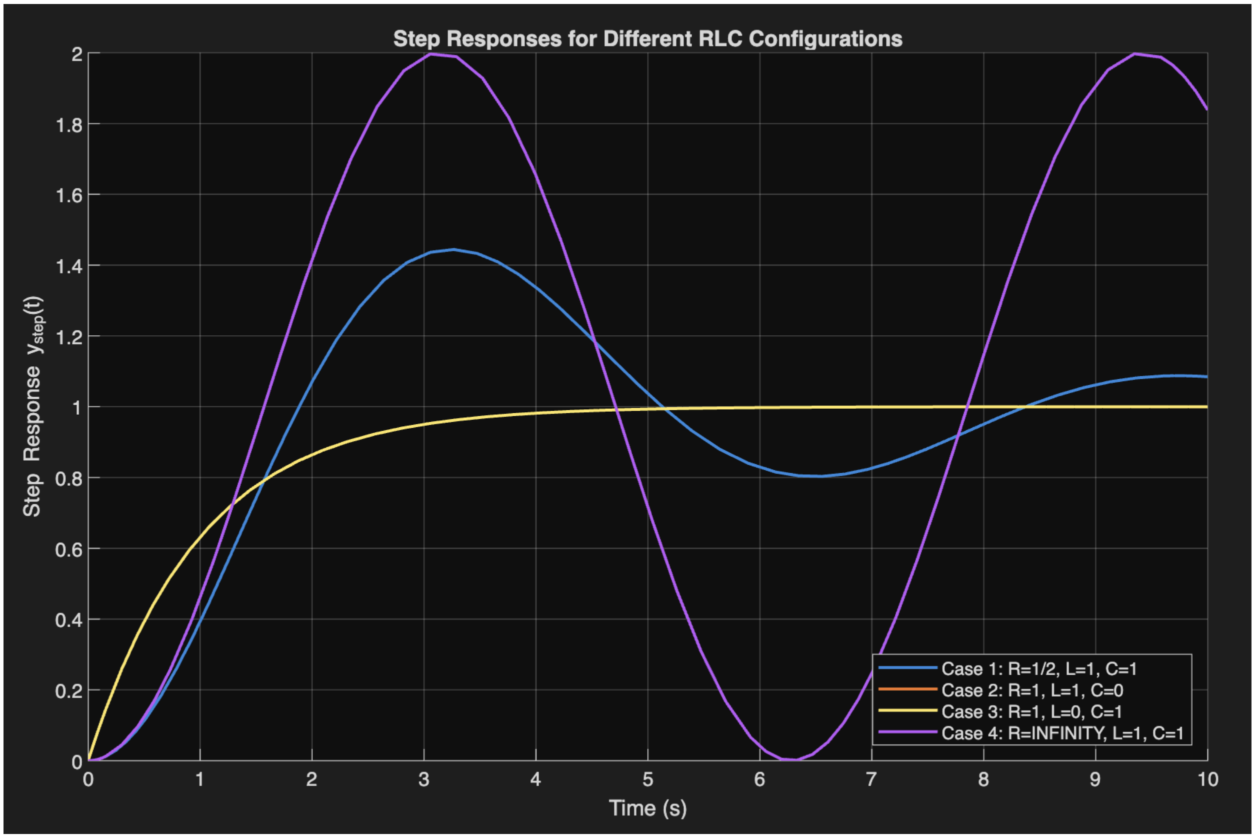

Problem 1:
The circuit consists of an inductor L in series with a parallel RC branch. Using the imepdenace relationships $Z_L = sL$, $Z_R = R$, and $Z_C = 1/(sC)$, the resulting equivalent impedance of the parallel branch is $Z_{RC} = 1/(1/R + sC)$. The total impedance of the circuit is $Z_{Total} = sL + Z_{RC}$. By applying the voltage divider rule, the transfer function becomes
$H(s) = Z_{RC}/Z_{Total} = 1/[1+sL(1/R+sC)]$. This equation represents the general relationship between the output and input voltages in the frequency domain. In the MATLAB implementation, this transfer function was applied directly through differential equations equivalent to each case of the circuit.

Problem 2:
The step responses of the four circuit configurations were computed numerically using MATLAB's ode45 solver. This is used to integrate the circuit's differential equations in the time domain. Each circuit type, RLC, RL, RC, and LC, was modeled by its corresponding first or second order differential equation that was derived from Kirchhoff's voltage law. A unit step input was used, and the system was simulated over the domain 0 to 10. The resulting plots demonstrate unique behaviors. The RLC case showed an underdamped oscillatory response. The

RL and RC cases exhibited exponential rises to steady-state. The LC circuit produced undamped oscillations due to the absence of resistance. Each plot was properly labeled with time and response axes. All cases were plotted in one figure so we could easily point out the differences in transient behavior among configurations. In the graph, the cases that create an RC circuit and an LC circuit overlap, hence the reason only 3 lines are visible.

Appendix:

```
% Computer Assignment 5 -- Luis Kligman
clear;
clc;
close all;
tspan = [0 10];  % simulation time
titles = {
   'Case 1: R=1/2, L=1, C=1'
   'Case 2: R=1, L=1, C=0'
   'Case 3: R=1, L=0, C=1'
   'Case 4: R=INFINITY, L=1, C=1'
};
cases = {
   struct('R', 0.5, 'L', 1, 'C', 1),    % Case 1
   struct('R', 1,   'L', 1, 'C', 0),    % Case 2 (RL)
   struct('R', 1,   'L', 0, 'C', 1),    % Case 3 (RC)
   struct('R', inf, 'L', 1, 'C', 1)     % Case 4 (LC open circuit)
};
figure; hold on;
for i = 1:4
   R = cases{i}.R;
   L = cases{i}.L;
   C = cases{i}.C;
   if isinf(R)
       % LC: L * d²y/dt² + (1/C)*y = input
       f = @(t, y) [y(2); (1/L)*(1 - y(1)/C)];
       y0 = [0; 0];
   elseif C == 0
       % RL: L * dy'/dt + R*y = 1 (step input)
       f = @(t, y) (1/L)*(1 - R*y);
       [t, y] = ode45(@(t, y) f(t, y), tspan, 0);
       plot(t, y, 'LineWidth', 1.5);
       continue;
   elseif L == 0
       % RC: dy/dt = (1/(R*C))*(1 - y)
       f = @(t, y) (1/(R*C))*(1 - y);
       [t, y] = ode45(@(t, y) f(t, y), tspan, 0);
       plot(t, y, 'LineWidth', 1.5);
       continue;
   else
       % RLC: L*y'' + R*y' + (1/C)*y = 1 (step input)
       f = @(t, y) [y(2); (1/L)*(1 - R*y(2) - y(1)/C)];
```

```
        y0 = [0; 0];
    end
    [t, y] = ode45(f, tspan, y0);
    plot(t, y(:,1), 'LineWidth', 1.5);
end
legend(titles, 'Location', 'southeast');
xlabel('Time (s)');
ylabel('Step Response y_{step}(t)');
title('Step Responses for Different RLC Configurations');
grid on;
```