P 5.10 a)

$$\frac{V_d - V_a}{72} + \frac{V_d - V_b}{120} + \frac{V_d - V_c}{450} + \frac{V_d}{600} + \frac{V_d - V_o}{180} = 0$$

$$V_o = -24V$$

b) $V_o = -8.4 - 0.4 V_c$

$-16 = -8.4 - 0.4 V_c \Rightarrow V_c = 19V$

$16 = -8.4 - 0.4 V_c \Rightarrow V_c = -61V$

$-61 \leq V_c \leq 19$ volts.

P5.19 a) Let V_{o1} = output voltage for left Op Amp-

V_{o2} = " " " right " ".

$$V_{o1} = \frac{-47}{10}(1) = -4.7V$$

$$V_{o2} = \frac{-220}{3}(-0.15) = 1V$$

$$i_a = \frac{V_{o2} - V_{o1}}{1000} = 5.7mA$$

b) $i_a = 0$ if $V_{o1} = V_{o2}$, $\Rightarrow V_{o2} = 1V$ and

$$-\frac{47}{10} V_L = 1$$

$$\therefore V_L = -\frac{10}{47} = -212.77mV$$

P6.4 a) $0 \le t \le 10^{-3}$ s

$$i = \frac{1}{L}\int_0^t V_s\,dx + i(0) = \frac{10^6}{300}\int_0^t 6\times10^{-3}\,dx + 0$$

$$= 20x\Big|_0^t = 20t$$

$$10^{-3} \le t \le 2\times10^{-3} \text{ s}$$

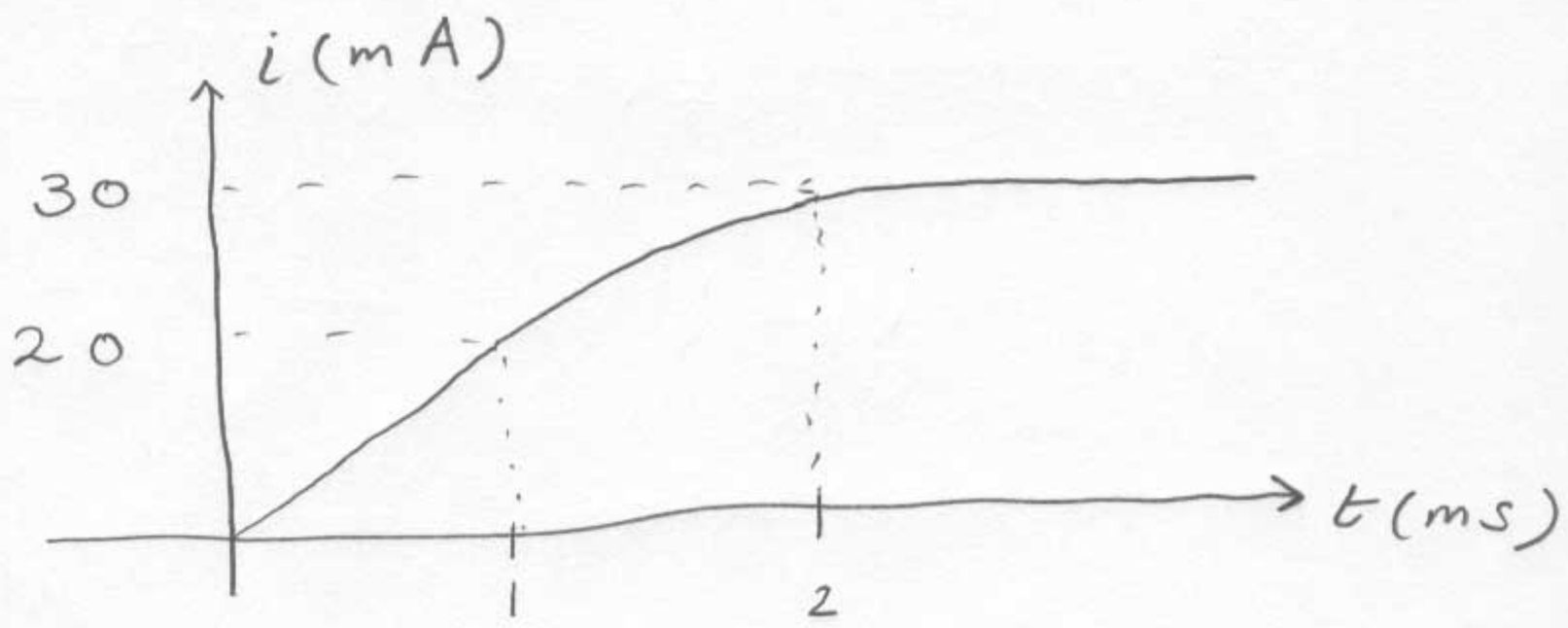
$$i = \frac{10^6}{300}\int_{10^{-3}}^t (12\times10^{-3} - 6x)\,dx + 20\times10^{-3}$$

$$\therefore i(t) = 40t - 10^4 t^2 - 10^{-2}$$

$$2\times10^{-3} \le t < \infty$$

$$i = \frac{10^6}{300}\int_{2\times10^{-3}}^t 0\,dx + 30\times10^{-3} = 30\text{ mA}$$

b)



P6.6 a)

$0 \le t \le 1s$

$v = -100t$, $i = \frac{1}{5}\int_0^t -100x\,dx + 0 = -20\,\frac{x^2}{2}\Big|_0^t = -10t^2$ [A]

$1 \le t \le 3$ s

$v = -200 + 100t$, $i(1) = -10$ A.

$\therefore i = \frac{1}{5}\int_1^t (100x - 200)\,dx - 10$

$= 10(t^2 - 1) - 40(t-1) - 10$

$3 \le t \le 5$

$v = 100$, $i(3) = 10(9) - 120 + 20 = -10$ A

$\therefore i = \frac{1}{5}\int_3^t 100\,dx - 10 = 20t - 60 - 10 = 20t - 70$ A

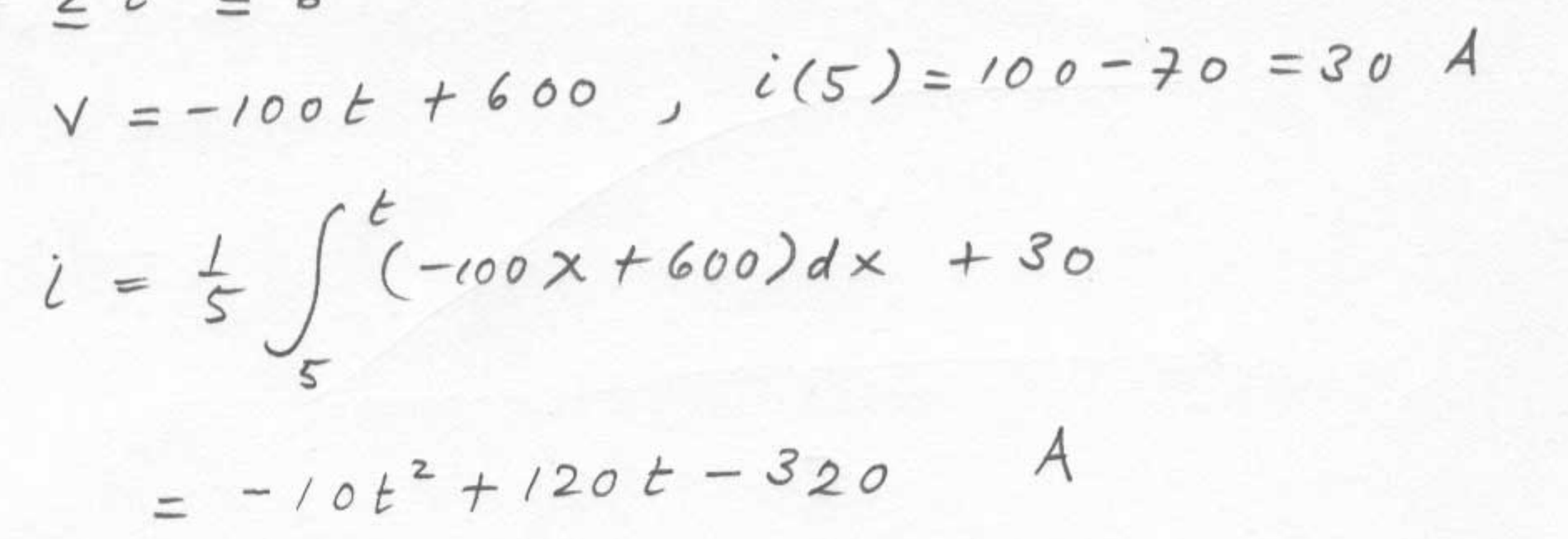
$5 \le t \le 6$

$v = -100t + 600$, $i(5) = 100 - 70 = 30$ A

$\therefore i = \frac{1}{5}\int_5^t (-100x + 600)\,dx + 30$

$= -10t^2 + 120t - 320$ A

b) $i(6) = -10(36) + 120(6) - 320 = 40$ A



P 6.14 a) $0 \le t \le 50\ \mu s$

$C = 0.5\mu F$, $\frac{1}{C} = 2 \times 10^6$

$$V = 2\times10^6 \int_0^t 20\times10^{-3}\,dx + 20 = 40\times10^3 t + 20 \ , \ 0 \le t \le 50\mu s.$$

$V(50\mu s) = 2 + 20 = 22\ V$

b) $50\ \mu s \le t \le 200\ \mu s$

$$V = 2\times10^6 \int_{5\times10^{-6}}^t -40\times10^{-3}\,dx + 22 = -8\times10^4 t + 4 + 22$$

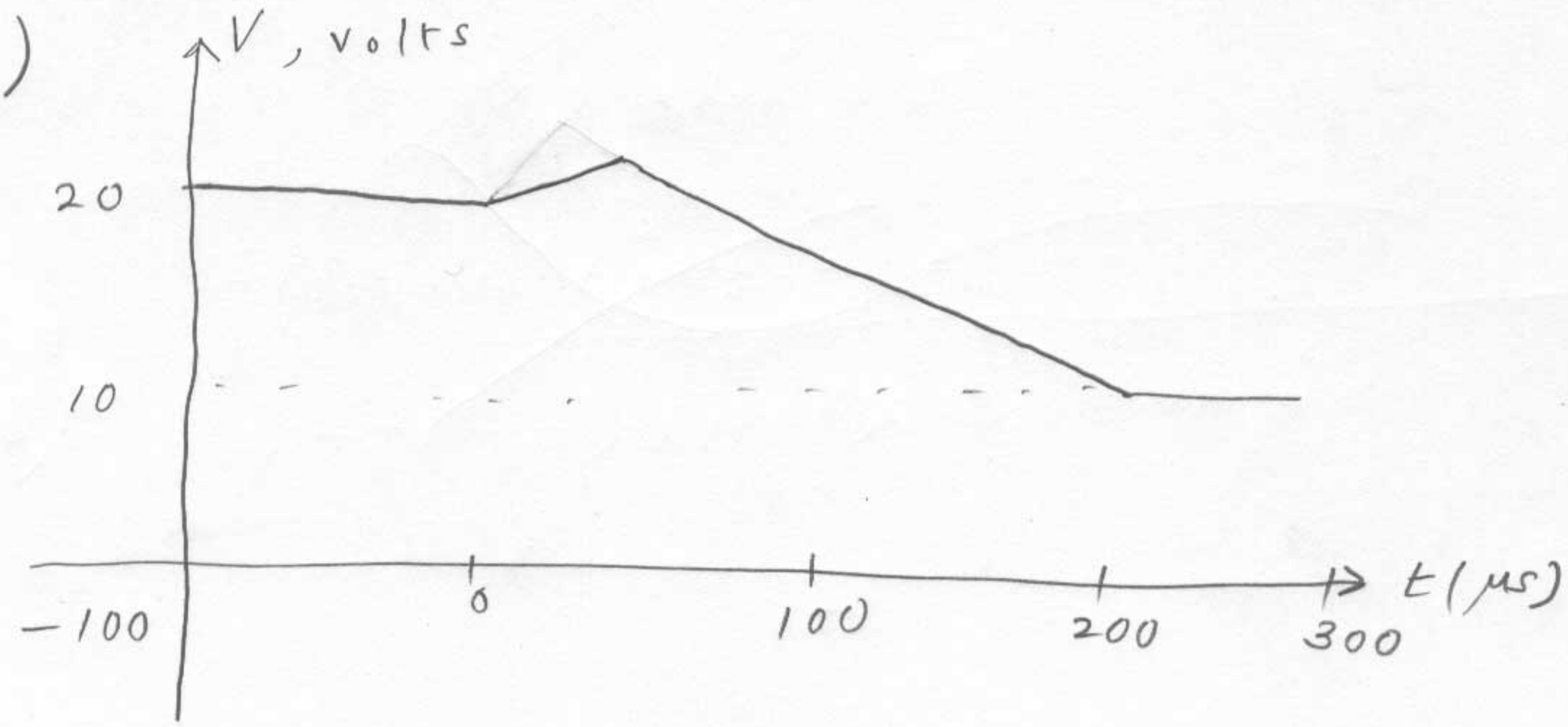
$$= -8\times10^4 t + 26 \ , \quad 50 \le t \le 200\ \mu s$$

$V(200\mu s) = -8\times10^4 (200\times10^{-6}) + 26 = 10v$

c) $200 < t < \infty\ \mu s$

$$V = 2\times10^6 \int_{200\times10^{-6}}^t 0\,dx + 10 = 10 \ , \ 200\mu s \le t < \infty$$

d)



P6.30

$c_1 = 1 + 1.5 = 2.5\,nF$

$\frac{1}{c_2} = \frac{1}{2.5} + \frac{1}{12.5} + \frac{1}{50} = \frac{1}{2}$

$\therefore c_2 = 2\,nF$

$v_d(0) + v_a(0) - v_c(0) = 40 + 15 + 45 = 100\,V$

a)

$$v_b = -\frac{10^9}{2}\int_0^t 50\times10^{-6} e^{-250x}\,dx + 100$$

$$= 100\,e^{-250t} \quad V$$

b) $$V_a = -\frac{10^9}{12.5}\int_0^t 50\times10^{-6} e^{-250x}\,dx + 15$$

$$= 16\,e^{-250t} - 1 \quad , V$$

c) $$V_c = -\frac{10^9}{50}\int_0^t 50\times10^{-6} e^{-250x}\,dx - 45$$

$$= -4\,e^{-250t} - 41 \quad , V$$

d) $$V_d = -\frac{10^9}{2.5}\int_0^t 50\times10^{-6} e^{-250x}\,dx + 40$$

$$= 80\,e^{-250t} - 40 \quad , V$$

Check: $v_b = v_d + v_a - v_c$

$$= 80e^{-250t} - 40 + 16e^{-250t} - 1 + 4e^{-250t} + 41$$

$$= 100e^{-250t} \quad , V$$

e) $i_1 = -10^{-9} \frac{d}{dt}[80e^{-250t} - 40]$

$= -10^{-9}(-2\times10^{4} e^{-250t}) = 20e^{-250t}\ \mu A$

f) $i_2 = -1.5\times10^{-9} \frac{d}{dt}[80e^{-250t} - 40]$

$= 30e^{-250t}\ \mu A$

Check: $i_1 + i_2 = 50e^{-250t}\ \mu A = i_b$