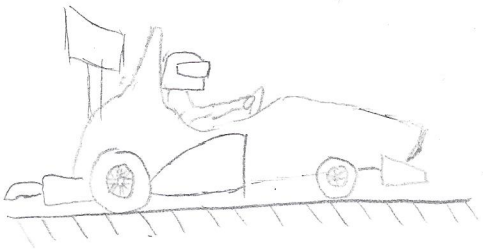
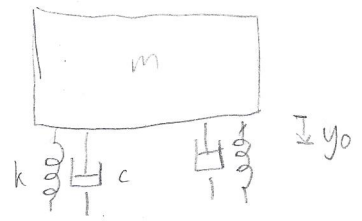
20-R-VIB-DY-27 Intermediate

A $m = 450kg$ race car's suspension consist of a damper, $c = 2500\ Ns/m$, and spring, $k = 10kN/m$, at each of its four wheels. As a result of the driver sitting in the car, the suspension has an initial displacement of 0.07m downwards. If the driver was to suddenly vanish, how long does it take for the free response to disappear? disappears at $3\tau = t$



Solution: FBD



$\sum F_y = ma_y \quad 4c\dot{y} + 4ky = -m\ddot{y}$

$m\ddot{y} + 4c\dot{y} + 4ky = 0$

$c^2 - 4mk > 0$ Overdamped

$r_1, r_2 = \frac{-c \pm \sqrt{c^2 - 4mk}}{2m} = \frac{-2500 \pm \sqrt{28000000}}{900} = \begin{matrix} 3.102 \\ -8.657 \end{matrix}$

$x(t) = ae^{r_1 t} + be^{r_2 t} \quad \frac{1}{r_{1,2}} = |\tau_{1,2}|$

slower / dominates $\leftarrow \tau_1 = 0.322$

$\tau_2 = 0.116$

$3\tau = t$

$t = 0.966$