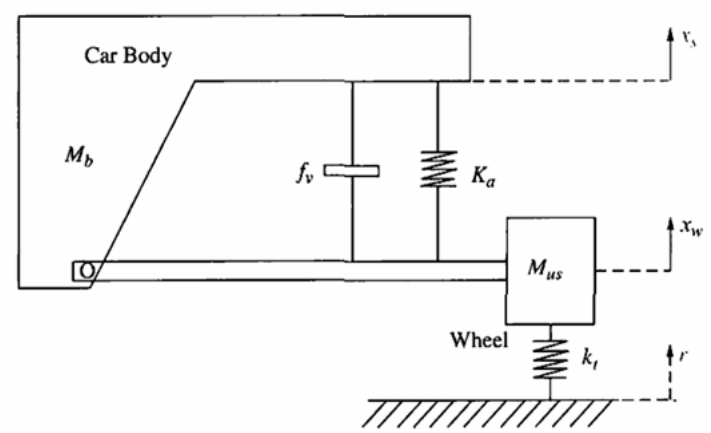
Quarter-Car Model

1. What is a transfer function? Explain its significance in analyzing dynamic systems.

2. Why do we use Laplace transforms when dealing with differential equations in system dynamics?



M_b = car's body mass
M_{us} = wheel's mass
K_a = strut's spring constant
K_t = tire's spring constant
f_v = strut's damping constant
r = road disturbance (input)
x_s = car's vertical displacement
x_w = wheel's vertical displacement

Consider the quarter-car suspension model as shown in Figure.

3. Write the force balance for both the sprung mass (M_b) and unsprung mass (M_{us}).

4. Using the equations of motion derived, express the system in terms of Laplace transforms, assuming zero initial conditions.

5. Derive the transfer function of the system from the road disturbance input R(s) to the car body displacement Xs(s).