

### Assignment 3 - Rectifier

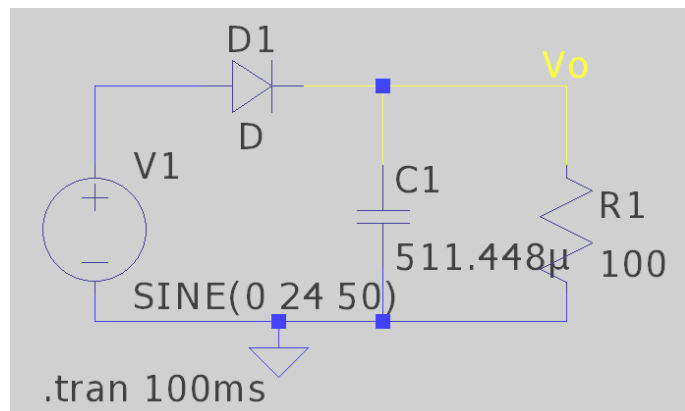
Forjanic Rémy (511448)

$$C_1 = \frac{511448}{1000} = 511.448 \mu f$$

$$U_{max} = 24V$$

$$f = 50Hz$$

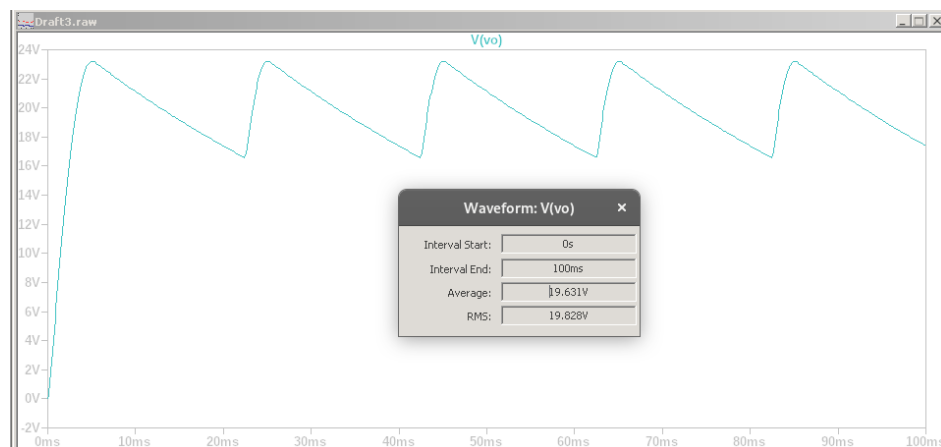
#### Question 1 - Half wave rectifier



Calculate the average voltage across the load and the voltage ripple.

$$U_{dc} \approx \left(1 - \frac{1}{2fR_L C}\right) V_{max}$$

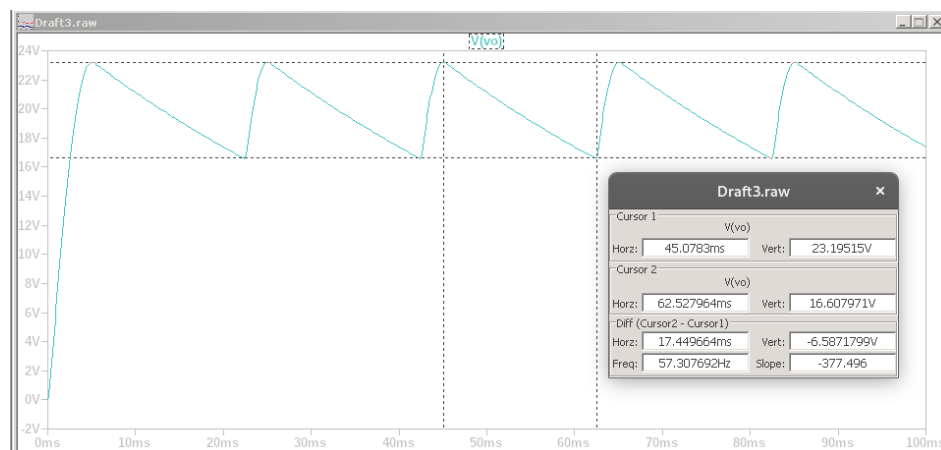
$$\approx \left(1 - \frac{1}{(2)(50)(100)(511.448 \times 10^{-6})}\right) (24) \approx 19.31V$$



$$F_r = \frac{1}{fR_L C}$$

$$= \frac{1}{(50)(100)(511.448 \times 10^{-6})} = 0.391 = 39.1\%$$

$$V_{rpp} = F_r \cdot U_{dc} = (0.391)(19.31) = 7.55V$$

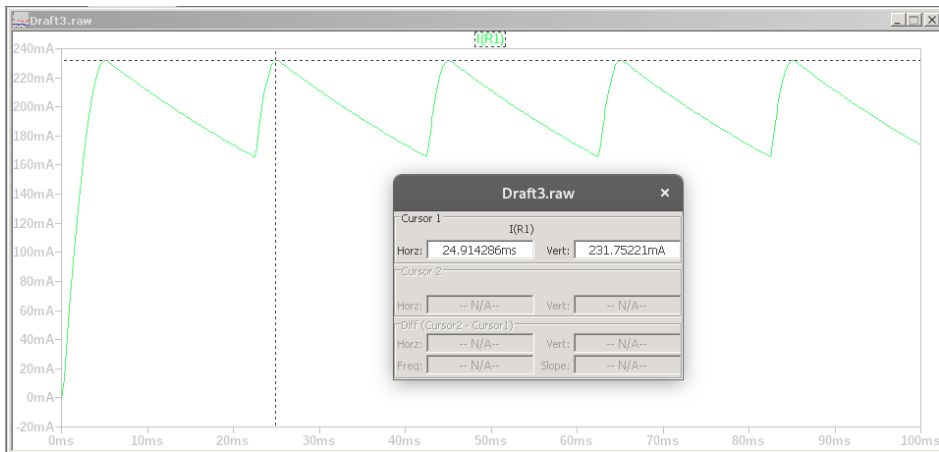


There is a difference of  $\approx 1V$  between the simulation and the calculation, this could be due to the fact that during the calculation all the components are assumed perfect, which might not be the case during the simulation.

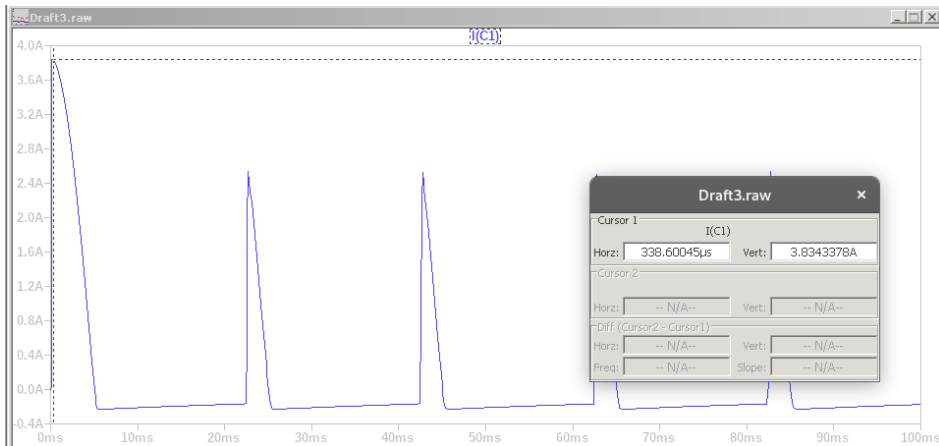
Calculate the peak current through the capacitor and the diode.

If we assume that the diode create a voltage drop of 0.7V:

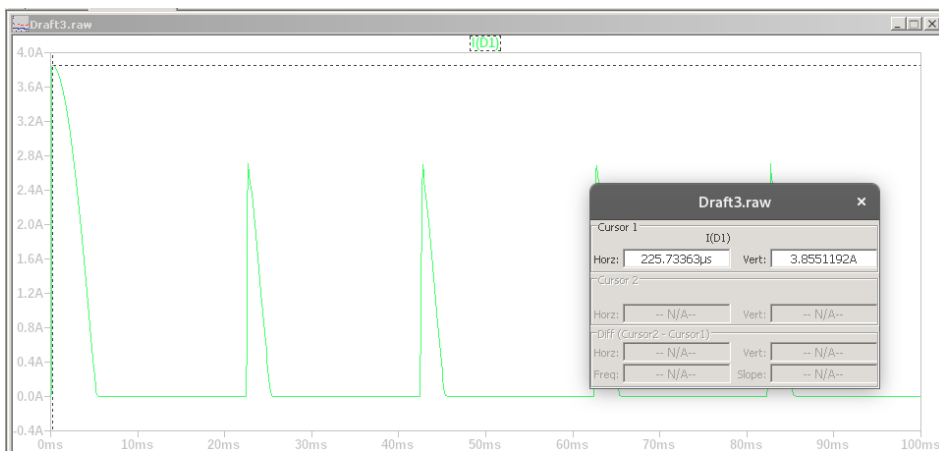
$$I_{R_L} = \frac{U_{max} - 0.7}{R_L} = \frac{23.3}{100} = 0.233A = 233mA$$



$$I_C = \omega C U_{maz} = (100\pi)(511.448 \times 10^{-6})(23.3) = 3.74A$$

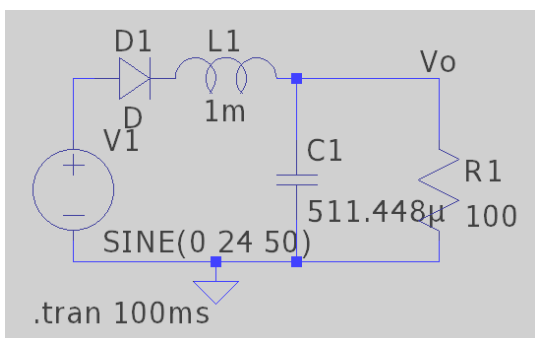


$$I_D = I_C + I_{R_L} = 3.74 + 0.233 = 3.974A$$

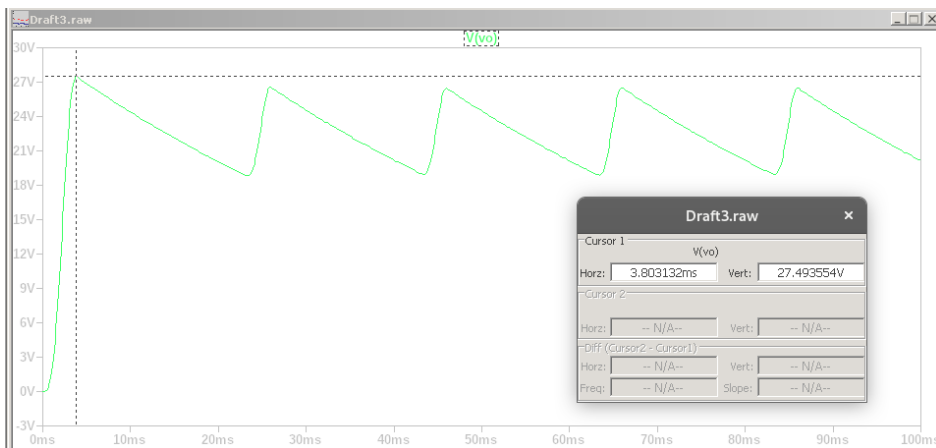


## Question 2 - Half wave rectifier with series inductance

With  $L = 1mH$

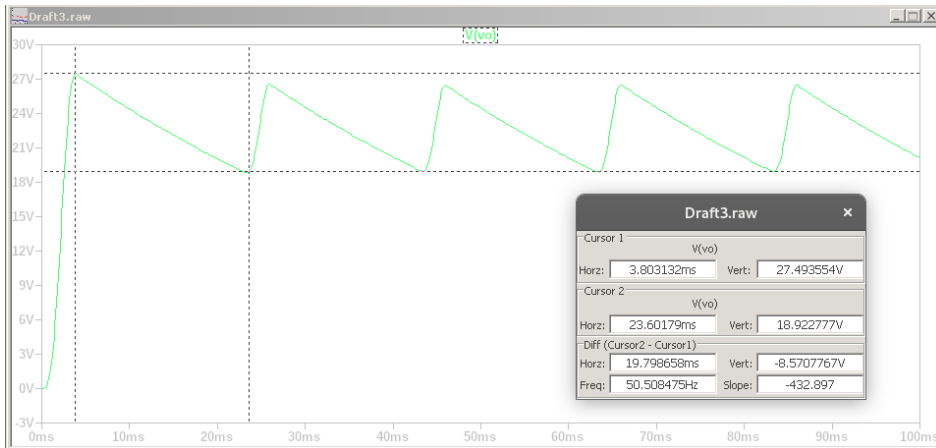


What is the influence of the inductor on the maximum voltage?



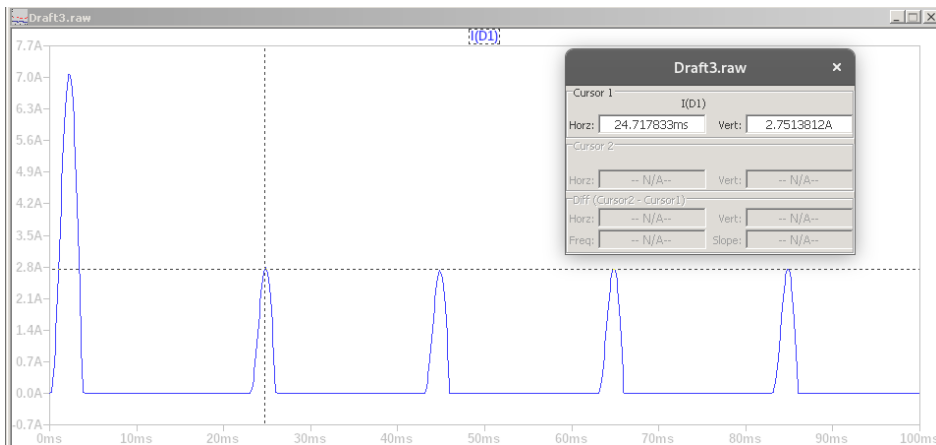
When we add the inductor, the maximum voltage decreases.

What is the influence on the ripple voltage



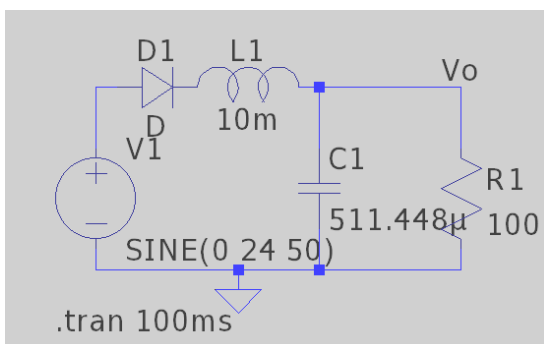
When we add the inductor, the ripple voltage increases.

What is the influence of the inductor on the peak current ( $t > 20ms$ ) through the diode?

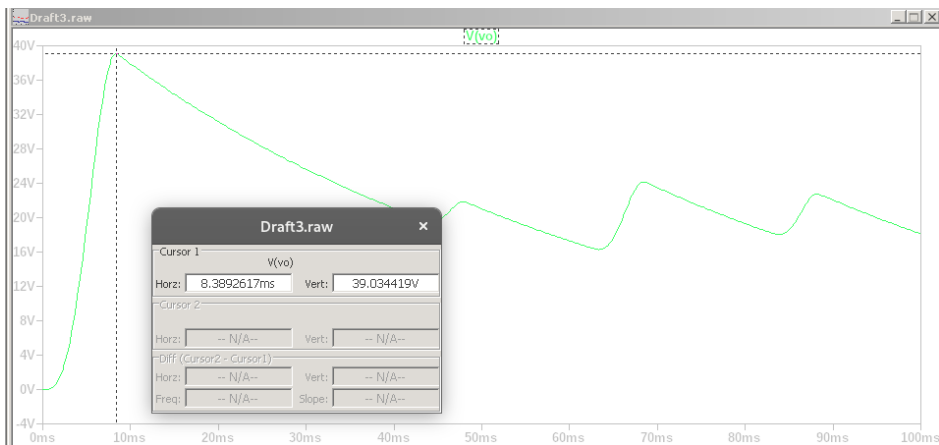


The inductor doesn't seem to change the peak current (when  $t > 20ms$ ) through the diode.

With  $L = 10mH$

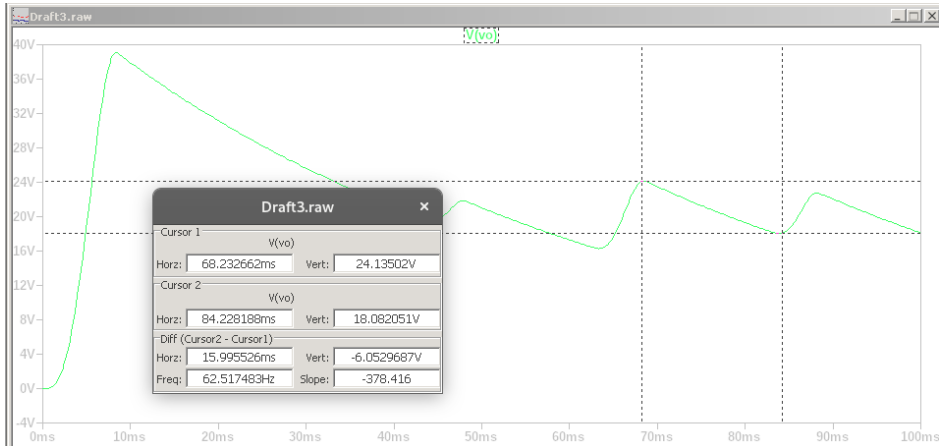


What is the influence of the inductor on the maximum voltage?



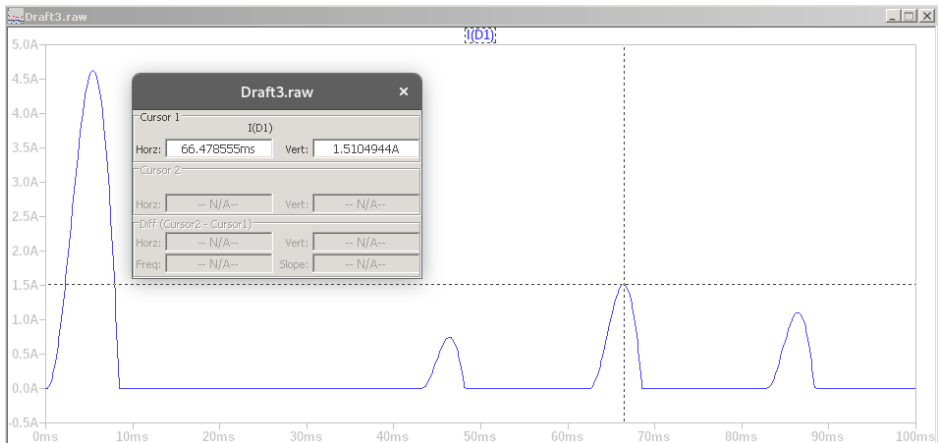
When we increase the value of the inductor, the maximum voltage decreases (when  $t > 20ms$ ) but increases when  $t < 20ms$ .

What is the influence on the ripple voltage



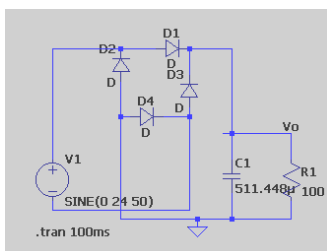
When we increase the inductance, the ripple voltage is not stable anymore but decreases (when  $t > 20ms$ ).

What is the influence of the inductor on the peak current ( $t > 20ms$ ) through the diode?



When we increase the inductance, the peak current decreases.

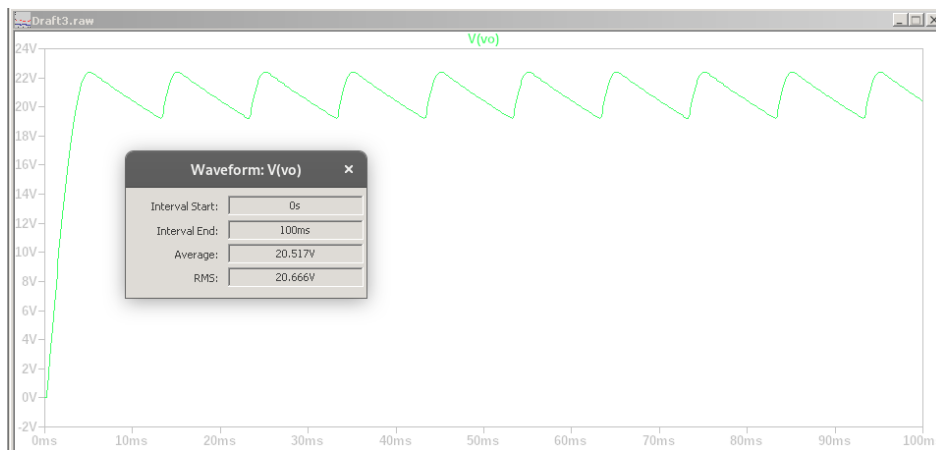
### Question 3 - Full wave rectifier



Calculate the average voltage across the load and the voltage ripple.

$$U_{dc} = U_{max} - \frac{U_{max}}{4fR_L C}$$

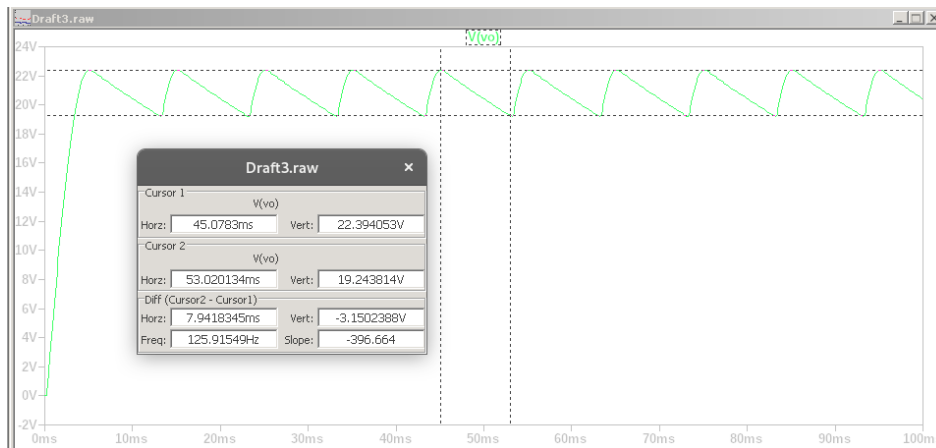
$$= 24 - \frac{24}{4(50)(100)(511.448 \times 10^{-6})} = 21.65V$$



The difference is due to  $U_{max}$  not being  $24V$  but  $\approx 22V$  because of the diodes.

$$\Delta U = \frac{U_{max}}{2fR_L C}$$

$$= \frac{24}{2(50)(100)(511.448 \times 10^{-6})} = 4.70V$$

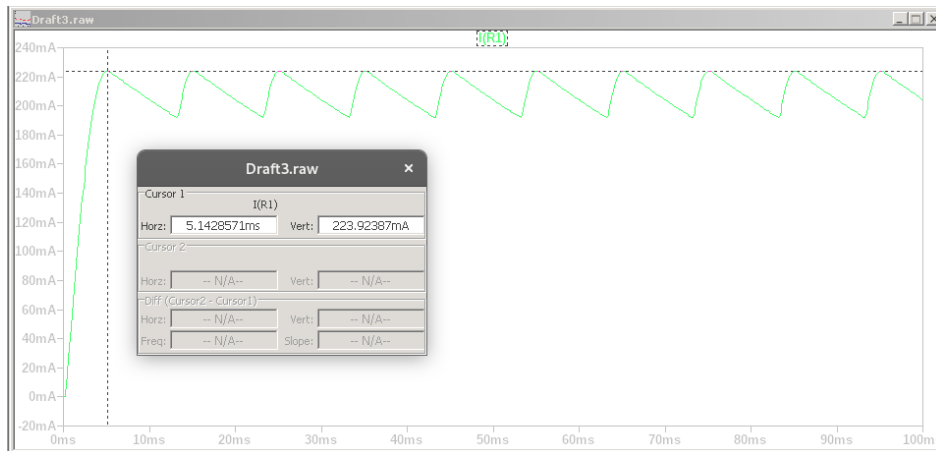


Same as above, the difference is due to  $U_{max}$ .

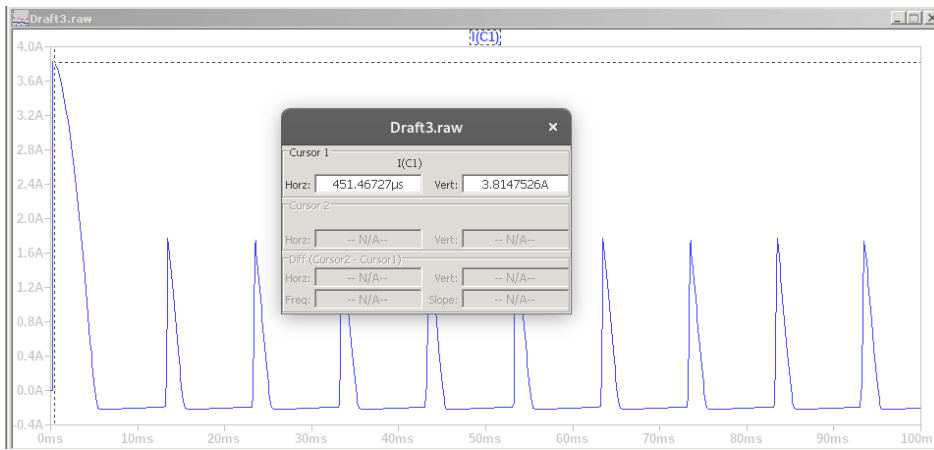
Calculate the peak current though the capacitor and the diode.

Assuming that the voltage drop of the diode is  $0.7V$ :

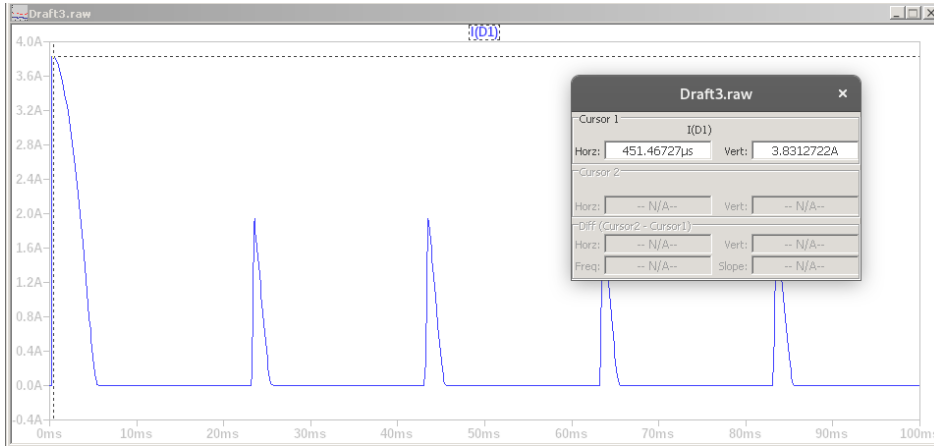
$$I_{R_L} = \frac{U_{max} - 1.4}{R_L} = \frac{22.6}{100} = 0.226A = 226mA$$



$$I_C = \omega C U_{max} = (100\pi)(511.448 \times 10^{-6})(22.6) = 3.63A$$

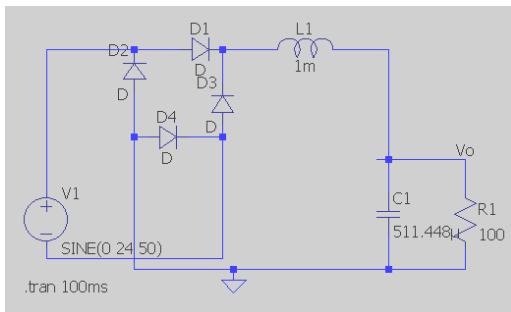


$$I_D = I_C + I_{R_L} = 3.63 + 0.226 = 3.853A$$

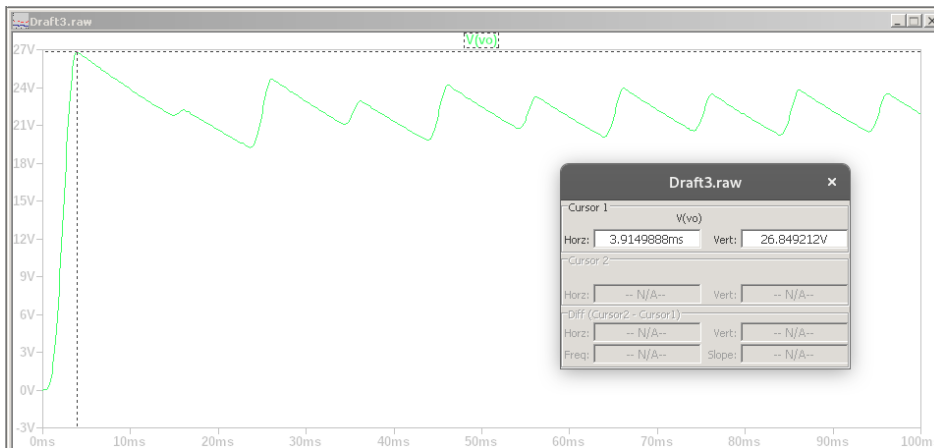


#### Question 4 - Full wave rectifier with series inductance

With  $L = 1mH$

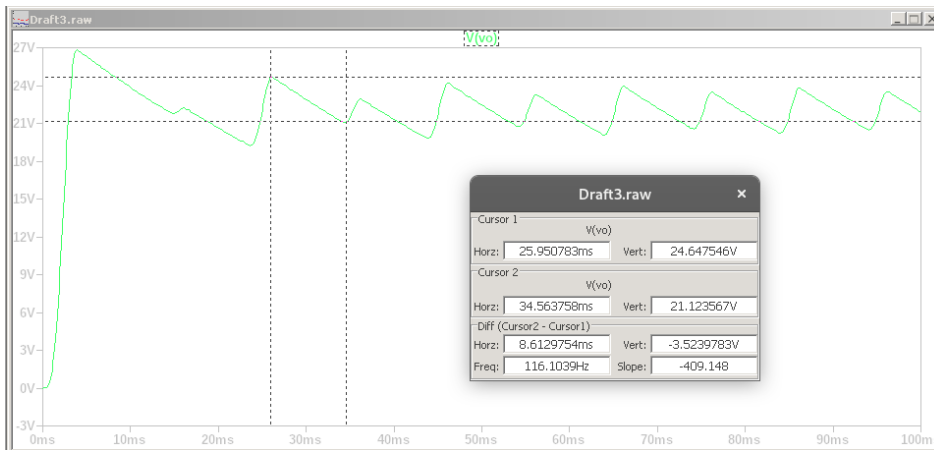


What is the influence of the inductor on the maximum voltage?



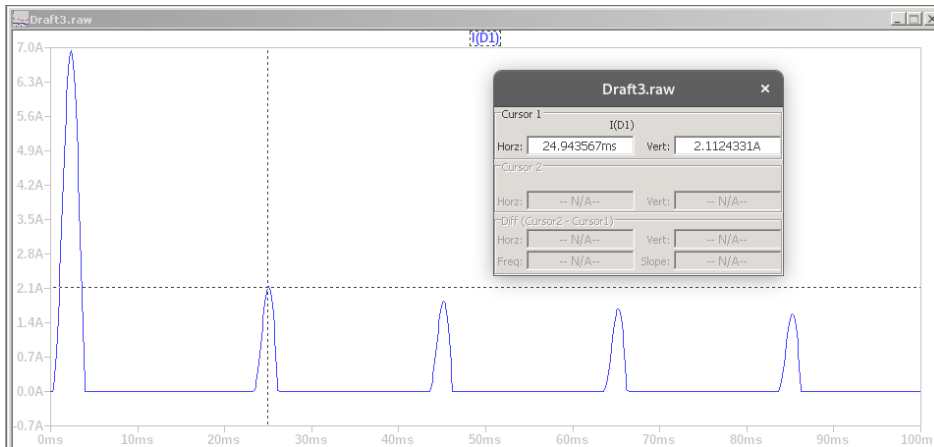
The maximum voltage decreases when we add the inductor.

What is the influence on the ripple voltage



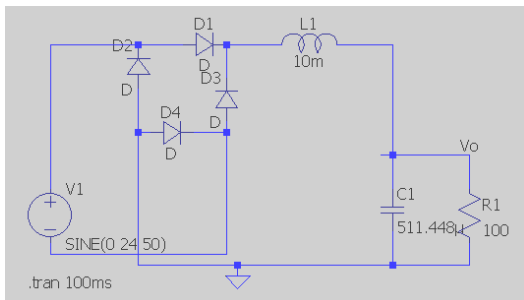
The ripple voltage decreases when we add the inductor but it seems like there are 2 different ripples.

What is the influence of the inductor on the peak current ( $t > 20ms$ ) through the diode?

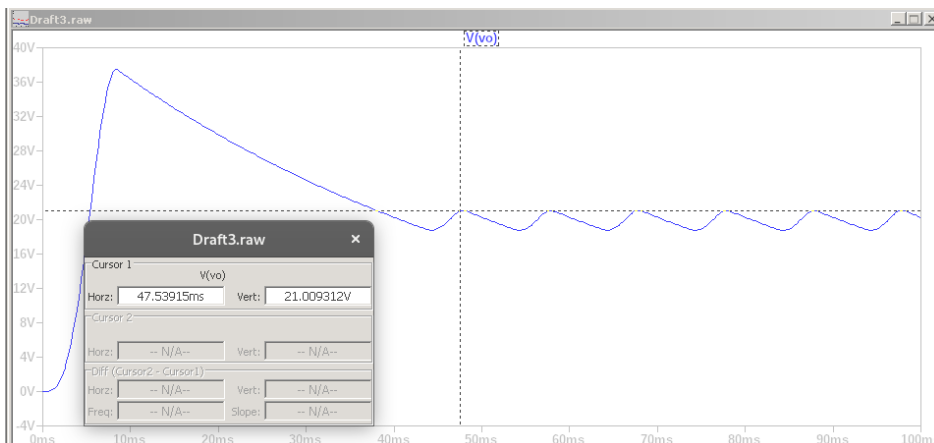


The peak current through the diode decreases when we add an inductor.

With  $L = 10mH$

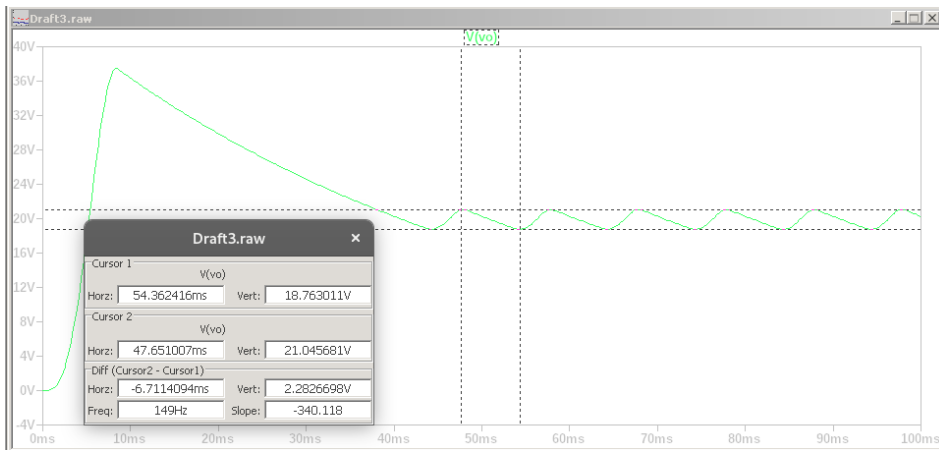


What is the influence of the inductor on the maximum voltage?



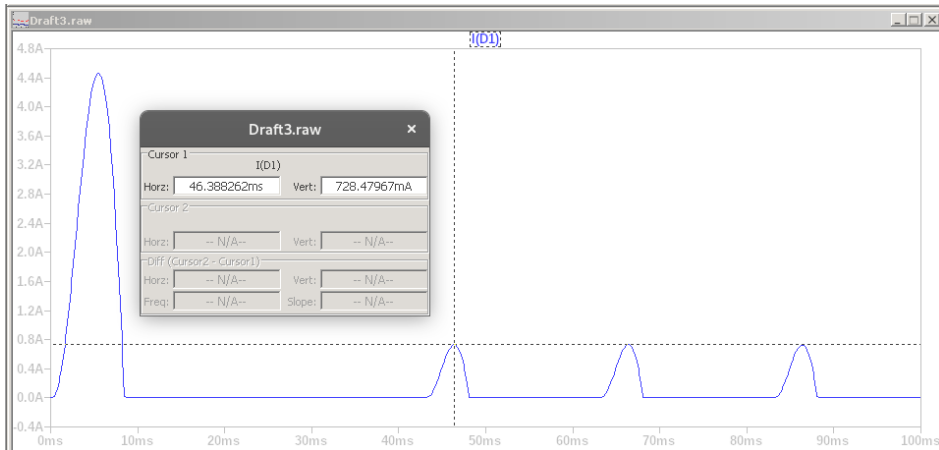
When we increase the inductance of the inductor, the maximum voltage decreases (at least for  $t > 20ms$ ).

What is the influence on the ripple voltage



When we increase the value of the inductor, the ripple voltage decreases.

What is the influence of the inductor on the peak current ( $t > 20ms$ ) through the diode?



When we increase the value of the inductor, the peak current through the diode (when  $t > 20ms$ ) decreases.