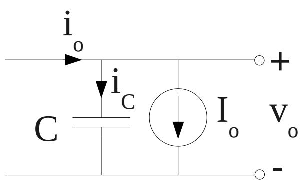
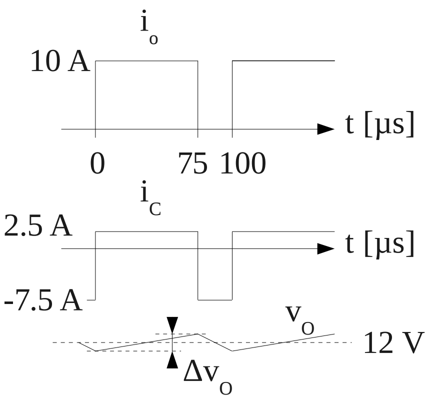
1. a) DPF = cos phi, and cos never becomes larger than 1.
   b) Fill factor = Pmax/(Uopen*Ishort), that is, the maximum output power over the product of no-load voltage times the short-circuit current.
   c) No it is not necessary. The three currents cancels out, and the current through a common ground wire would be zero.
   d) No, the capacitor will only produce reactive power, with zero active power.
   e) The transistor can have a lower forward voltage drop than the diode

2. a) I_{0avg} = 10*75/100 = 7.5 A
   b) $i_C = i_O - I_O$, alternating between 2.5 and -7.5 A.

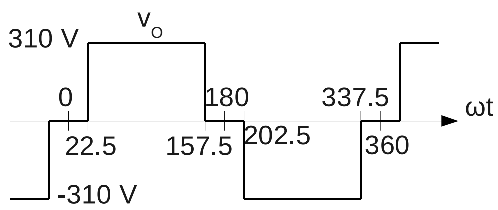




$$i_c(t)=C\frac{dv_c}{dt}=C\frac{dv_o}{dt}$$

$$\Delta v_o=\frac{1}{C}\int_0^{75\cdot 10^{-6}} 2.5\,dt=\frac{75\cdot 10^{-6}\cdot 2.5}{7500\cdot 10^{-6}}=25\,mV$$

3. a) Select ωt=0 in middle of cancellation time.



   b)

$$V_{O,RMS}=\sqrt{\frac{1}{T}\int_0^T v_o^2(t)dt}=$$
$$=\sqrt{\frac{1}{360}\int_0^{360} v_o^2(\omega t)d(\omega t)}=$$
$$=310\sqrt{\frac{1}{360}(\int_{22.5}^{157.5} d(\omega t)+\int_{202.5}^{337.5} d(\omega t))}=$$
$$=310\sqrt{\frac{1}{360}(157.5-22.5+337.5-202.5)}=$$
$$=310\sqrt{\frac{270}{360}}=310\frac{\sqrt{3}}{2}=268\,V$$

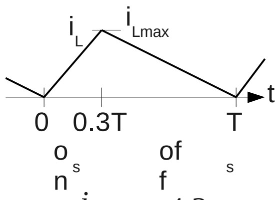
   c) f(t) with the chosen zero position is half-wave and odd, that is an odd quarter-wave (f(-t) = -f(t), f(t) = -f(t+1/2T)). Therefore $a_1 = 0$.

$$b_1=\frac{4}{\pi}\int_0^{\frac{\pi}{2}} f(t)\sin(\omega t)d(\omega t)=\frac{4}{\pi}\int_{\frac{\pi}{8}}^{\frac{\pi}{2}} 310\sin(\omega t)d(\omega t)=\frac{4\cdot 310}{\pi}\left[-\cos(\omega t)\right]_{\pi/8}^{\pi/2}=$$
$$=\frac{4\cdot 310}{\pi}(-\cos(\pi/2)--\cos(\pi/8))=\frac{4\cdot 310\cos(\pi/8)}{\pi}=365\,V$$

That is, the peak value of the fundamental of the output voltage is 365V.

4. a) Buck converter voltage output for continuous current gives $V_o = D\ V_d = 0.3*24 = 7.2V$

b) Boundary between discontinuous and continuous current => i_L goes to zero at $t = T_s = 1/10e3 = 0.1$ ms. Switch on between 0 and $0.3T_s$, off between $0.3T_s$ and T_s.

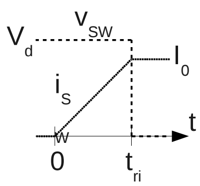


$$T_s = \frac{1}{f_s} = \frac{1}{10 \cdot 10^3} = 0.1\,ms$$

$$i_{Lmax} = 0.7\,T_s \frac{V_o}{L} = \frac{0.7}{f_s}\frac{V_o}{L} = \frac{0.7 \cdot 7.2}{10 \cdot 10^3 \cdot 0.12 \cdot 10^{-3}} = 4.2\,A$$

c) $I_O = \frac{i_{Lmax}}{2} = \frac{4.2}{2} = 2.1\,A$

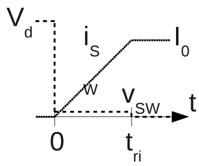
5. a) At turn on without the snubber results in the full voltage V_d being applied over the switch (diode in parallel with I_0 conducting) while the current increase from zero to I_0.



$$P_{SWon} = f_{SWon} \cdot V_d \cdot \frac{I_0}{2} \cdot t_{ri} = 10^3 \cdot 300 \cdot \frac{20}{2} \cdot 5 \cdot 10^{-6} = 15\,W$$

b) 5% of V_d across the switch at turn on leaves 95% of V_d across L. The current increase should still be same as defined by the switch.

$$L = \frac{v_L}{di_L/dt} = \frac{0.95\,V_d}{\Delta i_L/t_{ri}} = \frac{0.95 \cdot 300}{20/5 \cdot 10^{-6}} = 71.3\,\mu H$$



c) At turn-off will the diode in parallel with I_O start to conduct when the i_{SW} starts to decrease.

The snubber diode starts to conduct, and the current now flows through R instead of the switch. Assuming the current fall time can be neglected compared to the LR time constant τ_{LR} at time t_{off}:

$$v_{sw} = V_d + R I_0$$
$$v_{sw} < 2V_d$$
$$V_d + R I_0 < 2V_d$$
$$R I_0 < 2V_d - V_d = V_d$$
$$R < \frac{V_d}{I_0} = \frac{300}{20} = 15\,\Omega$$
$$R < 15\,\Omega$$