EDP 29072015-SolP2

Examen de Electrónica de Potencia 29/7/2015 CB 26/7/2015

Solución problema 2 - 1 (1)

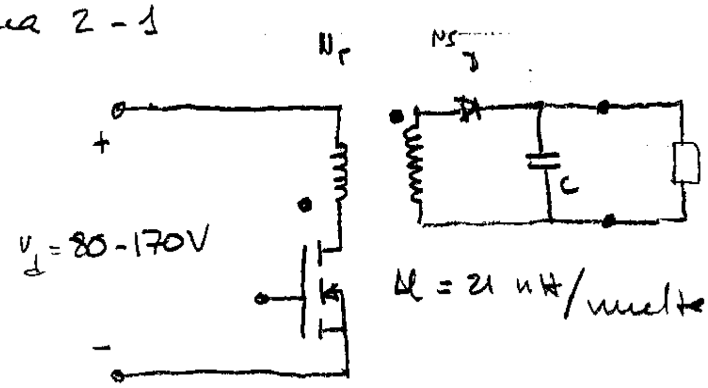
$f = 100 kHz$

$A_L = 21\ nH/vuelta^2$

$\hat{I}_Q = 20A$

$\hat{I}_D = 60A$

MCD



$24V = U_O$

$A_L = 21\ nH/vuelta^2$

Se diseña para que dé P_n máxima para cualquier condición de entrada y con $\hat{I}_Q = 20A$, $\hat{I}_D = 60A$

a) $P_{in} = U_{d_{min}} \dfrac{\hat{I}_Q \delta_{max} T}{2T} = P_O = U_O \dfrac{\hat{I}_D (1-\delta_{max}) T}{2T}$

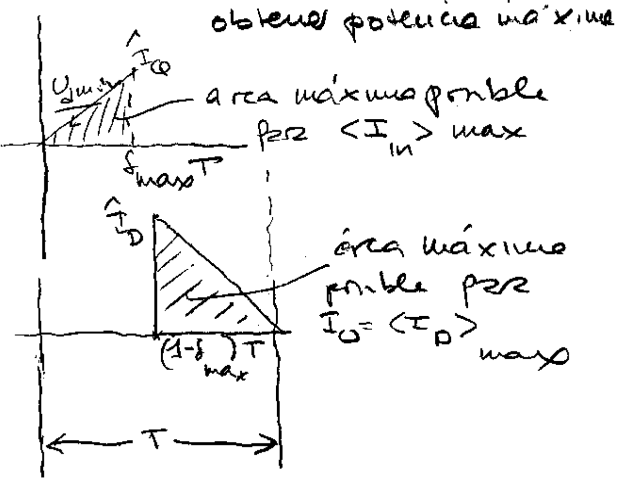
Con $U_{d_{min}}$ impongo límite de MCD para obtener potencia máxima

$$U_{d_{min}} \frac{\hat{I}_Q \delta_{max}}{2} = \frac{U_O \hat{I}_D (1-\delta_{max})}{2}$$

$$\delta_{max} = \frac{U_O}{U_{d_{min}}} \frac{\hat{I}_D}{\hat{I}_Q} (1-\delta_{max})$$

$$\delta_{max} \left(1 + \frac{U_O}{U_{d_{min}}} \cdot \frac{\hat{I}_D}{\hat{I}_Q}\right) = \frac{U_O}{U_{d_{min}}} \frac{\hat{I}_D}{\hat{I}_Q}$$

$$\delta_{max} = \frac{\frac{U_O}{U_{d_{min}}} \cdot \frac{\hat{I}_D}{\hat{I}_Q}}{\left(1 + \frac{U_O}{U_{d_{min}}} \frac{\hat{I}_D}{\hat{I}_Q}\right)} = \frac{0,9}{1+0,9} = \boxed{0,4737}$$



b) $P_n = P_O = P_{in} = U_{d_{min}} \cdot \dfrac{\hat{I}_Q \cdot \delta_{max}}{2} = \boxed{379\ W}$

c) La inductancia del primario es $L_p = U_{d_{min}} \cdot \dfrac{\delta_{max} T}{\hat{I}_Q}$

$$L_p = \frac{80V \cdot 0,4737 \cdot 10 \mu S}{20A} = 18,95\ \mu H$$

$L_p = A_L N_p^2$; $N_p = \sqrt{\dfrac{L_p}{A_L}} = \sqrt{\dfrac{18,95\ \mu H}{0,021\ \mu H/v^2}} = 30,04$ $\boxed{N_p = 30\ vueltas}$

$N_S = \dfrac{\hat{I}_Q}{\hat{I}_p} N_p$ $N_S = \dfrac{20}{60} \cdot 30 = 10$ vueltas $N_S = 10$ vueltas

verificación límite MCD $U_O = \dfrac{N_S}{N_P} U_{d_{min}} \left(\dfrac{\delta_{max}}{1-\delta_{max}}\right) = 24V$ ok

d) $U_{Q_{max}} = U_{d_{max}} + \dfrac{N_P}{N_S} U_O = 170 + \dfrac{30}{10} 24 = \boxed{242V}$

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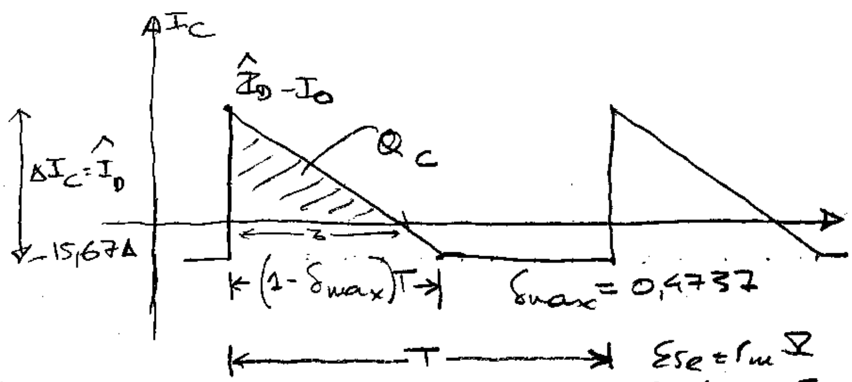
Solución problema 2-2 (1)

e) Rizado pico a pico de la tensión de salida $I_O = \frac{P_{in}}{U_O} = \frac{379}{24} = 15{,}79A$

$Q_C = \frac{(\hat{I}_D - I_O)\,\tau}{2}$

Corriente por el condensador:

$\tau = (1-0{,}4737)\,T\,\frac{(\hat{I}_D - I_O)}{\hat{I}_D}$



$ESR = r_m\ \Omega$

$C = 47000\mu F$

$\Delta U_{O_C} = \frac{Q_C}{C}$

$\Delta U_{O_C} = \frac{0{,}5263 \cdot 10\mu s}{47000\,\mu F}\frac{(60-15{,}79)^2}{2 \cdot 60} = 1{,}82 \times 10^{-3}\ V$

$\Delta U_{O_{ESR}} = \Delta I \cdot ESR = 60A \cdot 5\times10^{-3}\Omega = 0{,}3V$

$\Delta U_O = 0{,}3V$

f) $T_{j\,max} = 175°C$ $\quad R_{DS(on)max} = 0{,}069\Omega \times 3{,}25 = 0{,}224\ \Omega$ (de la hoja de datos)

$I^2_{Q\,eff} = \frac{1}{T}\int_0^{\delta T}\left(\frac{\hat{I}_Q}{\delta T}\right)^2 t^2\,dt = \frac{1}{T}\frac{\hat{I}_Q^2}{(\delta T)^2}\frac{(\delta T)^3}{3} = \hat{I}_Q^2\frac{\delta}{3}$

$\delta_{max} = 0{,}4737$; $\delta_{min}(@U_{d\,max}) = \frac{L\hat{I}_Q}{U_{d\,max}\,T} = \frac{18{,}95 \cdot 20}{170 \cdot 10} = 0{,}223$

Potencia disipada $P_D = R_{DS(on)_{175°}}\,I^2_{Q\,eff} + \left(U_d + \frac{N_1}{N_2}U_O\right)\frac{\hat{I}_Q}{2}\frac{t_f}{T} = R_{DS_{on\,175°}}\,\hat{I}_Q^2\,\frac{\delta}{3} + \left(U_d + \frac{N_1}{N_2}U_O\right)\frac{\hat{I}_Q}{2}\frac{t_f}{T}$

$t_f = 20ns = 0{,}02\ \mu s$

$P_{D_{U_{min}}} = \frac{0{,}224 \cdot 20^2 \cdot 0{,}4737}{3} + \frac{(80+24\times3) \cdot 20A \cdot 0{,}02\mu s}{2\times 10\ \mu s} = 17{,}2\ W$

$R_{jc} = 0{,}44\ K/W$

$P_{D_{U_{max}}} = 0{,}224\,\frac{20^2}{3}\,0{,}223 + \frac{(170+24\times3)\times 20 \times 0{,}02}{2\times10} = 11{,}5W$

$R_{cs} = 0{,}24\ K/W$

Peor caso $P_D = 17{,}2W$ $\quad \hat{T}_j - T_a = 17{,}2\,(0{,}44 + 0{,}24 + R_{sa})$

$\frac{175-50}{17{,}2} - 0{,}44 - 0{,}24 = R_{\theta sa}$

$R_{\theta_{sa}} = 6{,}58\ K/W$