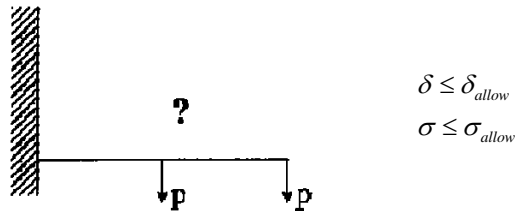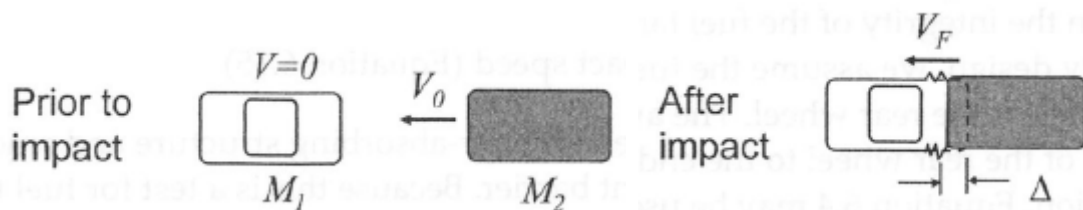1.   [Design Optimization]

(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)

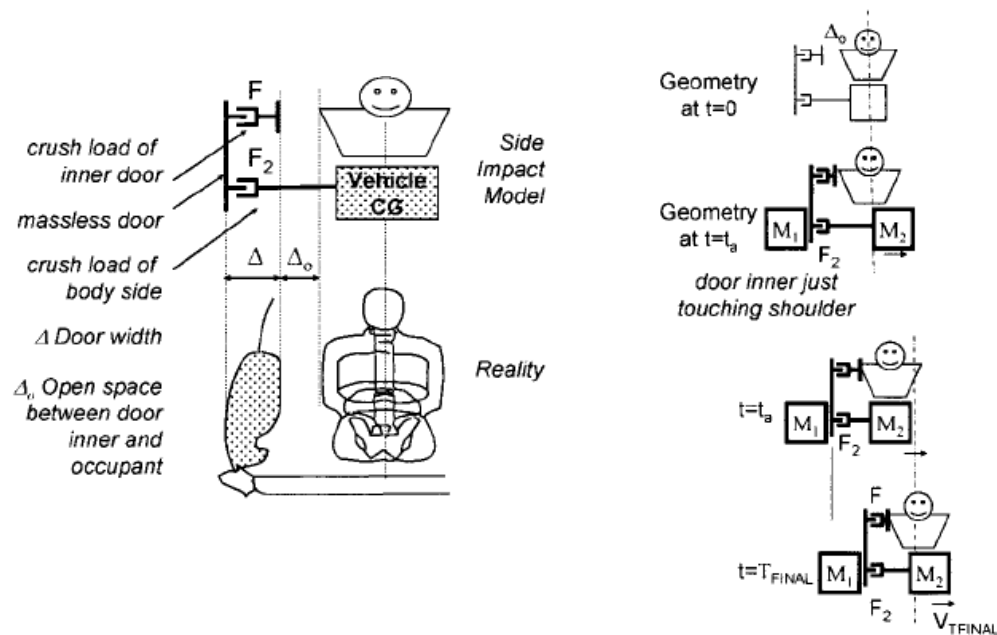$\delta \le \delta_{allow}$

$\sigma \le \sigma_{allow}$

(3) Describe the differences among size, shape and topology optimization. (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 final moving barrier impact speed. (5 pts)

(2) Find the work of deformation during the moving barrier impact. (5 pts)

(3) Identify the equivalent impact velocity which would result in the same work of deformation to be done by structure. (10 pts)

3.   Our design objective for design for vibration is to minimize the source vibration energy flowing to the receiver with undesirable results. Describe three most important strategies to meet this objective. (10 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 powertrain on rigid base in the figure.

(1) The mounted powertrain is a SDOF system. Find the magnitude of F_T/F_0 . (10 pts)

(2) At what frequency does isolation of unbalance forces begin? (10 pts)