EE352 Automatic Control Assignment - Question 3

Iterative Reduction of dd

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1. Define System Parameters

```
clc;
clear;
close all;

% User Parameters (DOB: 2003-01-18)
yy = 3;
mm = 1;
dd = 18;
SE = 291;

fprintf('Parameters: yy=%d, mm=%d, dd=%d, SE=%d\n', yy, mm, dd, SE);
```

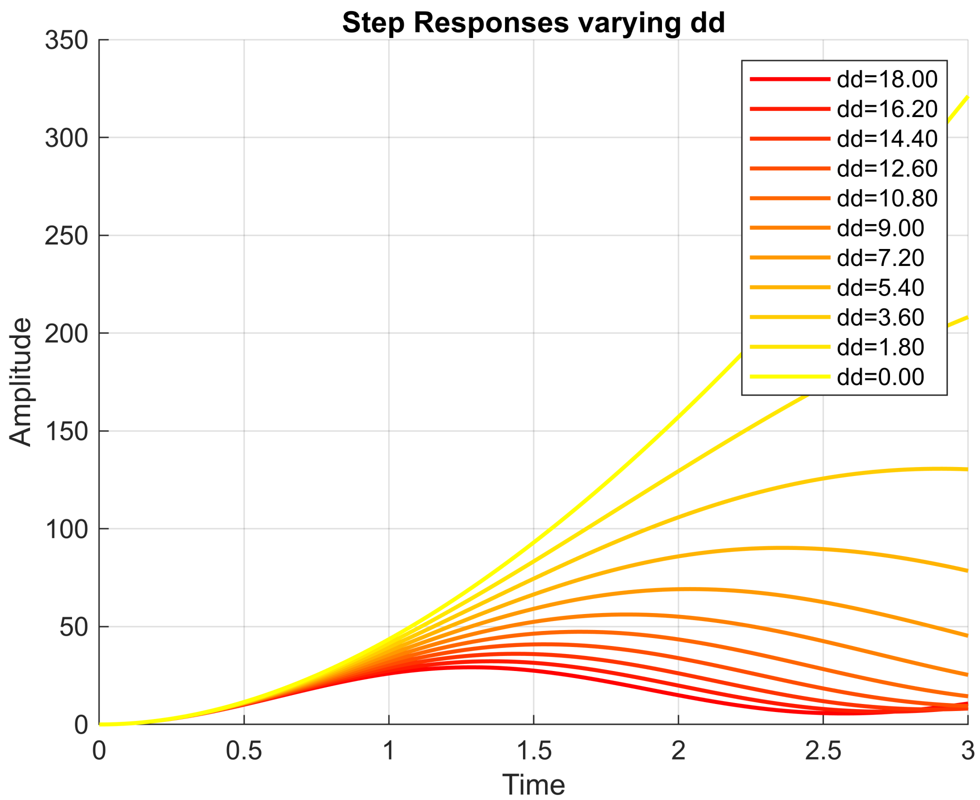
```
Parameters: yy=3, mm=1, dd=18, SE=291
```

Q3: Effect of Stiffness (dd) reduction

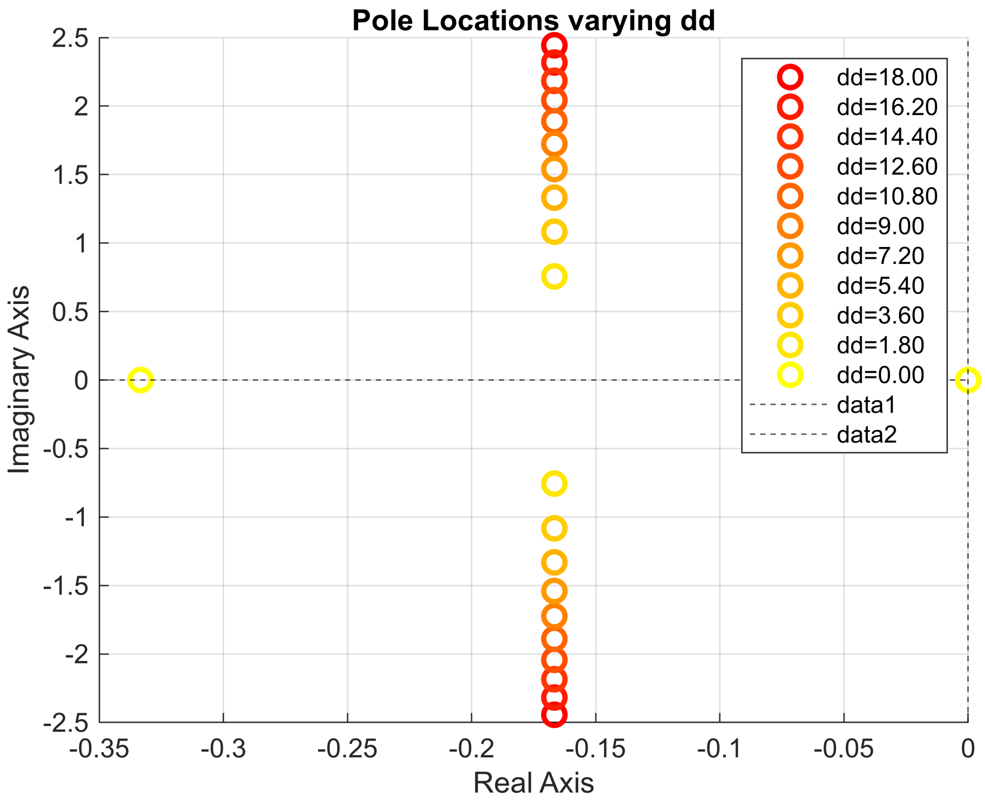
We will reduce the value of dd in 10 equal steps to zero.

```
num = [SE];
dd_values = linspace(dd, 0, 11); % Range from dd down to 0

% Prepare Figures
fig_resp = figure('Name', 'Q3: Step Responses');
hold on;
title('Step Responses varying dd');
xlabel('Time'); ylabel('Amplitude');

fig_poles = figure('Name', 'Q3: Pole Locations');
hold on;
title('Pole Locations varying dd');
xlabel('Real Axis'); ylabel('Imaginary Axis');
grid on; xline(0,'k--'); yline(0,'k--');

colors = autumn(length(dd_values));

% Iteration Loop
for i = 1:length(dd_values)
    curr_dd = dd_values(i);
    curr_den = [yy, mm, curr_dd];

    % Create temp TF
    G_temp = tf(num, curr_den);
```

```
    % Plot Step Response
    figure(fig_resp);
    [y, t] = step(G_temp, 3);
    plot(t, y, 'Color', colors(i,:), 'LineWidth', 1.5, ...
        'DisplayName', sprintf('dd=%.2f', curr_dd));

    % Plot Poles
    figure(fig_poles);
    p = roots(curr_den);
    plot(real(p), imag(p), 'o', 'Color', colors(i,:), 'LineWidth', 2,
'MarkerSize', 8, ...
        'DisplayName', sprintf('dd=%.2f', curr_dd));
end

figure(fig_resp); legend show; grid on;
```




```
figure(fig_poles); legend show;
```



Q3c: Explanation of Result for dd = 0

Observation:

As dd reduces, the natural frequency of the system changes.

At dd = 0: The denominator becomes $yy \cdot s^2 + mm \cdot s = s(yy \cdot s + mm)$. One pole is located exactly at the origin ($s = 0$) and the other at $s = -mm/yy$. A pole at the origin acts as a pure integrator. Consequently, the step response becomes a ramp function (unbounded growth over time).