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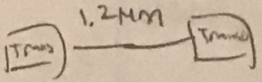
HW #1

1) 10 layers

Bottom layer transistors connected by copper lines

9 others all copper lines



5 billion transistors

(5 billion − 1) copper lines on bottom layer

$(100 \text{ million})(0.2\ \mu m) = 20{,}000{,}000\ \mu m$ = length of 1 adjacent layer

$\approx 20\ m$

$(5 \text{ billion} - 1)(1.2\ \mu m) = 5{,}999{,}999{,}998.8\ \mu m$ = length of copper connecting transistors

$\approx 6{,}000\ m$

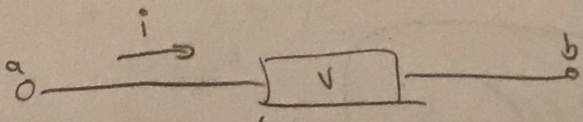
$2(5{,}999{,}999{,}998.8) = 11{,}999{,}999{,}997.6\ \mu m$ = length of copper in the upper 9 layers

$\approx 12{,}000\ m$

$9(20m) + (6000m) + 9(12{,}000m) = 180 + 6000 + 108000$

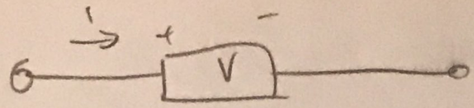
$= \boxed{114{,}180\ m \text{ total}}$

2)



Passive sign convention shows that the circuit is absorbing power.

3) a)



$$q(t) = \int i(t)\,dt = \int_0^t 125 e^{-2500t} \cdot 10^{-3}$$

$$= 10^{-3}\cdot 125 \int_0^t e^{-2500t}\,dt = 10^{-3}\cdot 125 \int_0^t \frac{1}{-2500} e^{-2500t}\,dt$$

$$= \frac{125 \cdot 10^{-3}}{-2500} \int_0^t e^{-2500t}\,dt = -\frac{1}{20}\cdot 10^{-3} e^{-2500t} \Big|_0^t$$

$$= \boxed{-\frac{1}{20}\cdot 10^{-3}\left(e^{-2500t} - 1\right)\ C}$$

b) $$\int_0^\infty 10^{-3}\cdot 125 e^{-2500t}\,dt = 10^{-3}\cdot -\frac{1}{20} e^{-2500t} \Big|_0^\infty =$$

$$-\frac{1}{20}\cdot 10^{-3}(0-1) = \boxed{\frac{1}{20}\cdot 10^{-3}\ C}$$

c) $$q(0.0005) = -\frac{1}{20}\cdot 10^{-3}\left(e^{(-2500)(0.0005)} - 1\right)$$

$$= \boxed{3.57 \cdot 10^{-5}\ C}$$

4) a) $i = 40\,A$ $\quad V = 12$

B should be absorbing power, so B.

b) $1.5\text{ min} \cdot \frac{60\text{ s}}{1\text{ min}} = 90\text{ s}$ $\quad P = \frac{dw}{dt} = vi$

$(12)(40) = \quad W = \int_0^{90} 480\,dt = (480)(90) = \boxed{43200\text{ J}}$

5) $v = 250\cos 800\pi t$ $\quad i = 8\sin 800\pi t$

a) $P = v \cdot i = 250\cos(800\pi t) \cdot 8\sin(800\pi t)$

$= 2000 \cdot 0.5[\sin(1600\pi t) + \sin(0)] = 1000\sin(1600\pi t)$

$P_{max} =$ when $\sin(1600\pi t) = 1$, so $\boxed{1000\text{ W}}$

b) $P_{delivered} = P_{absorbed}$

$\boxed{1000\text{ W}}$

c) $2.5\text{ ms} = 2.5 \cdot 10^{-3}$

$$\frac{1}{2.5 \cdot 10^{-3}} \int_0^{2.5 \cdot 10^{-3}} 1000\sin(1600\pi t)\,dt = \frac{1000}{2.5 \cdot 10^{-3}} \int_0^{2.5 \cdot 10^{-3}} \sin(1600\pi t)\,dt$$

$$= \frac{1000}{2.5 \cdot 10^{-3}} \left(-\frac{1}{1600\pi}\right) \cos(1600\pi t) \Big|_0^{2.5 \cdot 10^{-3}} = -\frac{1000}{1600\pi \cdot 2.5 \cdot 10^{-3}} + \frac{1000}{1600 \cdot 2.5 \cdot 10^{-3}} =$$

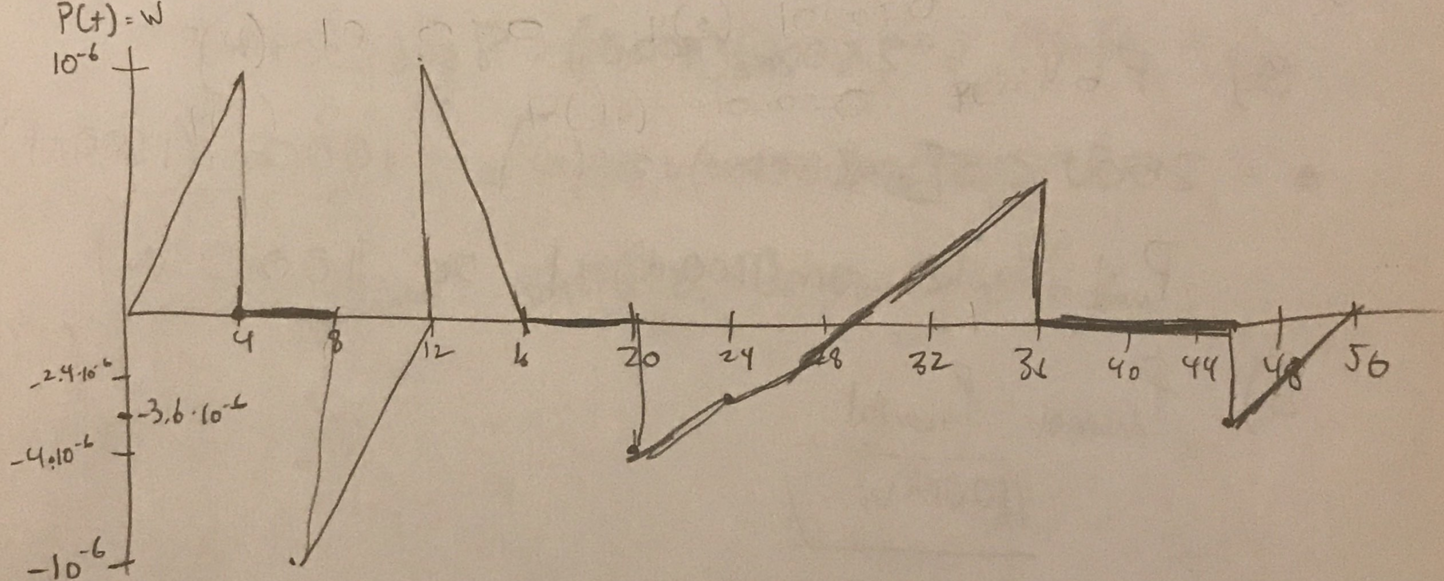
$\boxed{0\text{ W}}$

d) $\frac{1}{15.625\cdot10^{-3}}\int_0^{15.625\cdot10^{-3}} 1000\sin(1600\pi t)\,dt = \frac{1000}{15.625\cdot10^{-3}}\int_0^{15.625\cdot10^{-3}} \sin(1600\pi t)\,dt$

$= \left(\frac{1000}{15.625\cdot10^{-3}}\right)\left(-\frac{1}{1600\pi}\right)\cos(1600\pi t)\Big|_0^{15.625\cdot10^{-3}} =$

$\left(\frac{1000}{15.625\cdot10^{-3}}\right)\left(-\frac{1}{1600\pi}\right)(-1-1) = \boxed{25.46\ W}$

6) a) $p = V\cdot i$



b) $P(4) = 0W$ $\quad P(12) = 0W$

$P(36) = 0W$ $\quad P(50) = 0W$

7) $P_a = (-3)(250) = -750$

$P_b = 4 \cdot 400 = 1600$

$P_c = -400$

$P_d = 150$

$P_e = -800$

$P_f = 200$

$P_a + P_c + P_e = -750 + 400 - 800 = 1950$

$P_b + P_d + P_f = 1600 + 150 + 200 = 1950$

The circuit satisfies The power check

8) $d = -1A$

	V	X	P
a	120	-10	-1200
b	120	9	-1080
c	10	10	100
d	10	-1	10
e	-10	-9	90
f	-100	5	500
g	120	4	440
h	-220	-5	1100

$P_a + P_b = P_{developed} = -2280.$

$P_c + P_d + P_e + P_f + P_g + P_h = P_{absorbed} = 2280.$

$P_{developed} = P_{absorbed}.$