Start up the Pole-Zero ILM

Select settings for no zeros and a single pole. Play with the scale values on all the axes and see how they can be adjusted.

1) Place the pole in the s-plane to produce a step response with a time constant $\tau = 0.2$ s. Adjust the gain K to give an output that approaches 1. This circuit will have unity gain. Write down the corresponding H(s) and h(t), sketch the time response, and note the position of the pole on appropriately scaled axes. Draw the RC and RL circuits that will produce this step response and find 2 sets of values each for R & C and R & L that will yield this response

The function h(t) is the impulse response of the circuit, the output due to an input impulse function $\delta(t)$. Since integrating an impulse $\delta(t)$ gives a step function u(t) and since the circuit is linear, integrating h(t), the circuit's impulse response, gives the circuit's step response. Using Laplace transform properties, integrating the time function is the same as multiplying the transform function by 1/s. Integrate h(t) to find f(t), the output of the circuit to a step input, and multiply H(s) by 1/s to find F(s), the transform of f(t).

Move the pole to find a step response circuit that is 100 times faster (τ is 100 times smaller) than the original circuit. Sketch its step response on the same plot and note the position of the pole in the s-plane. You may not be able to adjust K for unity gain on the new circuit.

2) Go back to the pole position that gave a $\tau = 0.2$ s and add a single zero to the s-plane. Adjust K to give a step response that starts at 1 V. Note H(s) and h(t) and find F(s) as before by multiplying H(s) by 1/s and f(t) by integrating h(t). Compare F(s) & f(t) for the second circuit to H(s) and h(t) for the first. Also compare the RC and RL circuits for the 2 examples and comment on their similarities and differences.

Is it possible to obtain an oscillating response out of a system with a single pole?

3) Now select no zeros and 2 poles in the settings. Place one pole at the origin and the second at $s = -5$. Compare the impulse and step responses to the circuit's response in 1). Comment on similarities or differences. Is this circuit strictly realizable?

Place both poles at $s = -5$. What damping does this correspond to? Adjust the positions of the poles such that ω_{od} is approximately 5 and ζ is 0.3, 0.1, and 0. Sketch the impulse and step responses, noting the decay time constants and frequency of oscillations and write the corresponding H(s) and h(t) functions in both polynomial and factored form, substituting in the values of ζ and ω_{od}. Use the arrow keys to fine tune the positions of the poles. Draw the RLC circuit that will produce these responses. For which case does R have zero resistance?