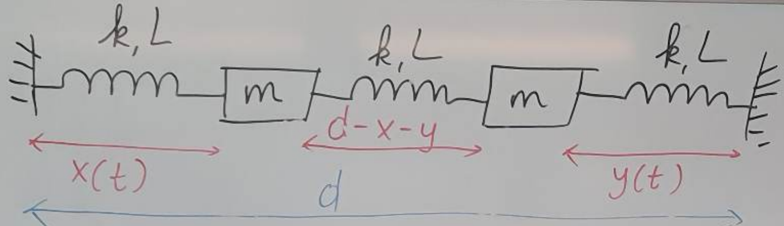
9.6.



a/ (1): $m\frac{d^2x}{dt^2} = -k(x-L) + k(d-x-y-L)$

(2): $m\frac{d^2y}{dt^2} = -k(y-L) + k(d-x-y-L)$

Equilibrium: $\begin{cases} -\cancel{k}(x-L)+\cancel{k}(d-x-y-L)=0 \\ -\cancel{k}(y-L)+\cancel{k}(d-x-y-L)=0 \end{cases}$

$\begin{cases} -x+\cancel{L}+d-x-y-\cancel{L}=0 \\ -y+\cancel{L}+d-x-y-\cancel{L}=0 \end{cases}$

$\begin{cases} -2x-y+d=0 \quad (*) \\ -x-2y+d=0 \quad (**) \end{cases}$

$(*)\cdot 2-(**): -3x+d=0 \Rightarrow \boxed{x=\frac{d}{3}}$

plug in (**): $-\frac{d}{3}-2y+d=0$

$C_1+C_2e^{5t} \Rightarrow \boxed{y=\frac{d}{3}}$

$r^2-5r=0 \quad r=0, r=5$

$\frac{d^2y}{dt^2}=5y$

$y''=5y$

$y''-5y=0$

$y - \cancel{x} = 0$

$y - \cancel{x} = 0$

$= 0 \quad (*)$

$= 0 \quad (**)$

$-3x + d = 0 \Rightarrow \boxed{x = \frac{d}{3}}$

$-2y + d = 0$

$\boxed{= \frac{d}{3}}$

$r = 5$

$\frac{d^2y}{dt^2} = 5y$

$y'' = 5y$

$y'' - 5y = 0$

b/ $\boxed{d - x - y} = d - (x+y) = z(t) \Rightarrow \frac{d^2z}{dt^2} = -\frac{d^2}{dt^2}(x+y)$

$d - z = (x+y)$

(1) + (2):

$$m\frac{d^2}{dt^2}(x+y) = -k(\underbrace{x+y}-2L) + 2k(d\underbrace{-x-y}-L)$$

$$m\left(-\frac{d^2z}{dt^2}\right) = -k\left(d - z - 2L\right) + 2k(z - L).$$

$$-m\frac{d^2z}{dt^2} = -kd + kz + \cancel{2L}k + 2kz - \cancel{2}kL$$

$$= -kd + 3kz$$

$$-m\frac{d^2z}{dt^2} = k(3z - d)$$

$$-m\frac{d^2z}{dt^2} = 3k\left(z - \frac{d}{3}\right) \Rightarrow z \text{ is oscilation}$$

$$T = \frac{2\pi}{w} = 2\pi \cdot \frac{1}{w} = 2\pi\sqrt{\frac{3k}{m}} \qquad w = \sqrt{\frac{m}{k}}$$

c/ (1)-(2): $m\frac{d^2}{dt}(x-y) = -k(x-y)$ $\boxed{B = x-y}$

$$m\frac{d^2B}{dt^2} = -kB \qquad T = 2\pi\frac{1}{w} = 2\pi\sqrt{\frac{k}{m}}$$

$\hookrightarrow$ B oscillate

d/ If $d - x - y = C \stackrel{?}{=} L$

$$m\frac{d^2x}{dt^2} = -k(x-L)$$

$$m\frac{d^2y}{dt^2} = -k(y-L)$$

e/ (1): $m\frac{d^2x}{dt^2} = -k(x-L) + k(d-2x-L)$

$$m\frac{d^2x}{dt^2} = -k(3x - d)$$

$$= -3k\left(x - \frac{d}{3}\right)$$

$$T = 2\pi\sqrt{\frac{3k}{m}}$$

9.6..

a/ (1): $m\frac{d^2x}{dt^2}$

(2): $m\frac{d^2y}{dt^2} =$

Equilibrium:

e/ (1): $m\dfrac{d^2x}{dt^2} = -k(x-L) + k(d-2x-L)$

$$m\frac{d^2x}{dt^2} = -k(3x - d)$$

$$= -3k\left(x - \frac{d}{3}\right)$$

$$T = 2\pi\sqrt{\frac{m}{3k}}$$

10.4 $F_f = \begin{cases} \gamma & \text{for } \dfrac{dx}{dt} < 0 \\ -\gamma & \dfrac{dx}{dt} > 0 \end{cases}$

a/ sign of γ: $\gamma > 0$, so that $F_f > 0$ when $\dfrac{dx}{dt} < 0$.

b/ dimension of γ: dimension of force.

c/ $m\dfrac{d^2x}{dt^2} = -kx - c\dfrac{dx}{dt}$

$$F_f = -c\frac{dx}{dt}$$

equilibrium: $\dfrac{d^2x}{dt^2} = 0$

$$m\frac{d^2x}{dt^2} = -kx + F_f$$

$$0 = -kx + F_f$$

$$x = \frac{F_f}{k} = \begin{cases} \dfrac{\gamma}{k} : & \dfrac{dx}{dt} < 0 \\ -\dfrac{\gamma}{k} : & \dfrac{dx}{dt} > 0 \end{cases}$$

$$|F_f| \leq \gamma$$

then: $|x| = \dfrac{|F_f|}{k} \leq \dfrac{\gamma}{k}$.

b

(1

m

m

$-m$