

```

1  %% Torsional System Simulation
2  clear; clc; close all;
3
4  %% System Parameters
5  J1 = 0.01; %Nms^2/rad
6  J2 = 0.1; %Nms^2/rad
7  K = 20; %N/rad
8  T_s = 0.2; %step input torque (Nm)
9  T0 = 0.0; %coulomb friction
10
11 %% Function defining first-order ODE system of equations
12 function dxdt = torsionalSystem(~, x, J1, J2, K, T_s, T0, C)
13
14     dx1 = x(2);
15     dx2 = (T_s-K*(x(1)-x(3)))/J1;
16     dx3 = x(4);
17     dx4 = (K*(x(1)-x(3))-T0*sign(x(4))-C*abs(x(4))*x(4))/J2;
18
19     dxdt = [dx1; dx2; dx3; dx4];
20 end
21
22 %% Simulation time
23 t_s = [0, 5];
24 t_e = linspace(0, 5, 1000);
25
26 %% Simulation values of C
27 C_v = [0.5, 1.0, 2.5, 5.0];
28
29 figure('Color', 'w');
30 hold on;
31
32 %% Iteration
33 for C = C_v
34
35     x0 = [0; 0; 0; 0]; %initial conditions
36
37     % First-Order ODE system solution
38     [t, x] = ode45(@(t, x)... ...
39     torsionalSystem(t, x, J1, J2, K, T_s, T0, C), t_e, x0);
40
41     % Plot for x4, Omega2
42     plot(t, x(:, 4), 'LineWidth', 1.5, 'DisplayName', ['C = ', num2str(C)]);
43 end
44 %% Plot
45 title('Step Response: State Variable x_4 for varying Damping C');
46 xlabel('Time (s)');
47 ylabel('State Variable x_4 (rad/s)');
48 legend('Location', 'SouthEast');
49 grid on;
50 hold off;

```