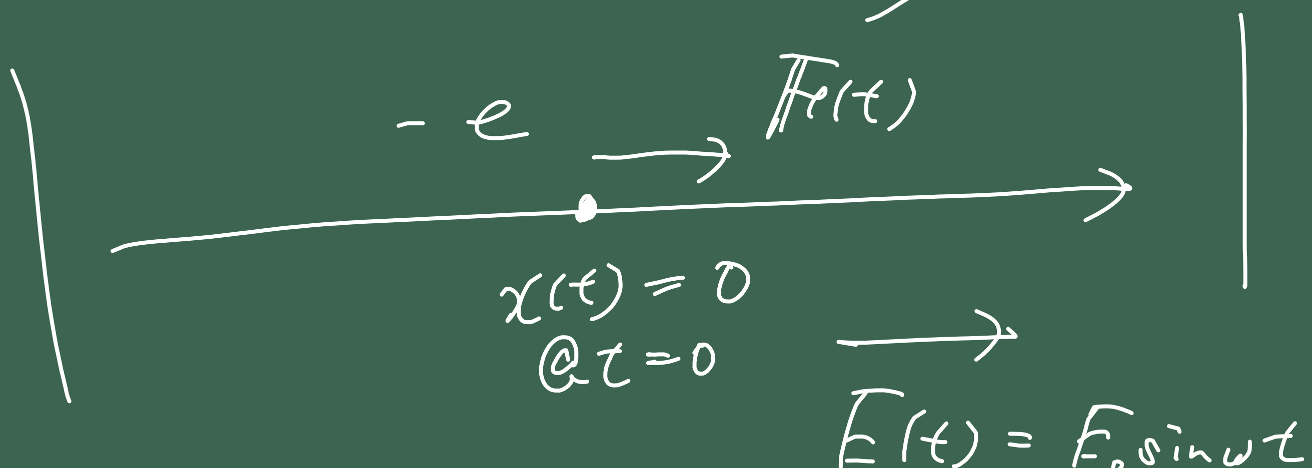
R5 問6

(1)

$$\mathbb{F}(t) = \begin{pmatrix} F_x(t) \\ F_y(t) \\ F_z(t) \end{pmatrix} = \begin{pmatrix} F_x(t) \\ 0 \\ 0 \end{pmatrix}$$



$$\mathbb{E}(t) = \begin{pmatrix} E_x(t) \\ E_y(t) \\ E_z(t) \end{pmatrix} = \begin{pmatrix} E(t) \\ 0 \\ 0 \end{pmatrix}$$

$$\mathbb{F}(t) = q\,\mathbb{E}(t)$$

$$\begin{pmatrix} F_x(t) \\ F_y(t) = 0 \\ F_z(t) = 0 \end{pmatrix} = q \begin{pmatrix} E_x(t) \\ E_y(t) = 0 \\ E_z(t) = 0 \end{pmatrix}$$

$$F_x(t) = q E_x(t)$$

$$F(t) = q E(t)$$

$$= \boxed{q E_0} \sin \omega t$$

$$\boxed{q = -e}$$

(1) ハ

$$F(t) = \boxed{-e E_0} \sin \omega t$$

||

(2)

$$F(t) = m \frac{dv}{dt}$$

↑ 力　↑ 質量　↑ 加速度　$a = \frac{dv}{dt}$

$$-eE \sin \omega t = m \frac{dv}{dt}$$

(2) ロ

$$\frac{dv}{dt} = \boxed{\frac{-eE}{m}} \sin \omega t$$

← $v(t)$ についての微分方程式

$\boxed{\text{定積分}}$

(3)

$$\frac{df(t)}{dt} = g(t)$$

$$\int_0^t \frac{df}{dt}(t)\,dt = \int_0^t g(t)\,dt$$

$$\Big[f(t)\Big]_0^t$$

$$f(t) - f(0) = \int_0^t g(t)\,dt$$

$$\int \underline{\sin}\ \omega t\,dt = -\frac{1}{\omega}\cos\omega t + K$$

$$\left(-\frac{1}{\omega}\cos\omega t + K\right)' = -\frac{1}{\cancel{\omega}}\left(-\cancel{\omega}\sin\omega t\right)$$

$$= \underline{\sin\omega t}$$

$$\int_a^b \sin\omega t\,dt = \left[-\frac{1}{\omega}\cos\omega t\right]_a^b$$

$$= -\frac{1}{\omega}\left(\cos bt - \cos at\right)$$

$$\frac{dv}{dt} = -\frac{eE_0}{m}\sin\omega t$$

$$\int_0^t \frac{dv}{dt}\,dt = -\frac{eE_0}{m}\int_0^t \sin\omega t\,dt$$

$$v_0$$

$$v(t) - \underset{\displaystyle v_0}{\underset{\parallel}{v(0)}} = -\frac{eE_0}{m}\left[-\frac{1}{\omega}\cos\omega t\right]_0^t$$

$$= +\frac{eE_0}{m\omega}\left[\cos\omega t\right]_0^t$$

$$- \frac{eE_0}{m\omega}\left(\cos\omega t - 1\right)$$

$$v(t) = v_0 + \frac{eE_0}{m\omega}\left(\cos\omega t - 1\right)$$

$$= v_0 - \boxed{\frac{eE_0}{m\omega}}\left(1 - \cos\omega t\right)$$

$$(\sin t)' = \cos t \qquad (3)\ 7$$

$$(\sin\omega t)' = \frac{d(\omega t)}{dt}\left(\frac{d}{d(\omega t)}\sin(\omega t)\right)$$

$$= \omega\cos\omega t$$

$$v(t) = v_0 - \frac{eE_0}{m\omega}(1 - \cos\omega t)$$

$$\parallel$$

$$\frac{dx(t)}{dt}$$

$$\int_0^t \qquad dt$$

$$\int_0^t \frac{dx(t)}{dt}\,dt = x(t) - \overset{=0}{x(0)} = x(t)$$

$$\int_0^t \left\{\left(v_0 - \frac{eE_0}{m\omega}\right) + \frac{eE_0}{m\omega}\cos\omega t\right\} dt$$

$$= \left[\left(v_0 - \frac{eE_0}{m\omega}\right) t + \frac{eE_0}{m\omega^2}\sin\omega t\right]_0^t$$

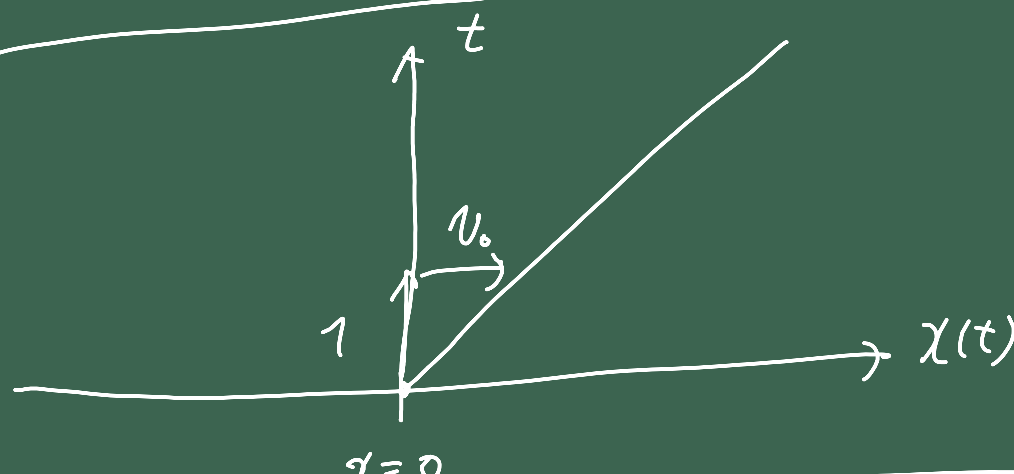
$$= \boxed{\left(v_0 - \frac{eE_0}{m\omega}\right) t + \frac{eE_0}{m\omega^2}\sin\omega t}$$

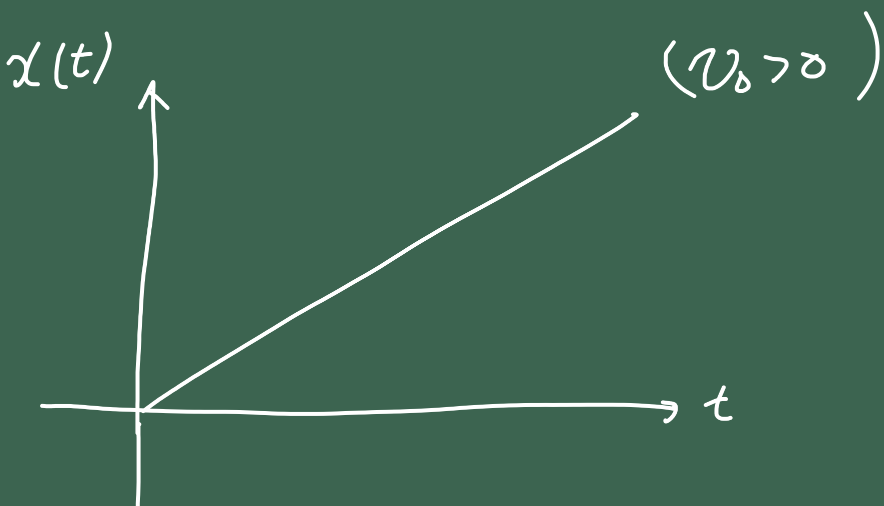
(カ)

(5) $$x(t) = \left(v_0 - \frac{eE_0}{m\omega}\right)t + \frac{eE_0}{m\omega^2}\sin\omega t$$

1. $E_0 = 0$

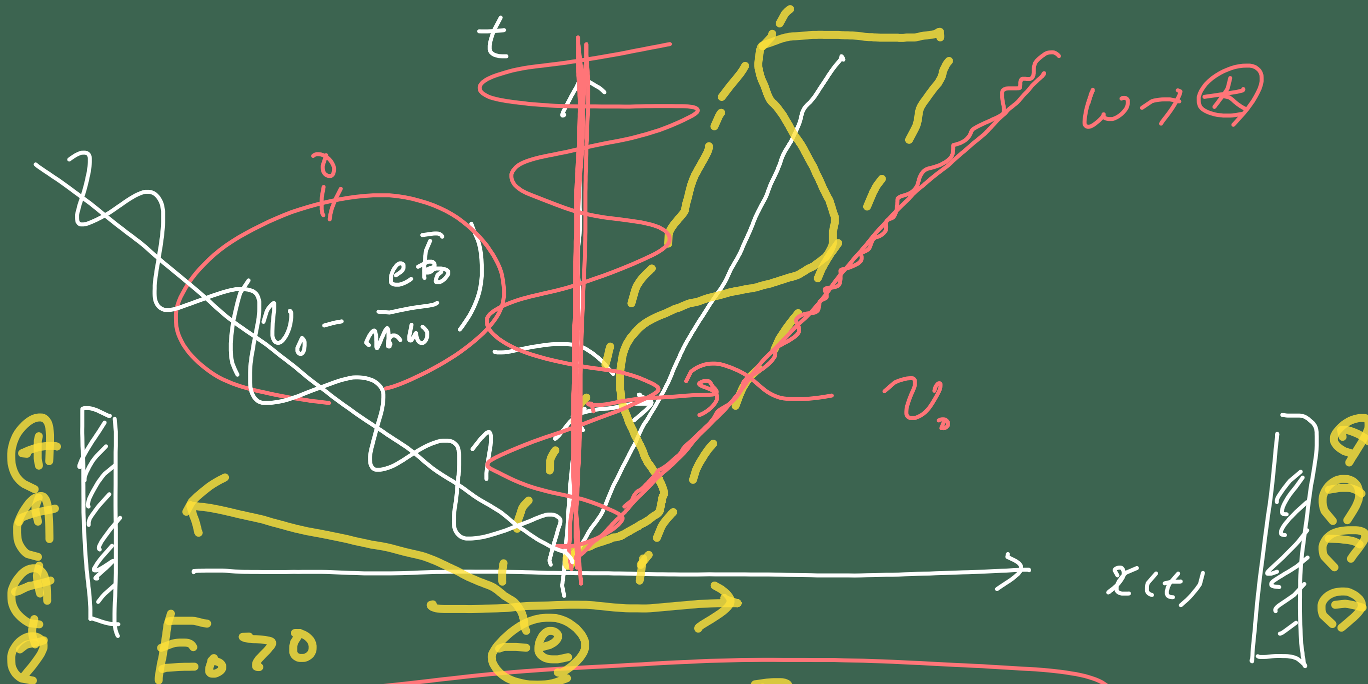
$$x(t) = v_0 t$$





$E_0 \neq 0$, ω を変化

$$x(t) = \left(v_0 - \frac{eE_0}{m\omega}\right) t + \frac{eE_0}{m\omega^2} \sin\omega t$$



$\omega \to$ 大 $\quad v_0 - \dfrac{eE_0}{m\omega} \to v_0$

$\dfrac{eE_0}{m\omega^2} \to 0$

$$v_0 - \frac{eE_0}{m\omega} = 0$$

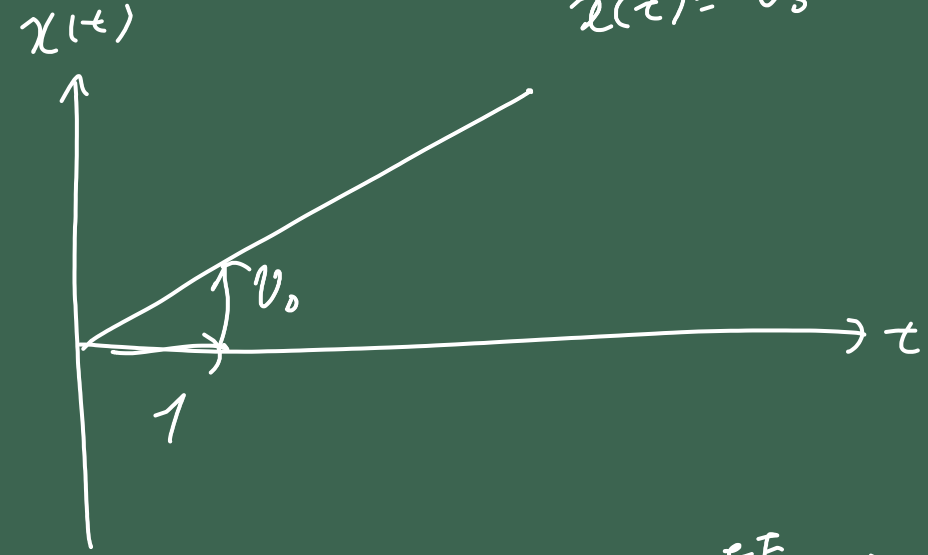
(5) $\omega = \dfrac{eE_0}{m v_0}$ // (=)

v_0 大 $\to$ ω 小

v_0 小 $\to$ ω 大

$E_0 = 0$

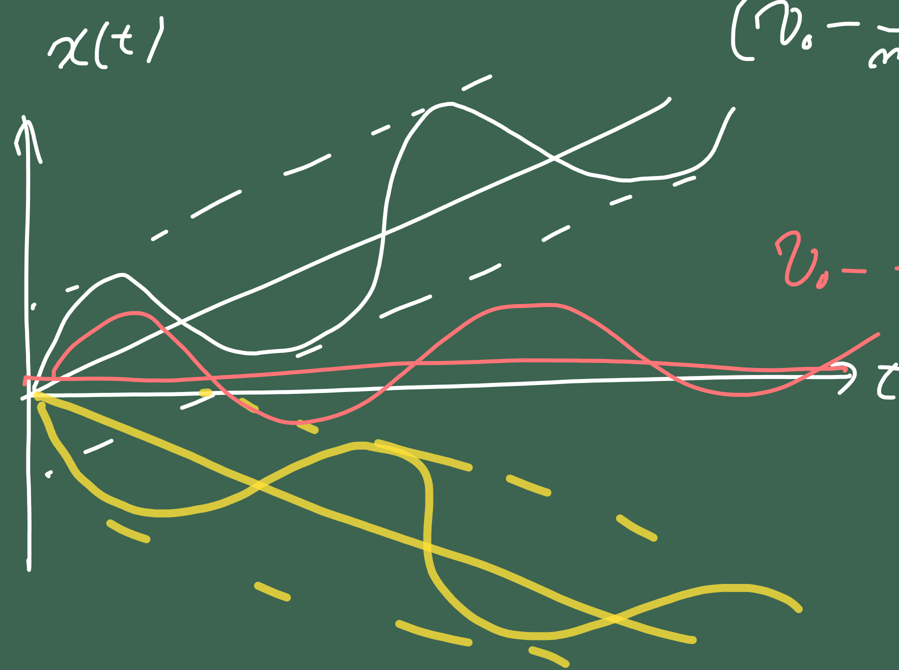
$x(t) = v_0 t$



$v_0 - \frac{eE}{m\omega} > 0$

$E_0 \neq 0$

$(v_0 - \frac{eE}{m\omega})t$



$v_0 - \frac{eE}{m\omega} \quad 0$

$v_0 - \frac{eE}{m\omega} < 0$

R5 问6

$$E(t) = E_0 \sin \omega t$$

$$\Downarrow$$

$$E(t) = E_{dc} + E_{ac} \sin \omega t$$

↑ 直流电界　　↑ 交流电界

$$x_1(t) = ?$$

$$\frac{dv_1(t)}{dt} = \frac{F(t)}{m} = \frac{-eE(t)}{m}$$

$$= -\frac{eE_{dc}}{m} - \frac{eE_{ac}}{m} \sin \omega t$$

$$x_1(t) = \underline{-\frac{eE_{dc}}{2m} t^2} + x(t)$$

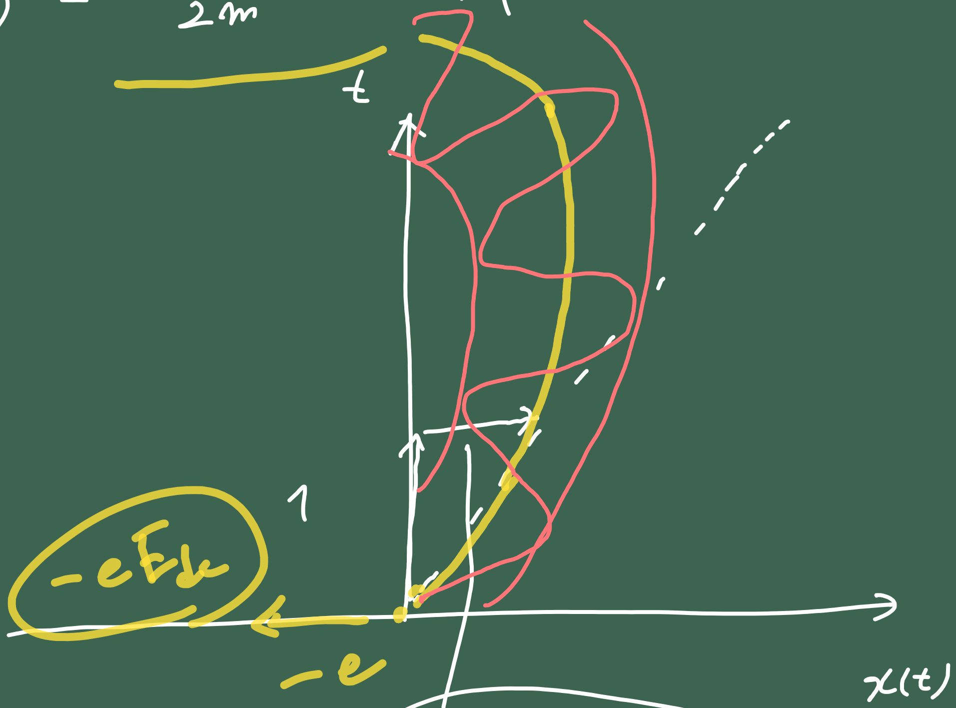
$$= -\frac{eE_{dc}}{2m} t^2 + \left(v_0 - \frac{eE_{ac}}{m\omega}\right) t + \frac{eE_{ac}}{m\omega^2} \sin \omega t$$

$$\int_0^t -\frac{eE_{dc}}{m} dt = -\frac{eE_{dc}}{m} t$$

$$-\frac{eE_{dc}}{m}\int_0^t t\,dt = -\frac{eE_{dc}}{2m}t^2$$

$$x_1(t) = -\frac{eE_{dc}}{2m}t^2 + \left(v_1 - \frac{eE_{ac}}{m\omega}\right)t + \frac{eE_{ac}}{m\omega^2}\sin\omega t$$

0



$E_{ac}, E_{dc} > 0$

$$v_0 - \frac{eE_{ac}}{m\omega} > 0$$