1.

$$m\ddot{u} + ku = p(t)$$

$$(a) \quad k = 2 \times \frac{12EI}{(L/2)^3} = \frac{192EI}{L^3}$$

$$(b) \quad k = \frac{3EI}{L^3}$$

$$(c) \quad k = \frac{12EI}{L^3}$$

2.

(가)

$$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{g}{\delta_{st}}}$$

$$= \sqrt{\frac{386}{0.8}} = 21.97 rad/s$$

(나)

$$\ln \frac{u_i}{u_{i+1}} = \frac{2\pi}{\sqrt{1-\xi^2}}$$ 에서

$$\frac{1}{2}\ln 8 = \frac{2\pi}{\sqrt{1-\xi^2}}$$

$$1-\xi^2 = \left(\frac{4\pi}{\ln 8}\right)^2 \xi^2$$

$$\xi^2 = \frac{1}{1+\left(\frac{4\pi}{\ln 8}\right)^2} = 0.0267$$

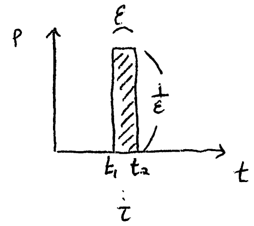
$$\therefore \xi = 0.163$$

그러므로 감쇠기 하나의 감쇠비는 0.163/4 = 0.0408

3.

(가)

뉴튼의 제2법칙에 의해



$$\frac{d}{dt}(m\dot{u}) = p$$

$$\int_1^{t_2} p \cdot dt = m(\dot{u}_2 - \dot{u}_1) = m\Delta\dot{u}$$

그러므로 단위 임펄스가 가해지는 시점 τ 에서의 속도항은

$\dot{u}(\tau) = \dfrac{1}{m}$ 이 된다.

$$h(t) = e^{-\xi\omega_n t}\left[u(0)\cos\omega_D t + \frac{\dot{u}(0) + \xi\omega_n u(0)}{\omega_D}\sin\omega_D t\right]$$ 에서

$t \to t - \tau$, $u(0) = 0$, $\dot{u}(0) = \dfrac{1}{m}$ 으로 바꾸면

$$\Rightarrow h(t-\tau) = \frac{1}{m\omega_D} e^{-\xi\omega_n (t-\tau)} \sin[\omega_D (t-\tau)]$$ (단, $t > \tau$)

(나)

임의의 하중 $p(t)$ 가 시간 τ 일 때 $p(\tau)\cdot d\tau$ 의 impulse가 가해진다고 생각하면

$du(t) = [p(\tau)\cdot d\tau]\cdot h(t-\tau)$ (단, $t > \tau$)

$$u(t) = \int_0^t p(\tau)\cdot h(t-\tau)d\tau$$

$$\therefore u(t) = \frac{1}{m\omega_D}\int_0^t p(\tau) e^{-\xi\omega_n (t-\tau)} \sin[\omega_D (t-\tau)]d\tau$$

4.

(a)

$$\omega = 2\pi f \qquad \omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{g}{\delta_{st}}}$$

$$TR = \frac{1}{\left|1-\left(\frac{\omega}{\omega_n}\right)^2\right|} = \frac{1}{\left|1-\left(\frac{2\pi f}{\sqrt{g/\delta_{st}}}\right)^2\right|} = \frac{1}{\left|1-\frac{4\pi^2 f^2 \cdot \delta_{st}}{g}\right|}$$

(b)

TR=0.1에서 절대값 안의 값은 1보다 크거나 0보다 작으므로 (-)값을 가져야 한다.

$$\frac{1}{\left|1-\frac{4\pi^2 f^2 \cdot \delta_{st}}{g}\right|} = -0.1$$

$$\frac{4\pi^2 f^2 \cdot \delta_{st}}{g} = 11$$

$$\therefore \delta_{st} = \frac{11g}{4\pi^2 f^2} = 0.279\frac{g}{f^2} = 0.279\frac{9.8}{20^2} = 0.00683m$$

5.

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.3} = \frac{20\pi}{3}, \quad \omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{50000\pi^2}{500}} = 10\pi \quad \Rightarrow \quad \frac{\omega}{\omega_n} = \frac{2}{3}$$

$$\frac{F}{P_0} = \frac{50}{100} = 0.5$$

$$\frac{U_0}{(U_{st})_0} = \frac{\left\{1-\left[\left(\frac{4}{\pi}\right)\left(\frac{F}{P_0}\right)\right]^2\right\}^{\frac{1}{2}}}{1-\left(\frac{\omega}{\omega_n}\right)^2} = \frac{\left\{1-\left[\left(\frac{4}{\pi}\right)\cdot 0.5\right]^2\right\}^{\frac{1}{2}}}{1-\left(\frac{2}{3}\right)^2} = 1.388$$

$$(U_{st})_0 = \frac{P_0}{k} = \frac{100\times 9.8}{50000\pi^2} = 1.986\times 10^{-3}$$

$$U_0 = 1.388\times U_{st} = 2.757\times 10^{-3}m$$