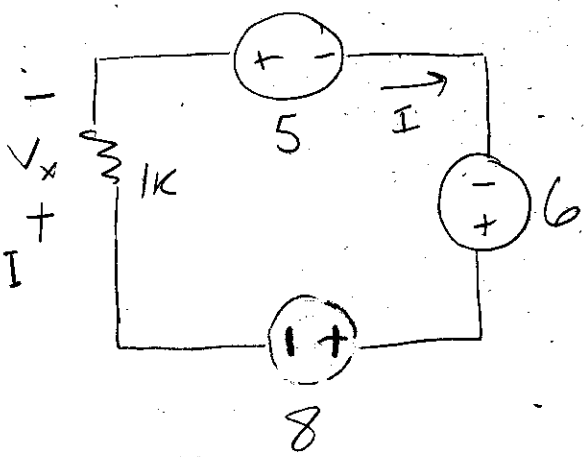
Practice Exam Solutions

Problem 1:

Assign a voltage to the resistor & do KVL:

assigned in this direction so I can find I



KVL: (clockwise, starting at top)

$$5 - 6 + 8 + x = 0$$

$$x = 6 - 8 - 5 = -7\ V$$

So $I = \frac{-7V}{1K} = -7mA$.

So positive current flows clockwise thru the circuit.

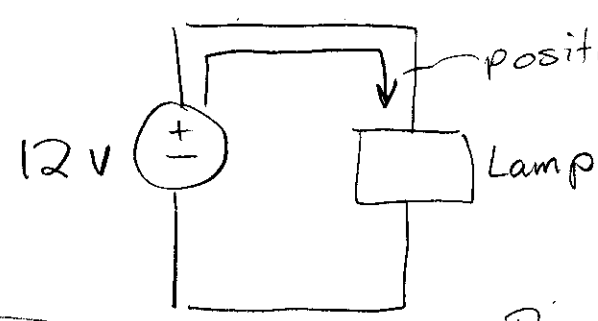
Positive current flows + to − thru 6V battery:

6V battery is charging (absorbing power).

Positive current flows − to + thru 5 + 8 V batteries:

5 + 8 V batteries are discharging (releasing)

Problem 2:



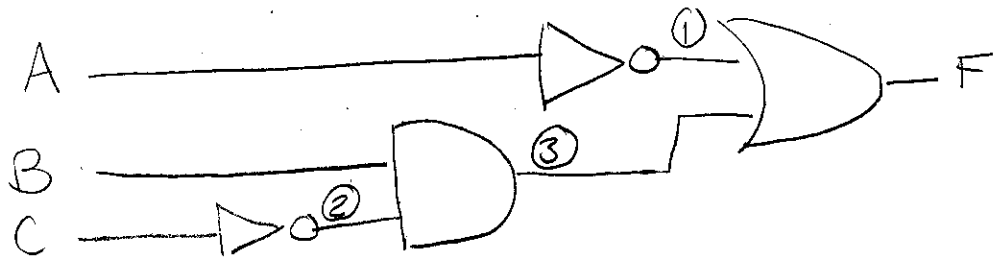
$10\ W = .28\ P_{total}$ — total power absorbed by lamp

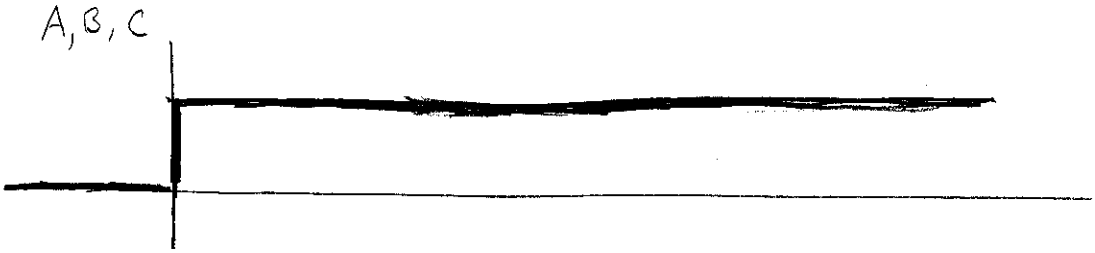
$P_{total} = 35.7\ W$

$P_{total} = VI \quad I = \frac{P_{total}}{V} = \frac{35.7}{12}$

$I = 2.975\ A$

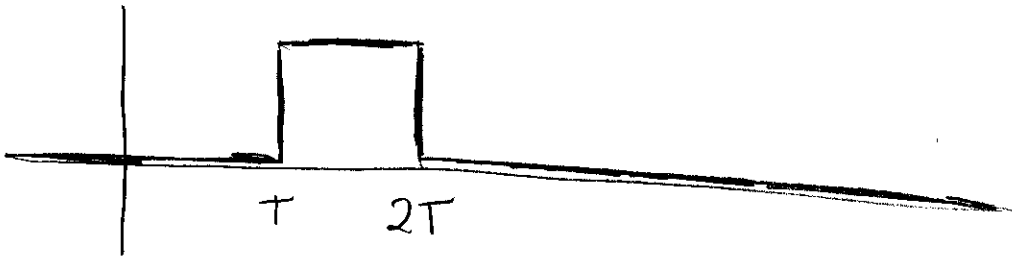
Problem 3:



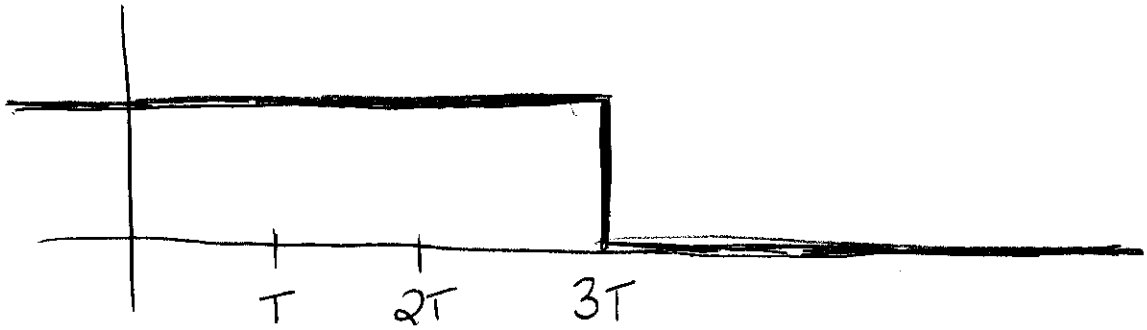


① and ② ($\bar{A}$ and $\bar{C}$) have the same graph:

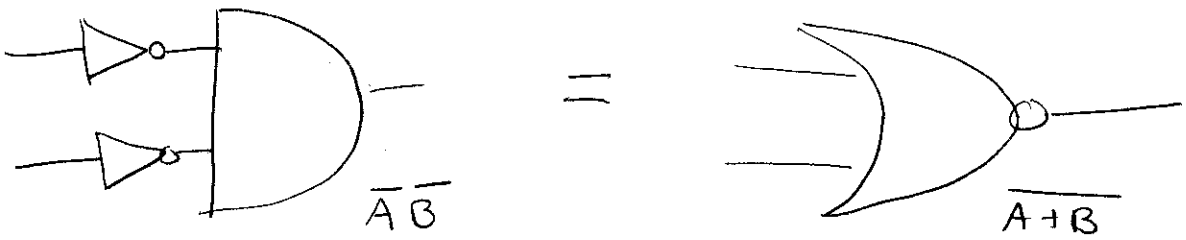
③ ($B\bar{C}$)

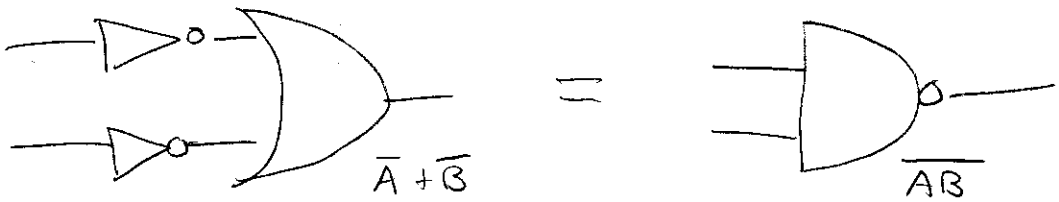


F ($\bar{A} + B\bar{C}$)

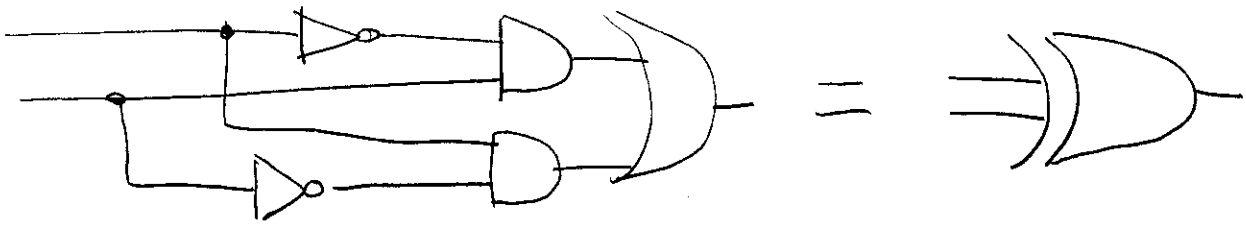


Problem 4:





Both are consequences of DeMorgan's Law.

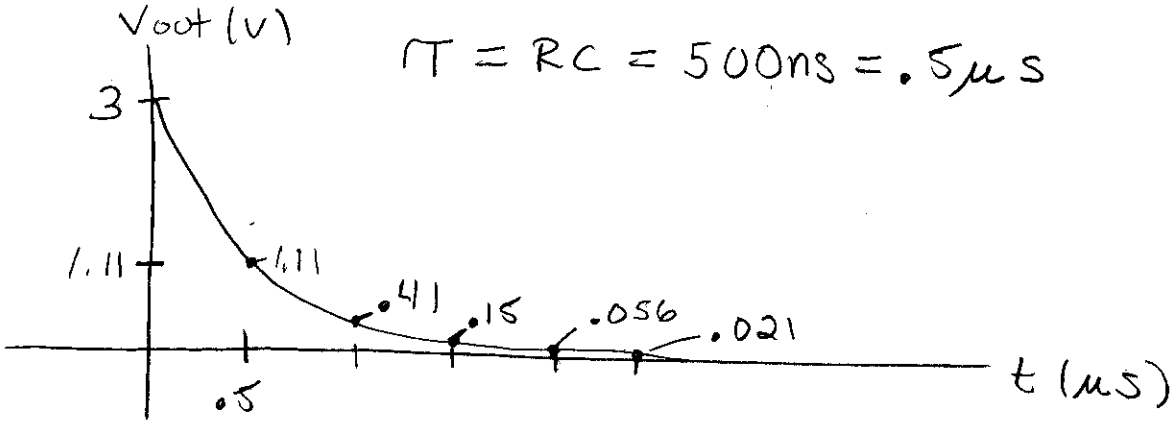


$\bar{A}B + \bar{B}A$ $\qquad$ $A \oplus B$

XOR

Problem 5:

a)



$\tau = RC = 500\text{ns} = .5\,\mu s$

b) $V_{out}(t) = V_{in} + (V_{out}(t=0) - V_{in})\,e^{-t/RC}$

$= 3e^{-t/500\text{ns}}\ \text{V}$

c) 2 ways: $i(t) = C\frac{dV_{out}}{dt}$ or

$$i(t) = \frac{V_R(t)}{R} = \frac{V_{in} - V_{out}(t)}{R}$$

resistor voltage

$$i(t) = \frac{-3e^{-t/500ns}}{10k\Omega} = -0.3e^{-t/500ns}\ mA$$

d) $$E = \int_0^\infty \underbrace{R(i(t))^2}_{P_R(t)}\,dt = \int_0^\infty 10\times10^3(-.3\times10^{-3}e^{-t/500ns})^2\,dt$$

nope I did my math right... :)

$$= \int_0^\infty .9\times10^{-3}e^{-\frac{t}{250ns}}\,dt$$

$$= (250\times10^{-9})(.9\times10^{-3})\,e^{-\frac{t}{250ns}}\Big|_0^\infty$$

$$= (250\times10^{-9})(.9\times10^{-3}) = 225\times10^{-12} = 225\,pJ$$

e) The resistor dissipated the energy that was stored in the capacitor.

f) energy produced by capacitor $= \frac{1}{2}C\,V_{out}(0)^2$

energy at start of dissipation

$$= \frac{1}{2}\cdot50\times10^{-12}\cdot3^2 = 225\times10^{-12} = 225\,pJ$$

Same as resistor dissipated!