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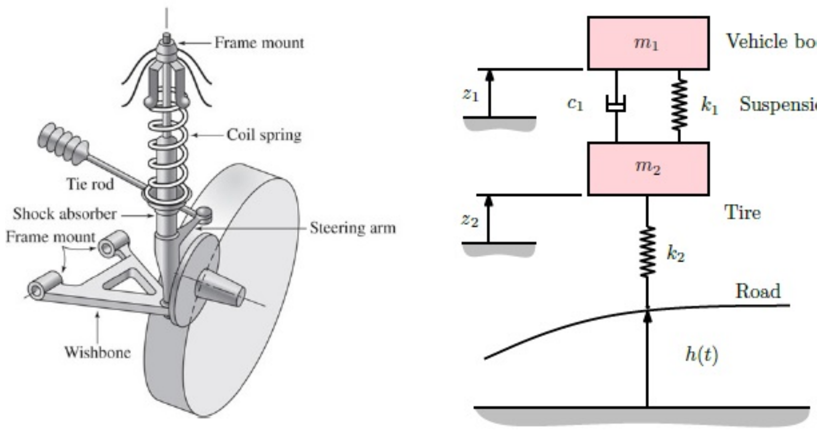
Question: A quarter car model of a vehicle suspension is shown in Figure...

A quarter car model of a vehicle suspension is shown in Figure 1. The model consists of a mass m1 corresponding to a quarter of the total vehicle mass (minus the wheels) and a mass m2 corresponding to a wheel. The suspension linking the vehicle body to the wheel consists of a spring of stiffness k1 in parallel with a shock absorber of damping coecient c1. Meanwhile, the wheel is modeled as having a stiffness k2. Coordinates z1 and z2 measure the positions of masses m1 and m2 with respect to their static equilibrium positions (i.e., where the springs balance the gravity forces). The input to the suspension is the road surface displacement h(t), which is dependent on the road profile and vehicle speed.

Figure 1:



a) Draw separate FBDs for the vehicle body and wheel (i.e., m1 and m2).

b) Use the FBDs to obtain the ordinary di erential equations corresponding to the dynamic model of the suspension.

c) Compute the system's transfer functions, i.e.,

$$G_1(s) = \frac{Z_1(s)}{H(s)}, \quad \text{and} \quad G_2(s) = \frac{Z_2(s)}{H(s)}$$

d) Express the dynamic model of the suspension in state-space form (i.e., obtain matrices A, B, C and D and define vectors x and u). For the moment, use the displacements of the vehicle body and wheel as the outputs, i.e., $y = \frac{z_1}{z_2}$

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Expert Answer

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