Name:

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1. The step response of the under-damped second order systems is given by

$$s(t) = 1 - e^{-\alpha t}\cos(\omega_d t) - \beta e^{-\alpha t}\sin(\omega_d t).$$

Compute the impulse response $i(t)$ and the ramp response $r(t)$ given $s(t)$ only.

Hint 1: Remember that the rate of change and integration of the step response are equal to the impulse and ramp responses, respectively.

Hint 2: $(f \cdot g)' = f' \cdot g + f \cdot g'$. $\int u(x)v'(x)dx = u(x)v(x) - \int v(x)u'(x)dx$.

2. Given a first order system, $H(s) = \dfrac{1}{Ts+1}$, with time-constant T.

   (a) What is the ramp response, i.e., what is $r(t)$ if the input to the system is a unit ramp function, i.e., $u(t) = t$? Your response should be in terms of T.

   (b) Obtain the tracking error $e(t) = y_{ramp}(t) - u(t)$? What's $e(\infty)$?