POWER ELECTRONICS PROJECT I
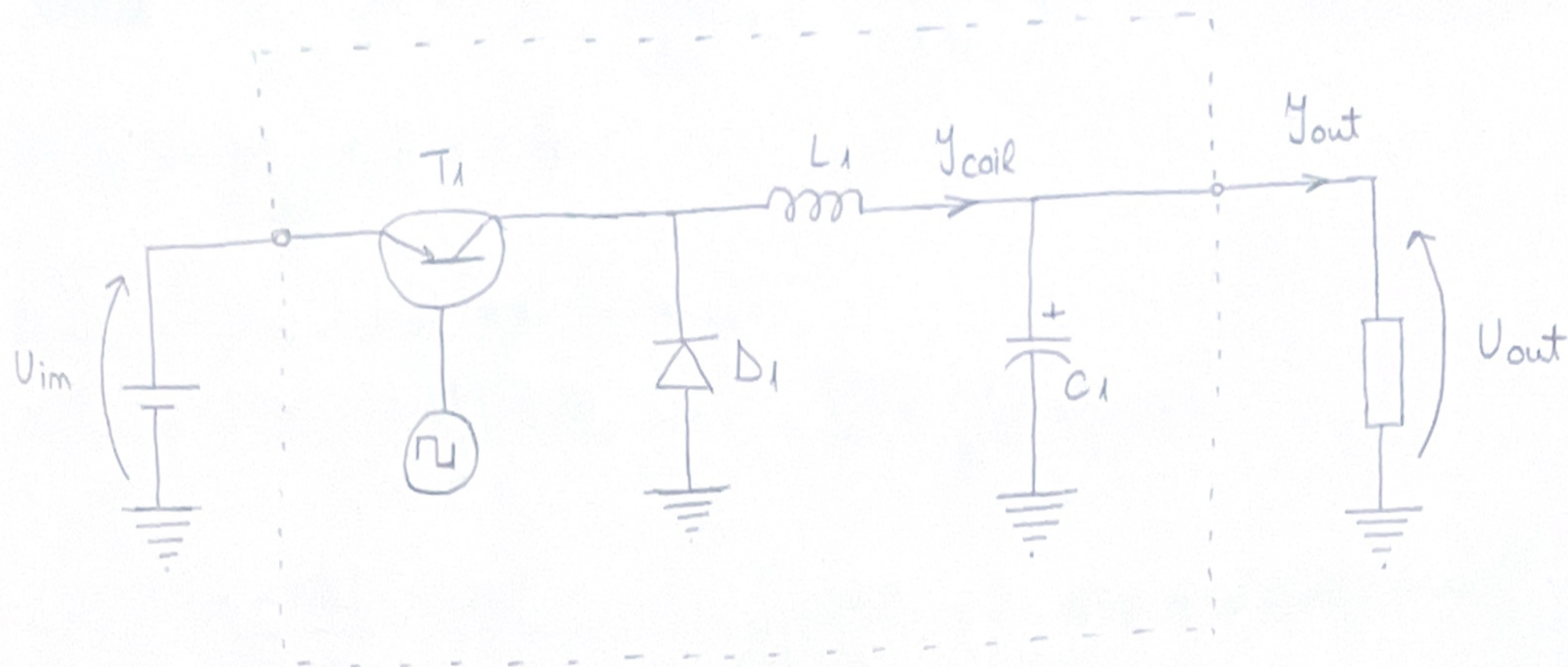
DC buck converter

$U_{im} = 48\,V$ $\qquad$ $I_{out\,max} = 5\,A$ $\qquad\qquad$ $\Delta U_{out} = 800\,mV$

$U_{out} = 12\,V$ $\qquad$ $\Delta I_L = 20\% \cdot max.\ crt.$ $\qquad$ $f_s = 1500\,Hz$

Det: Required duty cicle $\mu = ?$ $\qquad$ Diode average crt: $I_D = ?$

$\qquad$ C_1 capacitance: $C = ?$ $\qquad$ Transistor max crt: $I_{Tmax} = ?$

$\qquad$ L_1 inductance: $L = ?$

$U_{out} = U_{im} \cdot \mu$ $\quad$ — output voltage

$\Delta I_L = (U_{im} - U_{out}) * \mu / (f_s * L)$ — inductor ripple crt

$\Delta U_{out} = \Delta I_L / (8 * f_s * C)$ — output ripple voltage

$I_D = I_{out\,max} * (1 - \mu)$ — diode average crt

$I_{Tmax} = \Delta I_L / 2 + I_{out\,max}$ — transistor max. crt

Chosen components:

C_1: MAL214097602E3

L_1: SC22-06-60J

T_1: Q,H8KC6TCR

D_1: SB550

$$U_{out} = U_{im} \cdot \mu \Rightarrow \mu = \frac{U_{out}}{U_{im}} = \frac{12V}{48V} = 0.25V \Rightarrow \boxed{\mu = 0.25V}$$

$$\Delta Y_L = \frac{20}{100} \cdot 5A = 1A$$

$$\Delta Y_L = (U_{im} - U_{out}) * \mu / (\beta_s * L)$$

$$\Delta Y_L = \frac{(U_{im} - U_{out}) * \mu}{\beta_s * L} \Rightarrow L = \frac{(U_{im} - U_{out}) \cdot \mu}{\beta_s \cdot \Delta Y_L}$$

$$L = \frac{(48-12) \cdot 0.25}{1500 \cdot 1} = \frac{36 \cdot 0.25}{1500} = 0.006 H = 6mH \Rightarrow \boxed{L = 6mH}$$

$$\Delta U_{out} = \frac{\Delta Y_L}{8 \cdot \beta_s \cdot C} \Rightarrow C = \frac{\Delta Y_L}{8 \cdot \beta_s \cdot \Delta U_{out}}$$

$$C = \frac{1}{8 \cdot 1500 \cdot 0.8} = \frac{1}{9600} = 0.000104 F = 104 \mu F \Rightarrow \boxed{C = 104 \mu F}$$

$$Y_\Delta = Y_{outmax} \cdot (1 - \mu) = 5 \cdot (1 - 0.25) = 5 \cdot 0.75 = 3.75A \Rightarrow \boxed{Y_\Delta = 3.75 A}$$

$$Y_{Tmax} = \frac{\Delta Y_L}{2} + Y_{outmax} = \frac{1}{2} + 5 = 5.5A \Rightarrow \boxed{Y_{Tmax} = 5.5 A}$$

Results:

Required duty cicle: $\mu = 0.25V$

C_1 capacitance: $C = 104 \mu F$

L_1 inductance: $L = 6mH$

Diode average current: $Y_\Delta = 3.75A$

Transistor max current: $Y_{Tmax} = 5.5A$