기계진동학 연 습 문 제 정 답 (제2장) (2014. 5. 6.)

교 재 : D. J. Inman, Engineering Vibration, 3rd edition, Pearson Education, 2008.
황재혁 등 5인 공역, 최신기계진동학 제3판, 피어슨 에듀케이션 코리아, 2009.

2.1절 <2.1> $x(t)$ = -0.015 cos4.47t + 0.025 cos2t m

<2.2> $x(t)$ = -0.0163 cos4.08t + 0.0263 cos2t m

<2.3> ω_n = 105 rad/s, ω = 95 rad/s 또는 ω_n = 95 rad/s, ω = 105 rad/s

<2.4> T_b = 10 s <2.5> 생략

<2.6> $x(t)$ = 0.001 sin10t - 0.290 cos10t + 0.300 cos8.162t (m)

<2.7> (a) $x(t)$ = 0.00280 sin4.47t - 0.00125 sin10t (m)

(b) $x(t)$ = 0.00280 sin4.47t + 0.05 cos4.47t - 0.00125 sin10t (m)

<2.8> $x(t)$ = 11.7 sin0.968t - 1.13 sin10t (mm)

<2.9> $m\ddot{x}(t) + kx(t) = 90\sin 2.5t$, $x(t) = -0.073\sin 4.47t + 0.131\sin 2.5t$ (m)

<2.10> $x_0 = \dfrac{f_0}{\omega_n^2 - \omega^2}$, $v_0 = 0$

<2.11> k = 52.0 kN/m, E = 161.3 kPa <2.12> $|x(t)|$ = 8.68 mm

<2.13> X = 80.2 mm <2.14> X = 2.52 μm <2.15> $k > \dfrac{36J}{\pi}\left(\dfrac{2M_0}{J} + \dfrac{\pi\omega^2}{36}\right)$

2.2절 <2.16> $\phi = \tan^{-1}\dfrac{(x_0 - X\cos\theta)\omega_d}{v_0 + (x_0 - X\cos\theta)\zeta\omega_n - X\omega\sin\theta}$

$$A = \frac{1}{\omega_d}\sqrt{[v_0 + (x_0 - X\cos\theta)\zeta\omega_n - X\omega\sin\theta]^2 + [(x_0 - X\cos\theta)\omega_d]^2}$$

F_0 = 0 일 때, $\phi = \tan^{-1}\dfrac{x_0\omega_d}{v_0 + x_0\zeta\omega_n}$, $A = \dfrac{1}{\omega_d}\sqrt{(v_0 + x_0\zeta\omega_n)^2 + (x_0\omega_d)^2}$

<2.17> 노트 참조

<2.18> $x(t)$ = 1.15 $e^{-0.02t}$ sin(2.0 t + 1.11) + 0.0312 cos(10 t - 3.137) (m)

<2.19> X = 0.00407 m, θ = 1.856 rad

<2.20> $x(t)$ = 4.25 $e^{-5.005t}$ sin(16.58 t + 2.87) + 4.07 cos(18.8 t - 1.856) mm

<2.21> $x(t)$ = 0.0273 $e^{-1.00t}$ sin(4.358 t + 0.446) + 0.00182 cos(10 t - 2.896) (m)

<2.22> 생략 <2.23> 생략

<2.24> c = 55.7 N·s/m

<2.25> $x(t)$ = 0.0349 $e^{-0.112t}$ sin(0.961 t + 1.71) + 0.0347 cos(3 t - 3.06) (m)

<2.26> $m\ddot{x} + c\dot{x} + kx = F\cos\omega t$

<2.27> $\Theta(t)$ = 0.434 cos(2πt - 3.05) (rad)

<2.28> ζ = 0.01 일 때 X = 0.053 m, ζ = 0 일 때 X = 0.1 m

<2.29> ζ = 0.0241

2.4절 <2.35> X = 10 cm, F_T = 4001 N <2.36> 유도 <2.37> 생략

<2.38> $F_T = \dfrac{\frac{c\,k}{m}\omega_b Y}{\sqrt{(\frac{k}{m}-\omega_b^2)^2+(\frac{c}{m}\omega_b)^2}}$ <2.39> 11.03 mm

<2.40> c = 894 kg/s, F_T = 400 N

<2.41> v_1 = 21.7 km/h, v_2 = 17.3 km/h, X_1 = 33.2 mm, X_2 = 40.9 mm

<2.42> 최선의 감쇠비 ζ = 0.01. 바닥 진동수가 증가하면, 작은 감쇠비가 최선, 바닥 진동수가 감소하여 r<1.4 로 되면, 큰 감쇠비가 최선.

<2.43> c = 1331 N/(m/s) <2.44> 생략

<2.45> r = 2.5, ζ = 0.05 일 때, (a) k = 53650 N/m, c = 922.1 N/(m/s)
(b) X_b = 2.33 mm

<2.46> (a) $\zeta \le 0.239$ (b) F_T/kY = 1.782

<2.47> X_1 = 0.1872 m, X_2 = 0.1060 m <2.48> X = 0.498 m

2.5절 <2.49> X_r = 0.0140 m <2.50> ζ = 0.05 <2.51> X_r = 0.010 m

<2.52> e = 0.10 m <2.53> (a) X_r = 0.0339 mm (b) e = 3.16 mm

<2.54> 생략 <2.55> $k \le 22.1\times10^5$ N/m