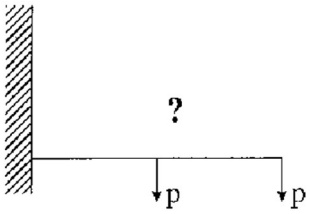
1. [Design Optimization]

(1) Describe three key elements to formulate the design optimization problem. (10 pts)

(2) Describe each for the following truss weight minimization problem. (10 pts)



$\delta \le \delta_{allow}$

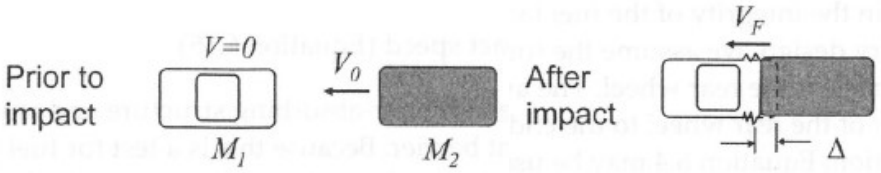
$\sigma \le \sigma_{allow}$

(3) Describe the differences among size, shape and topology optimization in terms of three key elements to formulate the design optimization problem. Draw the example figures. (10 pts)

2. In the standard rear impact test, the stationary target vehicle is impacted by a moving barrier. The criterion for this test is to minimize fuel system leakage, so we are interested in absorbing the energy of the barrier by deforming structure rearward of the fuel system. If we could replace this impact with one between a moving vehicle and fixed barrier, we could apply the structure-sizing procedure developed for the front barrier case.

(1) Find the work of deformation during the moving barrier impact. (10 pts)

(2) Identify the equivalent impact velocity which would result in the same work of deformation to be done by structure. (5 pts)

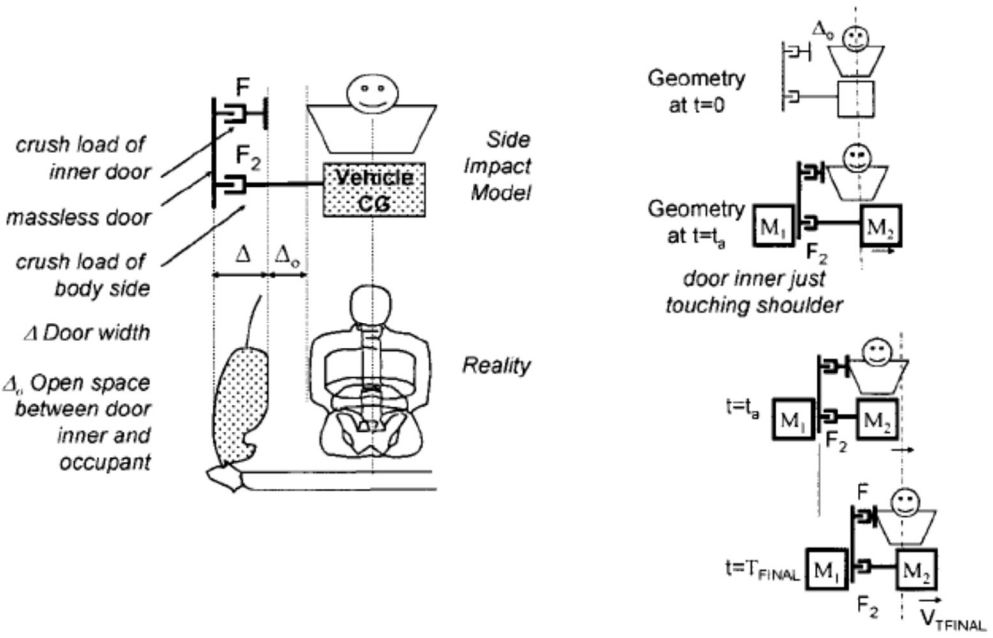


3. Describe three important strategies to minimize the source vibration energy flowing to the receiver including frequency-amplitude graphs. (15 pts)

4. Consider the impact of the vehicle(M_2) by a moving barrier(M_1). We can model each as a point mass with the impact being perfectly plastic. In this linear model, we are looking at motions lateral to the vehicle and will consider the lateral component of the barrier velocity as the initial impact velocity.

(1) Sketch the velocity-time histories for the barrier, the vehicle and the occupant based on the following figures. Indicate t_a, t_{final} and t_f in the time axis and corresponding V_a, V_{final} and V_f in the velocity axis. (10 pts)

(2) Specify Δ_0, Δ and a_{occ} (acceleration of occupant) in the histories. (10 pts)



5. Consider the first order model for the suspension in the figure.

(1) The spindle is a SDOF system. Find the magnitude of F_T/F_1 . (15 pts)

(2) At what frequency does isolation of unbalance forces begin? (5 pts)