$$\frac{d^2x}{dt^2} + k/m\, x = 0 \quad \text{(2)} \text{ (Equation of motion in SHM)}$$

① Trigonometric solution $\qquad \omega = \sqrt{k/m}$

$$x_1 = a \sin \omega t \quad (3)$$

$$x_2 = b \cos \omega t \quad (4)$$

$$x = a \sin \omega t + b \cos \omega t \quad (5)$$

② exponential

$$x_1(t) = \cancel{ce}^{\alpha t} = c e^{i\omega t} \quad \ldots (6)$$

$$x_2(t) = c e^{-i\omega t} \quad \ldots (7)$$

$$x(t) = c_1 e^{i\omega t} + c_2 e^{-i\omega t} \quad \ldots (8)$$

linear superposition principle

The resultant of sym dis is simply the aljebric sum of individual displacement.

$x_1 \qquad x_2$

$$x = x_1 + x_2$$

- Analitical, graphical, method using complex quantities.

$$\frac{d^2x}{dt^2} = -\omega^2 x + \alpha x^2 + \beta x^2 \quad \ldots (1)$$

$x_1, \quad x_2$ $\qquad$ non linear diff equa $\qquad A = B$, $-A = -B$

$$\frac{d^2x_1}{dt^2} = -\omega^2 x_1 + \alpha x_1^2 + \beta x_1^3 \quad (2)$$

$$\frac{d^2x_2}{dt^2} = -\omega^2 x_2 + \alpha x_2^2 + \beta x_2^3 \quad \ldots (3)$$

$x = x_1 + x_2$

$$\frac{d^2(x_1+x_2)}{dt^2} = -\omega^2(x_1+x_2) + \alpha(x_1+x_2)^2 + \beta(x_1+x_2)^3 + \dots \quad (4)$$

$$(2)+(3) \Rightarrow \frac{d^2x_1}{dt^2} + \frac{d^2x_2}{dt^2} = -\omega^2 x_1 - \omega^2 x_2 + \alpha x_1^2 + \alpha x_2^2 + \beta x_1^3 + \beta x_2^3 + \dots$$

$$= -\omega^2 x_1 - \omega^2 x_2 + \alpha(x_1^2 + x_2^2) + \beta(x_1^3 + x_2^3) + \dots \quad (5)$$

4 = 5

$$\frac{d^2(x_1+x_2)}{dt^2} = \frac{d^2x_1}{dt^2} + \frac{d^2x_2}{dt^2} \dots (6)$$

$$-\omega^2(x_1+x_2) = -\omega^2 x_1 - \omega^2 x_2 \quad (7)$$

X

$$\alpha(x_1+x_2)^2 = \alpha(x_1^2 + x_2^2) \rightarrow (8)$$

$$\beta(x_1+x_2)^2 = \beta(x_1^3 + x_2^3) \rightarrow (9)$$

not true expect

$\alpha = \beta = 0$