3)

a) We know that average current through C_2 at steady state is zero.

$V_o = 12V$ $\quad P_o = 24W \Rightarrow I_o = 2A$ $\quad R_o = R = 6\Omega$

$V_{in} = 16V$ $\quad P_{in} = 24W \Rightarrow I_{in} = I_{L_1, mean} = 1.5A$

$\downarrow$

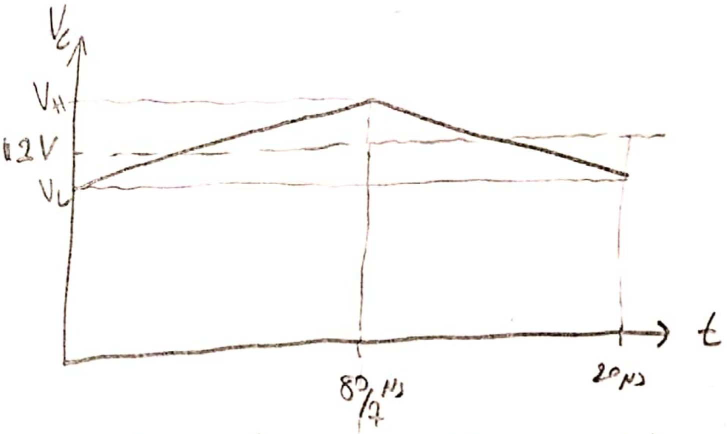
assumed all components are ideal

We know that $V_o = V_s\left(\frac{D}{1-D}\right)$

$12 = 16\left(\frac{D}{1-D}\right) \Rightarrow \frac{D}{1-D} = \frac{3}{4} \Rightarrow 7D = 3 \Rightarrow D = 3/7$

We know that $f_{sw} = 50kHz$ then $T = 20\mu s$

While the switch in conduction $\Rightarrow$ for $\frac{60}{7}\mu s$ capacitor supplies power to the load this means that capacitor is discharging.



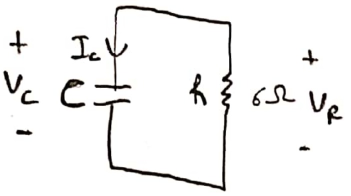
switch is not in conduction Capacitor is charging

switch in conduction capacitor is discharging

If we have 2% voltage ripple then

$V_H = 12.12V$, $V_L = 11.88V$ $\Rightarrow \Delta V = 0.24V$

discharging $\Rightarrow$



If we assume constant discharging current = 2A then

$$V_C(t) = V_C(0) + \frac{1}{C}\int_0^t i(t)\,dt$$

$$11.88 = 12.12 + \frac{1}{C}\int_0^{60/7\,\mu s} -2\,dt$$

$$\boxed{C = 71.43\,\mu F}$$

Lets calculate it without assuming constant discharge current. (But 6Ω R Load)

$$V_C(t) = V_C(0) + \frac{1}{C}\int_0^t i(t)\,dt$$

$$i_C = C\frac{dV_C}{dt}$$

$$V_C - V_R = 0 \Rightarrow V_C + C\frac{dV_C}{dt}R = 0 \Rightarrow V_C + CR\dot{V}_C = 0$$

$$+\frac{1}{CR}V_C + dV_C = 0$$

$$e^{+t/CR}\,dV_C + \left(+\frac{1}{CR}\right)e^{+t/CR}\,V_C = 0$$

$$d\left(e^{+t/CR}\,V_C\right) = 0$$

$$V_C = c\,e^{-t/CR}$$

$$V_C(0) = C = 12.12V$$

$$V_C(t) = V_C(0)\,e^{-t/RC} \Rightarrow V_C\left(\frac{60}{7}\mu s\right) = V_C(0)\,e^{-\frac{60/7\,\mu s}{6C}}$$

$$11.88 = 12.12\,e^{-\frac{60/7\,\mu s}{6C}}$$

$$-0.02 = -\frac{60/7\,\mu s}{6C} \Rightarrow \boxed{C = 71.42\,\mu F}$$

this shows us that we can we constant discharge current method.