

## Second Order Systems Pole Plots and Step Responses

System	Pole-zero plot	Response
<p>(a) <math>R(s) = \frac{1}{s}</math> <math>\xrightarrow{G(s)}</math> <math>C(s)</math></p> <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math display="block">\frac{b}{s^2 + as + b}</math> </div> <p style="text-align: center; color: blue;">General</p>		
<p>(b) <math>R(s) = \frac{1}{s}</math> <math>\xrightarrow{G(s)}</math> <math>C(s)</math></p> <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math display="block">\frac{9}{s^2 + 9s + 9}</math> </div> <p style="text-align: center; color: blue;">Overdamped</p>	<p>s-plane</p>	<p><math>c(t) = 1 + 0.171e^{-7.854t} - 1.171e^{-1.146t}</math></p>
<p>(c) <math>R(s) = \frac{1}{s}</math> <math>\xrightarrow{G(s)}</math> <math>C(s)</math></p> <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math display="block">\frac{9}{s^2 + 2s + 9}</math> </div> <p style="text-align: center; color: blue;">Underdamped</p>	<p>s-plane</p>	<p><math>c(t) = 1 - e^{-t}(\cos\sqrt{8}t + \frac{\sqrt{8}}{8}\sin\sqrt{8}t)</math>  <math>= 1 - 1.06e^{-t}\cos(\sqrt{8}t - 19.47^\circ)</math></p>
<p>(d) <math>R(s) = \frac{1}{s}</math> <math>\xrightarrow{G(s)}</math> <math>C(s)</math></p> <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math display="block">\frac{9}{s^2 + 9}</math> </div> <p style="text-align: center; color: blue;">Undamped</p>	<p>s-plane</p>	<p><math>c(t) = 1 - \cos 3t</math></p>
<p>(e) <math>R(s) = \frac{1}{s}</math> <math>\xrightarrow{G(s)}</math> <math>C(s)</math></p> <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math display="block">\frac{9}{s^2 + 6s + 9}</math> </div> <p style="text-align: center; color: blue;">Critically damped</p>	<p>s-plane</p>	<p><math>c(t) = 1 - 3te^{-3t} - e^{-3t}</math></p>