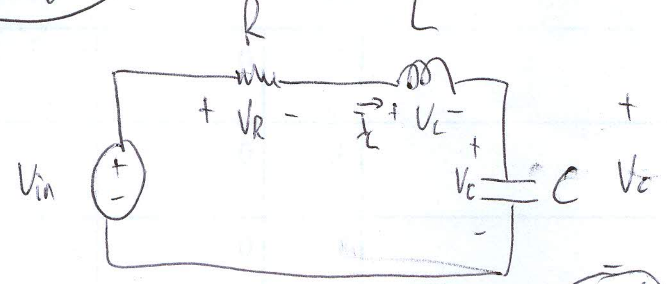
20 point

1



$$V_{in} = V_R + V_L + V_C$$ 2 point

$$V_{in} = R I_L + L \frac{dI_L}{dt} + V_c$$ 1 point 1 point

2 $$\boxed{\frac{dI_L}{dt} = \frac{V_{in}}{L} - \frac{R}{L} I_L - \frac{V_c}{L}}$$ 2 point

$$C \frac{dV_c}{dt} = I_L \qquad \boxed{\frac{dV_c}{dt} = \frac{I_L}{C}}$$ 1

4 point

Take derivative of 2 put 1 inside

$$\frac{d^2 I_L}{dt^2} = \frac{1}{L} \frac{dV_{in}}{dt} - \frac{R}{L} \frac{dI_L}{dt} - \frac{1}{L} \frac{dV_c}{dt}$$ 2 point

3 point

$$\frac{d^2 I_L}{dt^2} + \frac{R}{L} \frac{dI_L}{dt} = \frac{1}{L} \frac{dV_{in}}{dt} - \frac{1}{L} \frac{I_L}{C} \rightarrow \boxed{\frac{d^2 I_L}{dt^2} + \frac{R}{L} \frac{dI_L}{dt} + \frac{1}{LC} I_L = \frac{1}{L} \frac{dV_{in}}{dt}}$$

Take derivative of 1 put 2 inside

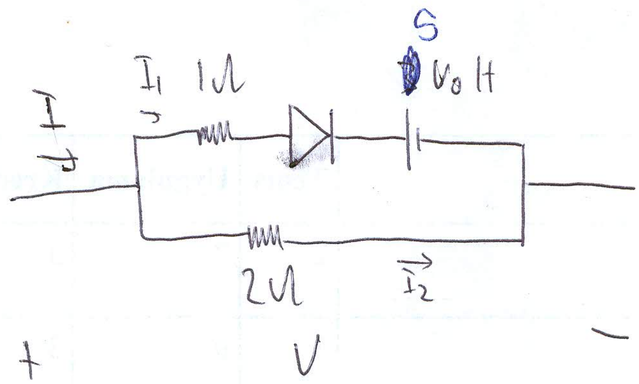
$$\frac{d^2 V_c}{dt^2} = \frac{1}{C} \frac{dI_L}{dt} = \frac{1}{C} \left[\frac{V_{in}}{L} - \frac{R}{L} I_L - \frac{1}{L} V_c \right]$$ 2 point

$$\frac{d^2 V_c}{dt^2} + \frac{1}{LC} V_c + \frac{R}{CL} \underbrace{I_L}_{C \frac{dV_c}{dt}} = \frac{V_{in}}{LC}$$

$$\boxed{\frac{d^2 V_c}{dt^2} + \frac{R}{L} \frac{dV_c}{dt} + \frac{1}{LC} V_c = \frac{1}{LC} V_{in}}$$

3 point

②



if $V > 5$ → I_1 ✓, → I_2 ✓

$I = I_1 + I_2 = \frac{V-5}{1} + \frac{V}{2}$

$= \frac{3V-10}{2}$

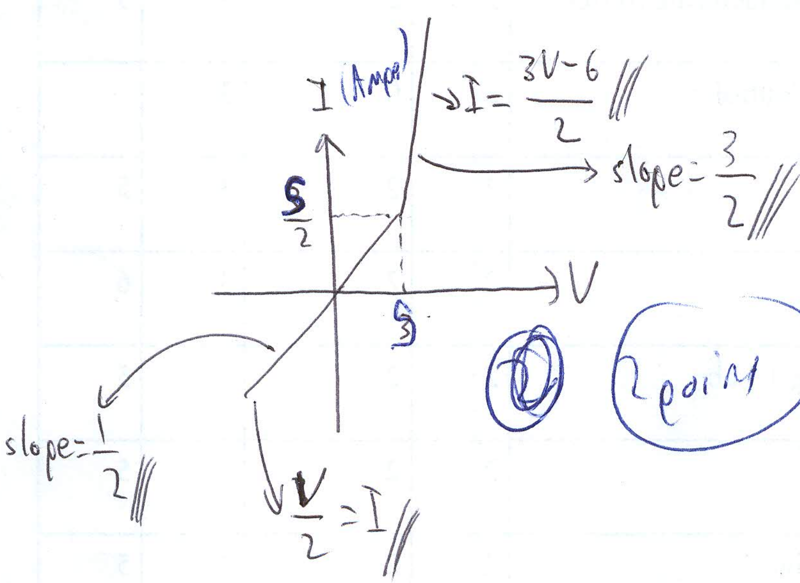
2 point

3 point

if $V < 5$ → I_1 ✗, → I_2 ✓

$I = \underset{\downarrow 0}{I_1} + I_2 = I_2 = \frac{V}{2}$

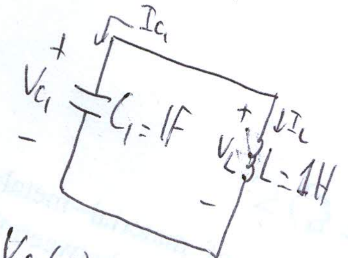
3 point



2 point

$0<t<2\pi$ $\quad$ $= \ldots$ Volt

$C_2 = 3F \quad R = \frac{1}{4}\Omega$



$V_{C_1}(0) = 1$ Volt

$I_L(0) = 0$ Amper

$V_{C_1} = V_L$ (1)

$V_{C_1} = L\frac{dI_L}{dt}$

$\frac{dI_L}{dt} = V_{C_1}$

$I_{C_1} + I_L = 0$ (1)

$C_1\frac{dV_{C_1}}{dt} + I_L = 0$

$\frac{dV_{C_1}}{dt} = -I_L$

$\frac{d^2 I_L}{dt^2} = \frac{dV_{C_1}}{dt} = -I_L$

$\boxed{\frac{d^2 I_L}{dt^2} + I_L = 0}$ (2)

$\frac{d^2 V_{C_1}}{dt^2} = -\frac{dI_L}{dt} = -V_{C_1}$

$\boxed{\frac{d^2 V_{C_1}}{dt^2} + V_{C_1} = 0}$ (2)

char_equ $s^2+1=0$ (2)

(2) $s = \mp j$ $\longrightarrow$ $V_{C_1h}(t) = A\,\text{Sin}(t) + B\,\text{Cos}(t)$ (1)

$I_{Lh}(t) = K\,\text{Sin}(t) + M\,\text{Cos}(t)$ (1)

Since there is no input $V_{C_1p} = 0$, $I_{Lp} = 0$

$V_{C_1} = V_{C_1h} + V_{C_1p} = A\,\text{Sin}(t) + B\,\text{Cos}(t)$ (1)

$I_L = I_{Lh} + I_{Lp} = K\,\text{Sin}(t) + B\,\text{Cos}(t)$ (1)

$\frac{dV_{C_1}}{dt} = A\,\text{Cos}(t) - B\,\text{Sin}(t)$

$V_{C_1}(0) = A\underbrace{\text{Sin}(0)}_{0} + B\underbrace{\text{Cos}(0)}_{1} = 1$

$B = 1$

$\longrightarrow \frac{dV_{C_1}}{dt}(0) = -I_L(0) = 0 = A\,\text{Cos}(0) - B\,\text{Sin}(0)$

$A = 0$

$V_{C_1}(t) = \text{Cos}(t) \quad 0<t<2\pi$

$I_L = -\frac{dV_{C_1}}{dt} = -\frac{d}{dt}\text{Cos}(t) = \text{Sin}(t) \quad 0<t<2\pi$

16

Gidiş 12

t

Amper

=0 Amper no change

re connected in parallel when $t=2\pi$ so the

the capacitors will be preserved.

$Q(2\pi^+)$ (3)

$_2 V_{C_2}(2\pi^-) = (C_1+C_2)V_{C_1}(2\pi^+)$, $V_{C_1}(2\pi^+) = 4$ Volt //

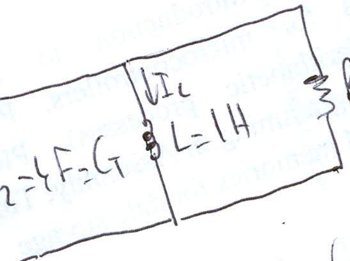
$3 \times 5 = 4 \times V_{C_1}(2\pi^+)$

(3)

diff-equations $\frac{d^2V_{C_1}}{dt^2} + \frac{1}{RC}\frac{dV_{C_1}}{dt} + \frac{1}{LC}V_{C_1} = 0$

$\frac{d^2I_L}{dt^2} + \frac{1}{RC}\frac{dI_L}{dt} + \frac{1}{LC}I_L = 0$ (3)

T



$V_{C_1}(t) = (A+Bt)e^{-\frac{1}{2}t}$ or

or

$V_{C_1}(t) = (K+M(t-2\pi))e^{-\frac{1}{2}(t-2\pi)}$ // (2)

-equation: $s^2+s+\frac{1}{4} = (s+\frac{1}{2})^2$ (2)

$\frac{dV_{C_1}}{dt} = -\frac{I_L}{C_T} - \frac{4V_C}{C_T} = -\frac{I_L}{4} - V_C$ (2)

we also know that $I_C + I_L + I_R = 0$ $\quad C_T\frac{dV_{C_1}}{dt} + I_L + \frac{V_C}{\frac{1}{4}} = 0$ (1)

$V_C(2\pi^+) = (K + M\times 0)e^{-\frac{1}{2}(2\pi-2\pi)} = K = 4$ //

$\frac{dV_{C_1}}{dt} = (K+M(t-2\pi))(-\frac{1}{2})e^{-\frac{1}{2}(t-2\pi)} + Me^{-\frac{1}{2}(t-2\pi)}$

$\frac{dV_{C_1}}{dt}(2\pi^+) = -\frac{I_L(2\pi^+)}{4} - V_C(2\pi^+) = 0 - 4 = -4 =$

$\frac{dV_{C_1}(2\pi)}{dt} = -\frac{1}{2}K + M = -4$

$-\frac{1}{2}\times 4 + M = -4$ $\quad M=-2$ (1)

(2)

$V_{C_1} = (4-2(t-2\pi))e^{-\frac{1}{2}(t-2\pi)}$

4- $\frac{d^2x}{dt^2} + x = \sin(t) = V_{in}(t)$

find $x_p(t) =$

char equation $s^2 + 1 = 0 \longrightarrow x_h(t) = A\sin(t) + B\cos(t)$

$\longrightarrow$ than

$s_{1,2} = \mp j \qquad V_{in}(t) = \sin(t) \longrightarrow w = 1$ rad/sec

↳ angular frequency of the input

$s_1 = j = j \times w$

$= j \times 1 =$ (The natural frequency of the char equation $j = j \times w$ (j multiplied by input angular frequency

so $x_p(t) = A t\sin(t) + B t\cos(t) = t\left[A\sin(t) + B\cos(t)\right]$

$\frac{d^2}{dt^2} x_p(t) + x_p(t) = \sin(t)$

5 $\frac{d}{dt} x_p(t) = \left[A\sin(t) + B\cos(t)\right] + t\left[A\cos(t) - B\sin(t)\right]$

7 $\frac{d^2}{dt^2} x_p(t) = \left[A\cos(t) - B\sin(t)\right] + \left[A\cos(t) - B\sin(t)\right] + t\left[A\sin(t) - B\cos(t)\right]$

$2A\cos(t) - 2B\sin(t) + t\left[-A\sin(t) - B\cos(t)\right] + t\left[A\sin(t) + B\cos(t)\right] = \sin(t)$

4 $2A\cos(t) - 2B\sin(t) = \sin(t) \qquad A = 0 \qquad B = -\frac{1}{2}$

$x_p(t) = -\frac{1}{2} t\cos(t)$

4