NAME: SOLUTIONS

Electronics Problems Involving Integration

Dawson College
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 # 17 p765

The electric current in a microprocessor circuit is 0.230 μA. How many coulombs pass a given point in the circuit in 1.50 ms?

$i = 2.3 \times 10^{-7}$ A
$t = 0.0015$ s

$$q = \int i \, dt$$
$$= \int 2.3 \times 10^{-7} \, dt$$
$$= 2.3 \times 10^{-7} t$$

ASSUMING INITIAL CHARGE IS 0

$$q = (2.3 \times 10^{-7})(0.0015)$$
$$= \boxed{3.45 \times 10^{-10} \text{ C}}$$

 # 19 p765

In an amplifier circuit, the current i (in A) changes with time t (in s) according to $i = 0.06t\sqrt{1+t^2}$. If 0.015 C of charge has passed a point in the circuit at $t = 0$, find the total charge to have passed the point at $t = 0.25s$.

$$q = \int 0.06t\sqrt{1+t^2}\,dt$$

$$= \int 0.03\,u^{1/2}\,du \qquad u = 1+t^2,\ du = 2t\,dt$$

$$q = 0.02\,u^{3/2} + C_1$$

$$q = 0.02(1+t^2)^{3/2} + C_1$$

AT $t=0$ $\quad q = 0.015$

$$0.015 = 0.02(1)^{3/2} + C_1 \implies C_1 = -0.005$$

$$q = 0.02(1+t^2)^{3/2} - 0.005$$

at $t = 0.25$

$$\boxed{q = 0.017 \text{ C}}$$

 # 20 p765

The current i (in μA) in a DVD player circuit is given by $i = 6.0 - 0.5t$, where t is the time in μs and $0 \le t \le 30\mu s$. If $q_0 = 0$ C, for what value of t is $q = 0$ C?

$$q = \int 6 - 0.5t\,dt$$

$$q = 6t - 0.25t^2 + C_1$$

$$0 = C_1$$

$$q = 6t - 0.25t^2$$

$$0 = 6t\left(1 - \frac{1}{24}t\right)$$

$t = 0$ OR $\boxed{t = 24\,\mu s}$

 # 21 p765

The voltage across a 2.5 μF capacitor in a copying machine is zero. What is the voltage after 12 ms if a current of 25 mA charges the capacitor?

$$V_c = \frac{1}{C}\int i\,dt$$

$$= \frac{1}{2.5\times10^{-6}}\int 0.025\,dt$$

$$V_c = \frac{1}{2.5}(10^6)(0.025t)$$

NO CONSTANT b/c INITIAL VOLTAGE IS 0

at $t = 0.012$ s

$$V_c = \frac{10^6}{2.5}(0.025)(0.012)$$

$$= \boxed{120\text{ V}}$$

 # 22 p765

The voltage across an 8.5 nF capacitor in an FM receiver circuit is zero. Find the voltage after 2.00 μs if a current (in mA) $i = 0.042t$ charges the capacitor.

$$V_c = \frac{1}{8.5\times10^{-9}}\int 0.042t\cdot10^{-3}\,dt$$

$$= \frac{10^6}{8.5}(0.021t^2)$$

At $t = 2\times10^{-6}$ s

$$\boxed{V_c = 9.88\text{ nV}}$$

 # 23 p765

The voltage across a 3.75 μF capacitor in a television circuit is 4.50 mV. Find the voltage after 0.565 ms if a current (in μA) $i = \sqrt[3]{1+6t}$ further charges the capacitor.

$$V_c = \frac{1}{3.75\times10^{-6}} \int (1+6t)^{1/3} \cdot 10^{-6}\, dt$$

$$= \frac{1}{3.75} \int (1+6t)^{1/3}\, dt$$

$$= \frac{1}{3.75}\left(\frac{1}{8}(1+6t)^{4/3}\right) + C_1$$

$$V_c = \frac{1}{30}(1+6t)^{4/3} + C_1$$

At $t = 0$ $\quad V_c = 0.0045$

$$0.0045 = \frac{1}{30} + C_1 \qquad C_1 = -0.028833$$

$$V_c = \frac{1}{30}(1+6t)^{4/3} - 0.028833$$

at $t = 0.000565$ s $\quad \boxed{V_c = 0.00465 \text{ V}}$

 # 24 p765

A current $i = \frac{t}{\sqrt{t^2+1}}$ (in A) is sent through an electric dryer circuit containing a previously uncharged 2.0 μF capacitor. How long does it take for the capacitor voltage to reach 120V?

$t=0 \quad V_c = 0$

$$V_c = \frac{1}{2\times10^{-6}} \int \frac{t}{\sqrt{t^2+1}}\, dt$$

$$V_c = \frac{1}{2\times10^{-6}} \sqrt{t^2+1} + C_1$$

$$0 = \frac{1}{2\times10^{-6}} + C_1 \qquad C_1 = -500000$$

$$V_c = (0.5)10^6\sqrt{t^2+1} - 500000$$

At $t = ?$ does $V_c = 120$V?

$$120 = 0.5(10^6)\sqrt{t^2+1} - 500000$$

$$\sqrt{t^2+1} = 1.00024$$

$$t^2 = 0.00048$$

$$t = 0.0219 \qquad \boxed{21.9 \text{ ms}}$$