12.5 At $f = 120$ Hz, $|M_v| = 0.5$, $|T| = 34$ dB, and the ripple input voltage is $V_{r(in)} = 1$ V. Find the output ripple voltage.

when $f = 120$ Hz

$$|M_{vcl}| = \frac{|M_v|}{|1+T|} \approx \frac{|M_v|}{|T|} = -40dB = 0.01$$

And we can know

$$V_{r(out)} = |M_{vcl}| V_{r(in)} = 0.01 \times 1 = 10mV$$

13.5 A boost PWM converter has $V_I = 156$ V, $V_O = 400$ V, $V_R = 3.25$ V, $T_{ko} = 1.8118$, $\beta = 1/123$, $\xi = 0.162$, $f_{zn} = 159$ kHz, $f_{zp} = 1.17$ kHz, and $f_0 = 322$ Hz. Design a control circuit such that $PM \geq 55°$.

we set $f_c = f_m = 0.5$ kHz

$P_{nom} = 0.65$ $R_{Lm} = 177.8\,\Omega$

$r_{ds} = 1\,\Omega$ $V_F = 0.7V$ $R_T = 0.0171\,\Omega$

$L = 30mH$ $r_C = 24\,\Omega$ $C = 1\mu F$

$r_L = 1\,\Omega$

$V_R = 3.25V$ $R_{1} = 992\,\Omega$

$$\phi_{\beta T_1}(f_c) = -180° + \tan^{-1}\left(\frac{f_c}{f_{zp}}\right) - \tan^{-1}\left[\frac{\left(\frac{2\xi f_c}{f_0}\right)}{1-\left(\frac{f_c}{f_0}\right)^2}\right]$$

$$= -180 + 0.18 - 23.14 + 19.62 = -183.34°$$

we set $PM = 65°$

$$\phi_m = PM - \phi_{\beta T_1}(f_c) - 90° = 65 + 183.34 - 90 = 158.34°$$

$$K = \tan^2\left(\frac{158.34^\circ}{4} + 45^\circ\right) = 111.29$$

K factor

$$\left|T_{K_0}(f_c)\right| = \frac{\sqrt{1+\left(\frac{w_c}{w_{zH}}\right)^2}\sqrt{1+\left(\frac{w_c}{w_{zH}}\right)^2}}{\sqrt{\left[1-\left(\frac{w_c}{w_0}\right)^2\right]^2+\left(\frac{2\zeta w_c}{w_0}\right)^2}} = 1.3144$$

$$= 2.375\,dB$$

Assume $R_1 = 120\,k\Omega$

$$R_3 = \frac{R_1\,(R_1 - h_{11}(K-1))}{(K-1)(R_1+h_{11})} = \frac{120\times[120 - 0.992\times(111.29-1)]}{(111.29-1)(120+0.992)}$$

$= 6.0953\,k\Omega$

pick $R_3 = 95\ \Omega$

$$C_2 = \frac{|T_{K_0}(f_c)|}{w_c(R_1+h_{11})} = \frac{1.3144}{2\times\pi\times0.5\times10^3\times(120+0.992)\times10^3}$$

$= 4.14\,nF$

set $C_2 = 3.9\,nF$,

$$R_2 = \frac{\sqrt{K}}{w_c C_1} = \frac{\sqrt{111.29}}{2\times\pi\times0.5\times10^3\times270\times10^{-9}}$$

$= 12.437\,k\Omega$

Pick $R_2 = 12k\Omega$

$$C_2 = \frac{R_1 + h_n}{w_c\sqrt{K}\left[R_1R_3 + h_n(R_1+R_3)\right]}$$

$$= \frac{(120 + 0.992)\times 10^3}{2\times\pi\times 25\times 10^3\sqrt{111.29}\left[120\times 5.095 + 0.992(120+0.095)\right]\times 10^6}$$

$= 27.9nF$

Pick $C_3 = 28nF$