

```

1 clear;
2 clc;
3 close all;
4
5 %% Model
6 dxdt = @(t, x) x * (x^2 - 1);
7 tspan = [0 6];
8 initial_conditions_group1 = [-1.00001, -1, -0.99999, 1.00001, 1, 0.99999];
9 initial_conditions_group2 = [-0.9, -0.8, -0.5, -0.1, 0, 0.1, 0.5, 0.8, 0.9];
10
11 %% around -1 & 1
12 figure;
13 for i = 1:length(initial_conditions_group1)
14     x0 = initial_conditions_group1(i);
15
16     [t, x] = ode45(dxdt, tspan, x0);
17
18     subplot(2, 3, i);
19     plot(t, x, 'DisplayName', 'Nonlinear System');
20     hold on;
21
22     x_linear_minus_1 = -1 + (x0 + 1) * exp(2 * t);
23     plot(t, x_linear_minus_1, '--', 'DisplayName', 'Linearized around x=-1');
24
25     x_linear_0 = x0 * exp(-t);
26     plot(t, x_linear_0, '-.', 'DisplayName', 'Linearized around x=0');
27
28     x_linear_1 = 1 + (x0 - 1) * exp(2 * t);
29     plot(t, x_linear_1, ':', 'DisplayName', 'Linearized around x=1');
30
31     title(['x(0) = ', num2str(x0)]);
32     xlabel('Time');
33     ylabel('x(t)');
34     ylim([-2, 2]);
35     legend;
36     grid on;
37     hold off;
38 end
39
40 %% around 0
41 figure;
42 for i = 1:length(initial_conditions_group2)
43     x0 = initial_conditions_group2(i);
44
45     [t, x] = ode45(dxdt, tspan, x0);
46
47     subplot(3, 3, i);
48     plot(t, x, 'DisplayName', 'Nonlinear System');
49     hold on;
50
51     x_linear_minus_1 = -1 + (x0 + 1) * exp(2 * t);
52     plot(t, x_linear_minus_1, '--', 'DisplayName', 'Linearized around x=-1');
53
54     x_linear_0 = x0 * exp(-t);
55     plot(t, x_linear_0, '-.', 'DisplayName', 'Linearized around x=0');
56
57     x_linear_1 = 1 + (x0 - 1) * exp(2 * t);
58     plot(t, x_linear_1, ':', 'DisplayName', 'Linearized around x=1');
59
60     title(['x(0) = ', num2str(x0)]);
61     xlabel('Time');
62     ylabel('x(t)');
63     ylim([-1.1, 1.1]);
64     legend;
65     grid on;
66     hold off;
67 end
68

```

