■ **충격하중**

Recall

Homogeneous second order linear differential equation.

$ay'' + by' + cy = 0$ 을 만족시킬 수 있는 함수 $y(x) = e^{rx}$ a, b, c, r=상수.

$$ar^2e^{rx} + bre^{rx} + ce^{rx} = (ar^2 + br + c)e^{rx} = 0$$

$$ar^2 + br + c = 0 \Rightarrow r = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$b^2 - 4ac > 0 \Rightarrow y = C_1e^{r_1x} + C_2e^{r_2x}, \; r_1, r_2 = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$b^2 - 4ac = 0 \Rightarrow y = C_1e^{rx} + C_2xe^{rx}, \; r = \frac{-b}{2a}$$

$$b^2 - 4ac < 0 \Rightarrow y = e^{\alpha x}\{C_1\cos(\beta x) + C_2\sin(\beta x)\}$$

$$\alpha = \frac{-b}{2a}, \; \beta = \frac{\sqrt{4ac-b^2}}{2a}$$

***Euler's formula: $e^{i\theta} = \cos\theta + i \cdot \sin\theta$

Non-homogeneous second order differential equation.

$$ay'' + by' + cy = G(x)$$

Complementary eq.

$ay'' + by' + cy = 0$

Particular solution.

$y(x) = y_p(x) + y_c(x)$

Undetermined coefficients.

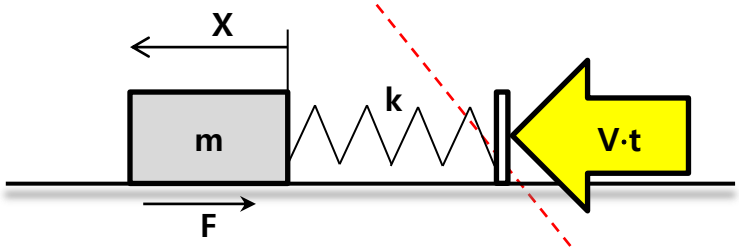
$G(x)$ => **polynomial**, exponential, sin, cos.

$G(x) = x^2 \rightarrow y_p(x) = Ax^2 + Bx + C$

Variation of parameters.

$G(x)$ => **tan(kx)**

Series solution: ex) $y'' - 2xy' + y = 0$



$ay''+by'+cy=G(x)$, $y=y(x) \rightarrow mx'' + kx = kvt - F$, $x = x(t)$

$b^2 - 4ac < 0 \rightarrow y = e^{\alpha x}\{C_1 \cos(\beta x) + C_2 \sin(\beta x)\}$

$$\alpha = \frac{-b}{2a}\ ,\ \beta = \frac{\sqrt{4ac-b^2}}{2a}$$

$-4mk < 0 \rightarrow x_c = C_1 \cos\left(\sqrt{\frac{k}{m}} \cdot t\right) + C_2 \sin\left(\sqrt{\frac{k}{m}} \cdot t\right)$

$$\alpha = 0\ ,\ \beta = \frac{\sqrt{4mk}}{2m} = \sqrt{\frac{k}{m}}$$

$Assume \quad x_p = At + B \rightarrow k(At + B) = kvt - F \rightarrow A = v,\ B = -\frac{F}{k}$

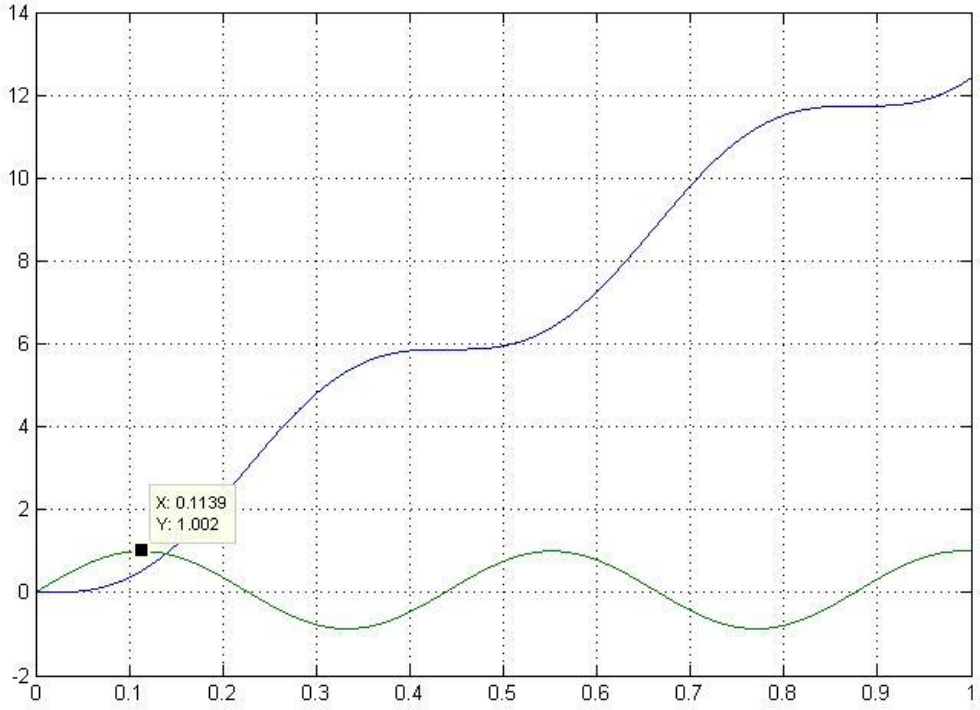
$x = C_1 \cos\left(\sqrt{\frac{k}{m}} \cdot t\right) + C_2 \sin\left(\sqrt{\frac{k}{m}} \cdot t\right) + vt - \frac{F}{k}$

For t=0 , x=0 , x'=0

$$C_1 = \frac{F}{k}$$

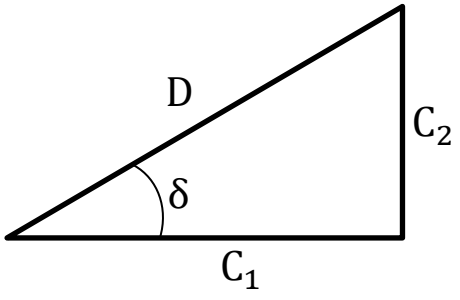
$$C_2 = -v \cdot \sqrt{\frac{m}{k}}$$

$$x = \frac{F}{k}\cos\left(\sqrt{\frac{k}{m}} \cdot t\right) - v \cdot \sqrt{\frac{m}{k}}\sin\left(\sqrt{\frac{k}{m}} \cdot t\right) + vt - \frac{F}{k}$$



$$x(t) = D\cos\left(\sqrt{\frac{k}{m}} \cdot t + \delta\right) + F(t)$$

$$D = \sqrt{{C_1}^2 + {C_2}^2}$$



- Maximum stress

From beam theory $\sigma_x = -E\kappa y = -\frac{My}{I}$

$$\sigma_{max} = \frac{F_{impact} \cdot l \cdot d}{2 \cdot I} = \frac{1175.2 \cdot 120 \cdot 16 \cdot 64}{2 \cdot \pi \cdot 16^4} = 350.7\left(N/mm^2\right) = 3578.6\left(Kgf/cm^2\right)$$

- **경사핀 재질**

하중조건: 충격하중 →표면경화 열처리 가능 재질 선정.

→ SUJ2 등 고 탄소강 계열 사용은 바람직하지 않음.

→ Misumi 표준은 바람직하지 않음.

→ DME 표준의 재질(W.-nr 1.7131: AISI 5115 해당) 참고.

항복강도: 탄소강 계열 사용 불가 → return pin 으로 대체 불가.

→금형 업체의 잘못된 관행.

→경사핀 파손 사고 빈번.

합금강 사용 →nitriding 이 가능한 재질.

→HP4M, SCM 계열 등.