# 기 계 진 동 학  도전문제 (제3장)

출처 및 해답 [수업지정도서 (중앙도서관 5층 디지털미디어룸 내)]

[1] S. G. Kelly, Fundamentals of Mechanical Vibrations, 2nd ed., McGraw-Hill, 2000.
[2] L. Meirovitch, Fundamentals of Vibrations, McGraw-Hill, 2001.
[3] 이시복 등 8인 공역, 기계진동학, 제6판, 퍼스트북, 2019.
(원서 : S. S. Rao, Mechanical Vibrations, Prentice Hall, 2017.)

## 3.1 충격하중 응답 [3] Ex. 4.8

EXAMPLE 4.8 Response of a Structure Under Impact

In the vibration testing of a structure, an impact hammer with a load cell to measure the impact force is used to cause excitation, as shown in Fig. 4.8(b). Find the response of the system. $m$ = 5 kg, $k$ = 2 kN/m, $c$ = 10 N·s/m and $F(t)$ = $20\,\delta(t) + 10\,\delta(t-0.2)$ N,

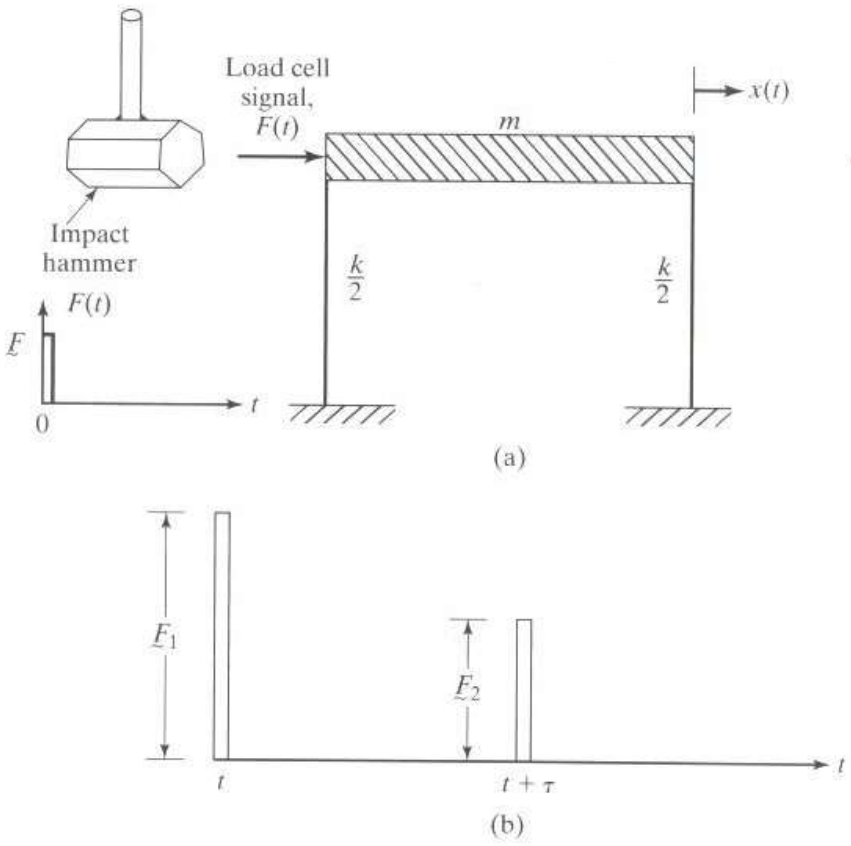


FIGURE 4.8 Structural testing using an impact hammer.

EXAMPLE 4.12 Compacting Machine Under Linear Force

Determine the response of the compacting machine shown in Fig. 4.13(a) when a linearly varying force (shown in Fig. 4.13(b)) is applied due to the motion of the cam. (Assume $c = 0$)

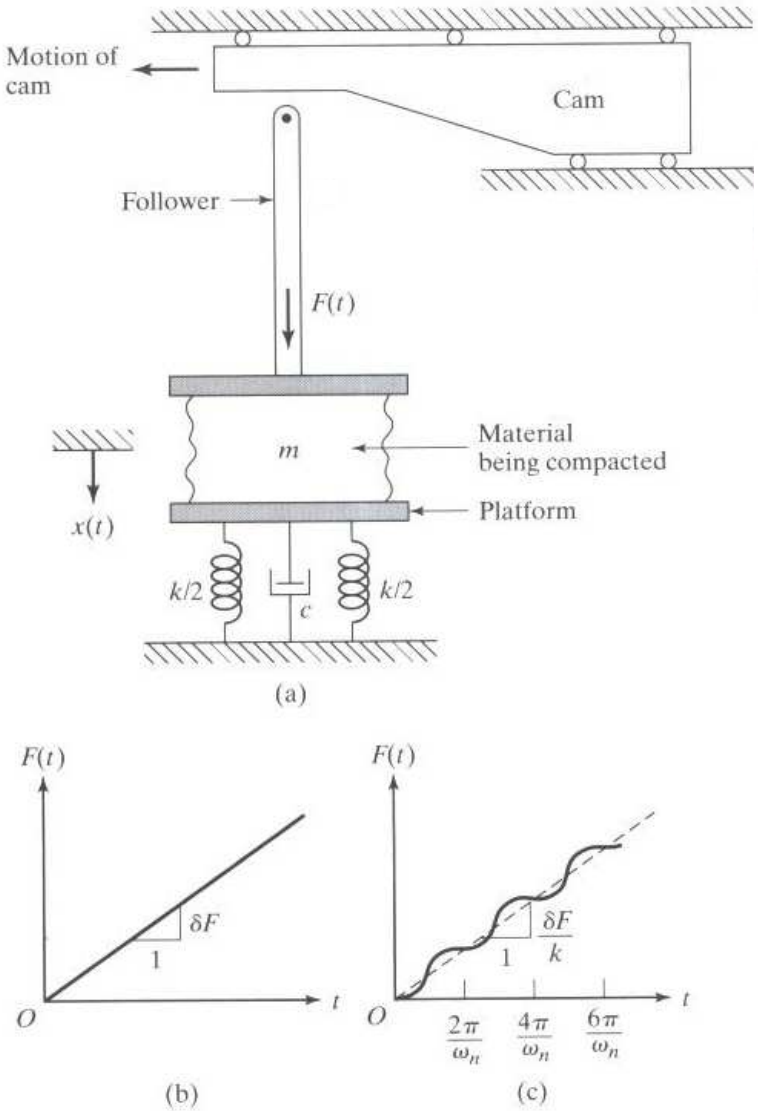


FIGURE 4.13 Compacting machine subjected to a linear force.

## EXAMPLE 4.4 Periodic Vibration of a Hydraulic Valve

In the study of vibrations of valves used in hydraulic control systems, the valve and its elastic stem are modeled as a damped spring–mass system, as shown in Fig. 4.4(a). In addition to the spring force and damping force, there is a fluid pressure force on the valve that changes with the amount of opening or closing of the valve. Find the steady-state response of the valve when the pressure in the chamber varies as indicated in Fig. 4.4(b). Assume $k$ = 2,500 N/m, $c$ = 10 N·s/m, and $m$ = 0.25 kg.

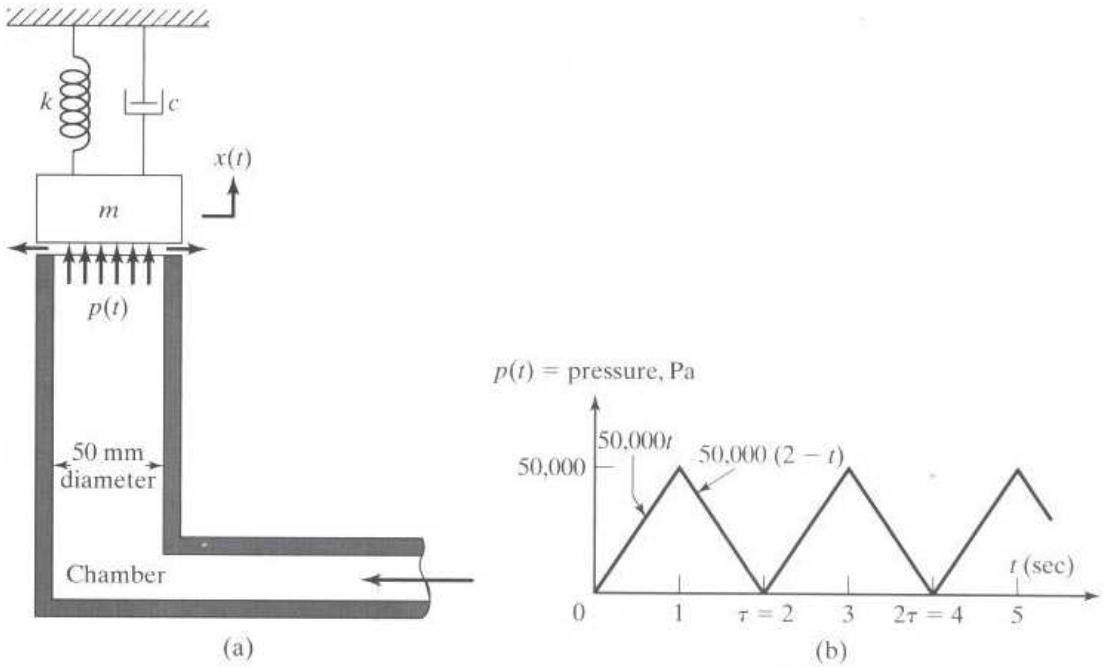


**FIGURE 4.4** Periodic vibration of a hydraulic valve.

EXAMPLE 4.26 Step Response of a Compacting Machine

Find the response of the compacting machine of Fig. 4.10(a) assuming the system to be underdamped (i.e. $\zeta < 1$) and using Laplace transform technique.

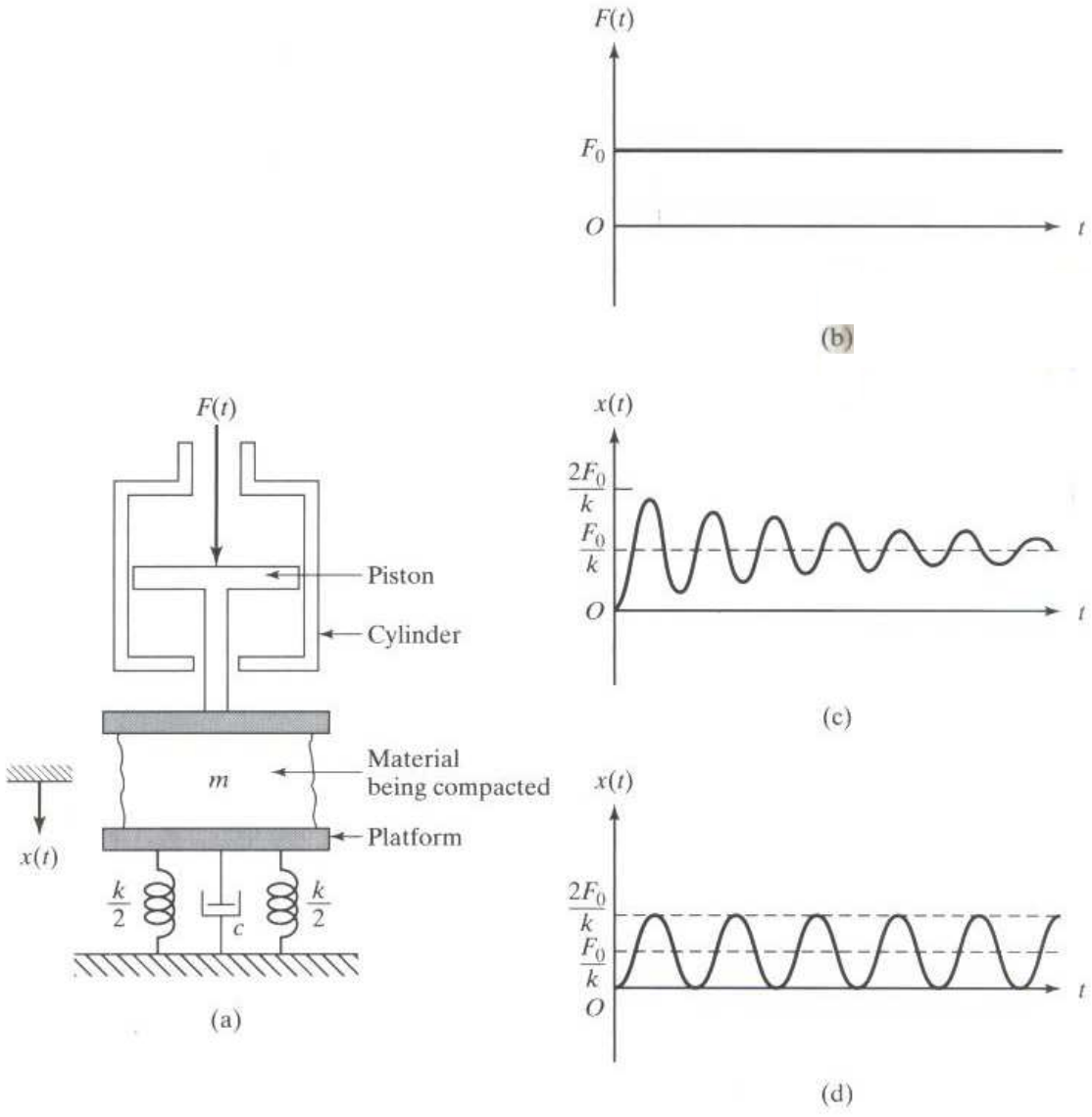


FIGURE 4.10 Step force applied to a compacting machine.

# 정 답

## 3.1 충격하중 응답 [3] Example 4.8

$$x(t) = 0.200\ e^{-t}\ \sin 19.98t + 0.1001\ e^{-(t-0.2)}\ \sin 19.98(t-0.2)\ \Phi(t-0.2) \quad \text{m}$$

## 3.2 임의의 가진에 대한 응답 [3] Example 4.12

$$x(t) = \frac{\delta F}{k}\frac{1}{\omega_n}[\omega_n t - \sin\omega_n t]$$

## 3.3 주기적 가진에 대한 응답 [3] Example 4.4

$$x_p(t) = 0.01964 - 0.01593\ \cos(\pi t - 0.01257) - 0.001783\ \cos(3\pi t - 0.0380) \quad \text{m}$$

## 3.4 변환법 [3] Example 4.26

$\zeta$=0일 때

$$x(t) = \frac{F_0}{k}[\cos\omega_n(t-t_0) - \cos\omega_n t] + x_0\ \cos\omega_n t + \frac{\dot{x}_0}{\omega_n}\ \sin\omega_n t$$