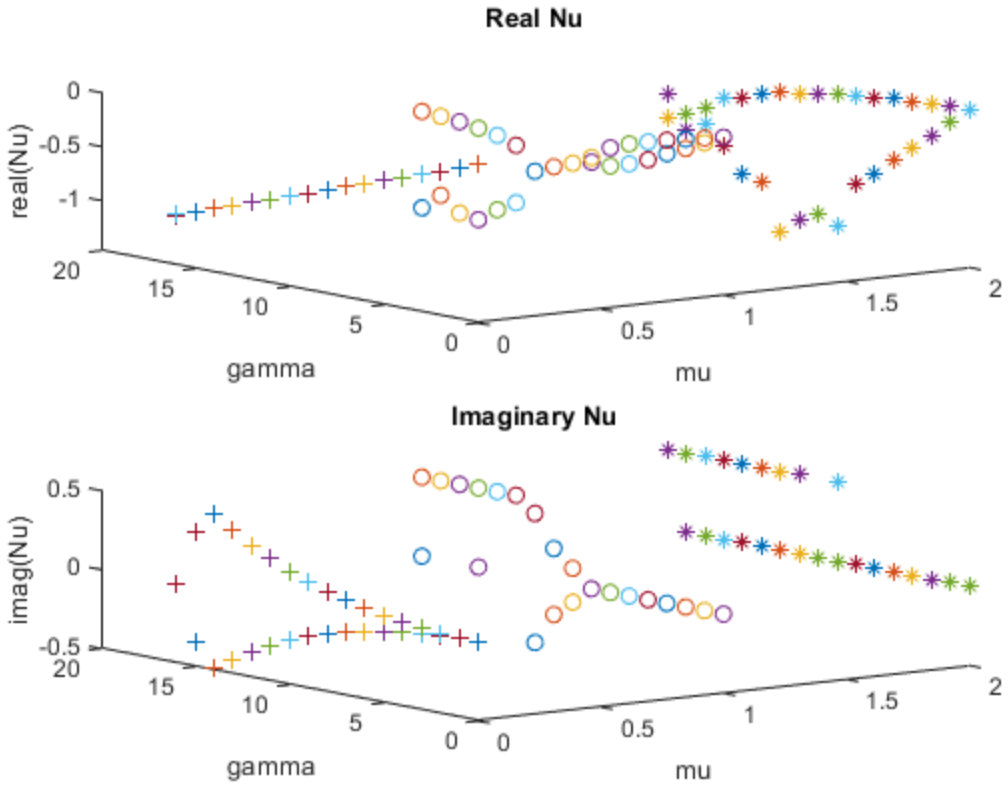
```
        Nu = [Nu nu];
    end
end
figure
hold on
mu = 0:2;
gamma = 0:16;
subplot(2,1,1)
for i = 1:length(gamma)
    plot3(mu(1),gamma(i),real(Nu(:,i)),'+')
    hold on
    plot3(mu(2),gamma(i),real(Nu(:,17+i)),'o')
    hold on
    plot3(mu(3),gamma(i),real(Nu(:,34+i)),'*')
    hold on
end
title('Real 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 = 1;
p = 1;
K1 = gamma.*((B.^3).*mu.*cos(t)/6 + (B.^2).*(mu.^2).*sin(2.*t)/8);
K2 = (1/2)*(K1 + gamma.*(mu.^4)*(-sin(2.*t)/24 + sin(4.*t)/48));
K3 = 0;
C1 = gamma.*((B.^4)/8 + (B.^3).*mu.*sin(t)/6);
C2 = (1/2)*(C1 + gamma.*(mu.^4).*(1/32 - cos(2.*t)/24 -
 cos(4.*t)/96));
C3 = 0;
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  -0.0625 + 0.0019i  -0.1250 + 0.0078i  -0.1875 +
 0.0177i
  -0.0000 - 0.0000i  -0.0625 - 0.0019i  -0.1250 - 0.0078i  -0.1875 -
 0.0177i

  Columns 5 through 8

  -0.2500 + 0.0318i  -0.3125 + 0.0501i  -0.3750 + 0.0730i  -0.4375 +
 0.1008i
  -0.2500 - 0.0318i  -0.3125 - 0.0501i  -0.3750 - 0.0730i  -0.4375 -
 0.1008i

  Columns 9 through 12

  -0.5000 + 0.1340i  -0.5625 + 0.1732i  -0.6250 + 0.2194i  -0.6875 +
 0.2738i
  -0.5000 - 0.1340i  -0.5625 - 0.1732i  -0.6250 - 0.2194i  -0.6875 -
 0.2738i

  Columns 13 through 16

  -0.7500 + 0.3385i  -0.8125 + 0.4170i  -0.8751 + 0.4841i  -0.9375 +
 0.3480i
  -0.7500 - 0.3385i  -0.8125 - 0.4170i  -0.8751 - 0.4841i  -0.9375 -
 0.3480i

  Columns 17 through 20

  -0.9979 + 0.0000i  -0.0000 + 0.0000i  -0.0415 + 0.0000i  -0.0841 +
 0.0000i
  -1.0021 + 0.0000i  -0.0000 - 0.0000i  -0.0862 + 0.0000i  -0.1727 +
 0.0000i

  Columns 21 through 24

  -0.1288 + 0.0000i  -0.1777 + 0.0000i  -0.2304 + 0.0000i  -0.3000 +
 0.0000i
  -0.2535 + 0.0000i  -0.3430 + 0.0000i  -0.4155 + 0.0000i  -0.4693 +
 0.0000i
```

```
 Columns 25 through 28

  -0.4227 + 0.0000i  -0.5098 + 0.1068i  -0.5761 + 0.2088i  -0.6514 +
0.4085i
  -0.4667 + 0.0000i  -0.5098 - 0.1068i  -0.5761 - 0.2088i  -0.6514 -
0.4085i

 Columns 29 through 32

  -0.9762 + 0.5000i  -1.0756 + 0.5000i  -1.2009 + 0.0000i  -1.1730 +
0.5000i
  -0.4446 + 0.5000i  -0.3859 + 0.5000i  -0.3530 + 0.5000i  -0.3267 +
0.5000i

 Columns 33 through 36

  -1.0425 + 0.5000i  -1.1917 + 0.0000i  -0.0000 + 0.0000i  -0.0067 +
0.0000i
  -0.3104 + 0.5000i  -0.2987 + 0.5000i  -0.0000 - 0.0000i  -0.1522 +
0.0000i

 Columns 37 through 40

  -0.0153 + 0.0000i  -0.0277 + 0.0000i  -0.0354 + 0.0000i  -0.0556 +
0.0000i
  -0.3057 + 0.0000i  -0.4501 + 0.0000i  -0.6026 + 0.0000i  -0.7577 +
0.0000i

 Columns 41 through 44

  -0.0725 + 0.0000i  -0.0957 + 0.0000i  -0.1240 + 0.0000i  -0.1580 +
0.0000i
  -0.8916 + 0.0000i  -1.3065 + 0.5000i  -1.2387 + 0.0000i  -1.3301 +
0.5000i

 Columns 45 through 48

  -0.1812 + 0.0000i  -0.2261 + 0.0000i  -0.2962 + 0.0000i  -0.3283 +
0.0000i
  -1.4646 + 0.5000i  -1.0477 + 0.5000i  -0.9919 + 0.5000i  -0.7722 +
0.5000i

 Columns 49 through 51

  -0.4656 + 0.0000i  -0.6907 + 0.0000i  -0.6074 + 0.5000i
  -0.6069 + 0.5000i  -0.5410 + 0.5000i  -0.3958 + 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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