EENG307 Unit 2: Lecture Summaries

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1 Summary of Systems

$Y(s) = G(s)R(s)$ where $Y(s)$ is the system output, $R(s)$ is the input, and $G(s)$ is the closed-loop system transfer function. Common inputs $R(s)$ are found in Table 1. **We have defined G(s) to be our open-loop transfer function in the past, but in this case it is the closed-loop transfer function of our system (which could have a controller in it or could just be our plant in feedback)**

Table 1: Common System Inputs

Name	Time Domain	Laplace Domain
Impulse	$r(t) = \delta$	$R(s) = 1$
Step	$r(t) = u(t)$	$R(s) = \frac{1}{s}$
Ramp	$r(t) = tu(t)$	$R(s) = \frac{1}{2}$

Table 2: Step Response Specifications for Systems

System	Poles	Rise Time	Settling Time	% Overshoot
$\frac{Y(s)}{R(s)} = K\frac{\sigma}{s+\sigma}$	$s = -\sigma$	$t_r = \frac{2.2}{\sigma}$	$t_s = \frac{4.6}{\sigma}$	0
$\frac{Y(s)}{R(s)} = K\frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$	$s = -\zeta\omega_n \pm \omega_n\sqrt{\zeta^2 - 1}$	$t_r = \frac{2.2}{\omega_n}$	$t_s = \frac{4.6}{\zeta\omega_n}$	$e^{\frac{-\zeta\pi}{\sqrt{1-\zeta^2}}} * 100\%$

Table 3: Response of System Summary II

$\frac{Y(s)}{R(s)}$	$R(s)$	$Y(s)$	$y(t)$
$K\frac{\sigma}{s+\sigma}$	1	$K\frac{\sigma}{s+\sigma}$	$y(t) = K\sigma e^{-\sigma t}$
$K\frac{\sigma}{s+\sigma}$	$\frac{1}{s}$	$K\frac{\sigma}{s(s+\sigma)}$	$y(t) = (K - Ke^{-\sigma t})u(t)$
$K\frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$	$\frac{1}{s}$	$K\frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}\frac{1}{s}$	$y(t) = K - Ke^{-\zeta\omega_n}\left(\cos(\omega_n\sqrt{1-\zeta^2}t) + \frac{\zeta}{\sqrt{1-\zeta^2}}\sin(\omega_n\sqrt{1-\zeta^2}t)\right)$

Table 4: Step Response of Under-damped Second Order Systems

Varying Parameter	Rise Time	Settling Time	% Overshoot	Final Value
Increase ζ	unchanged	decrease	decrease	unchanged
Increase ω_n	decrease	decrease	unchanged	unchanged
Increase K	unchanged	unchanged	unchanged	increase