

## 1. (10 pts each)

(1) design variable(설계변수), objective function(목적함수), constraint(제약/구속조건)

(2) 설계변수: 각 트러스 부재의 단면적, 목적함수: 트러스 구조의 무게(부피), 제약조건: 트러스 구조의 허용응력, 허용변위

(3)

| Optimization | Size(치수)      | Shape(형상)             | Topology(위상) |
|--------------|---------------|-----------------------|--------------|
| 설계변수         | 부재크기, 두께, 단면적 | 조정점 좌표<br>경계점의 방향과 거리 | 재료밀도         |
| 위상변화         | X             | X                     | O            |

설계변수, 목적함수, 재료 제한조건, 변수 제한조건 각 5점

2.

$$(1) M_1(0) + M_2 V_0 = (M_1 + M_2) V_F \rightarrow V_F = \frac{M_2}{M_1 + M_2} V_0 \quad (5 \text{ pts})$$

$$W = \frac{1}{2} M_2 V_0^2 - \frac{1}{2} (M_1 + M_2) V_F^2 = \frac{1}{2} \left( \frac{M_1 M_2}{M_1 + M_2} \right) V_0^2 \quad (5 \text{ pts})$$

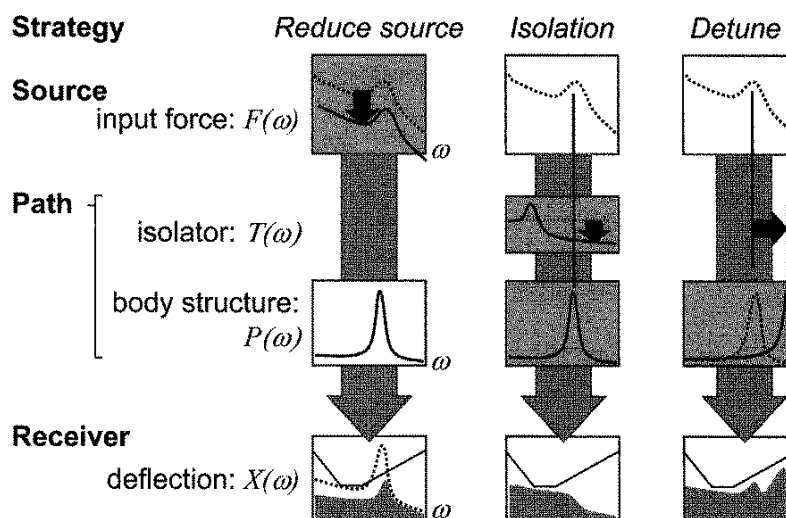
$$(3) \frac{1}{2} M_1 V_{EQ}^2 = W \rightarrow V_{EQ} = V_0 \sqrt{\frac{M_2}{M_1 + M_2}} \quad (5 \text{ pts})$$

## 3. (5 pts each)

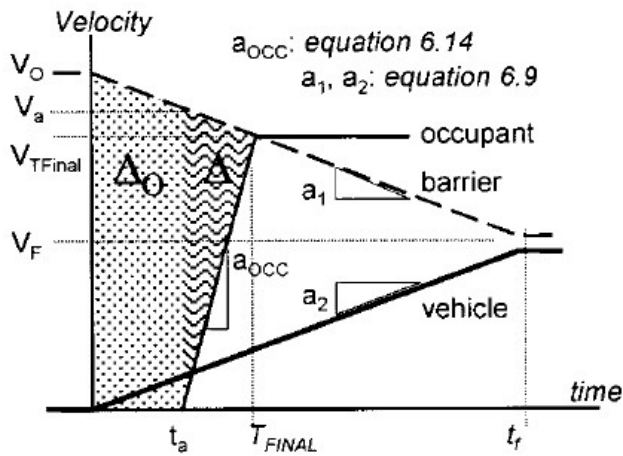
(1) Reduce amplitude of the source

(2) Block the flow of energy using isolators in the path

(3) Detune resonances in the system



4. (10 pts each)



- (1)  $T_{final} \leftrightarrow F$  바뀌서 쓴 경우 감점 -1 ( $V, t$  각각)
- (2)  $\Delta_O, \Delta, a_{occ}$  각 3점, 식으로 표현한 경우 각 1점 (기본 1점)

5.

$$(1) \underbrace{-k_1 X_1 - k_2 X_1 - iC\omega X_1 + F_1}_{\text{forces on unsprung mass}} = m(-\omega^2 X_1)$$

$C$ : shock absorber viscous damping factor

(1000 ~ 2000  $Ns/m$ )

$$\frac{X_1}{F_1} = \frac{1}{k_1 + k_2 - m\omega^2 + iC\omega} = \frac{\frac{1}{k_1 + k_2}}{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right] + i\left(\frac{C\omega}{k_1 + k_2}\right)} \rightarrow \left|\frac{X_1}{F_1}\right| = \frac{\frac{1}{k_1 + k_2}}{\sqrt{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(\frac{C\omega}{k_1 + k_2}\right)^2}}$$

where  $\omega_n^2 = \frac{k_1 + k_2}{m}$  ( $\rightarrow f_n$ : wheel hop frequency)

$$F_T = X_1(k_2 + iC\omega) \rightarrow \left|\frac{F_T}{X_1}\right| = \sqrt{k_2^2 + (C\omega)^2} \rightarrow \left|\frac{F_T}{F_1}\right| = \frac{\left(\frac{k_2}{k_1 + k_2}\right)\sqrt{1 + \left(\frac{C\omega}{k_2}\right)^2}}{\sqrt{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(\frac{C\omega}{k_1 + k_2}\right)^2}} = |T(\omega)| \quad (15 \text{ pts})$$

force transmitted to body through shock absorber and ride spring

$$(2) \left|\frac{F_T}{F_1}\right| < 1 \quad (5 \text{ pts})$$