EE2101 Assignment 1

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September 11, 2020

1. Figure shows a quarter-car model commonly used for analyzing suspension systems. The car's tire is considered to act as a spring without damping, as shown. The parameters of the model are

$M_b = car'sbodymass$
$M_{us} = wheel'smass$
$K_a = strut'sspringconstant$
$K_t = tire'sspringconstant$
$f_v = strut'sdampingconstant$
$r = roaddisturbance(input)$
$x_s = car'sverticaldisplacement$
$x_w = wheel'sverticaldisplacement$

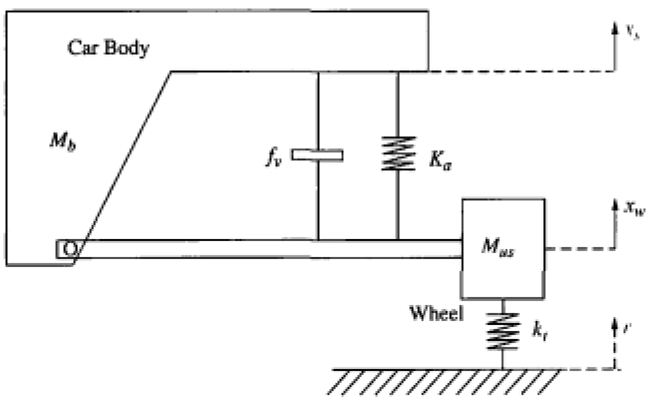

FIGURE P2.36 Quarter-car model used for suspension design.

Soln. The two differential eqns for this system are
$M_b\ddot{x}_s + K_a(x_s - x_w) + C_a(\dot{x}_s - \dot{x}_w) = 0$
$M_u s\ddot{x}_w + K_a(x_w - x_s) + C_a(\dot{x}_w - \dot{x}_s) + K_t(x_w - r) = 0$

Obtaining Laplace transform on both sides gives
$(M_b s^2 + C_a s + K_a)X_s - (K_a + C_a s)X_w = 0$
$(M_{us} s^2 + C_a s + (K_a + K_t))X_w - (K_a + C_a s)X_s = RK_t$

Solving the first equation for X_s and substituting into the second one gets
$\frac{X_w}{R}(s) = \frac{K_t(M_b s^2 + C_a s + K_a)}{(M_{us} s^2 + C_a s + (K_a + K_t))(M_b s^2 + C_a s + K_a) - (K_a + C_a s)^2}$