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1\. i. $i_L(0) = 0.5A$

$$i_L(t) = i_{final} + (i_{init} - i_{final}) e^{-t/\tau}$$

$$\tau = \frac{L}{R} = \frac{100\mu H}{1\Omega} = 100\mu s.$$

When switch is ON;

$$i_L(t) = \underbrace{i_{final}}_{\substack{(on,final) \\ = \frac{V_d}{R} = \frac{12V}{1\Omega} = 12A}} + (\underbrace{i_{L\,init}}_{= 0.5A} - i_{final}) e^{-t_{on}/\tau} \quad ; \quad t_{on} = 20\mu s.$$

$$\Rightarrow i(t_{on}) = i(20\mu s) = 12 + (0.5 - 12) e^{-20\mu s/100\mu s} = 2.58A.$$

When switch is OFF;

$$i_L(t) = \underbrace{i_{L,final,OFF}}_{\frac{V_d - V_o - V_{D1}}{R} = \frac{12 - V_o - 0.8}{1\Omega} = 11.2 - V_o} + (\underbrace{i_{L,init,OFF}}_{= i_L(t_{on})} - i_{L\,final,OFF}) e^{-t_{off}/\tau}.$$

$$i_L(0) = i_L(T_s)$$

$$0.5A = (11.2 - V_o) + (2.58 - 11.2 + V_o) e^{-20\mu s/100\mu s}$$

$$\Rightarrow \underline{V_o = 20.09V}.$$

ii. Average diode current $I_o = \frac{1}{T} \int_{t_{on}}^{T_s} i_L(t) dt$

$$\Rightarrow I_o = \frac{1}{T_s} \int_{t_{on}}^{T_s} [0.5A + (2.58 - 0.5) e^{-\frac{(t - 20\mu s)}{100\mu s}}] dt.$$

$$= \frac{1}{T_S}\left[10\mu + 2.08 \int_{t_{ON}}^{T_S} e^{-\frac{(t-20\mu s)}{100\mu s}}\, dt\right]$$

$$I_o = \frac{1}{T_S}\left[10\mu + 37.7\mu\right] = \frac{47.7\mu}{40\mu} = 1.19\,A.$$

$$R_L = \frac{V_o}{I_o} = \frac{20.09V}{1.19\,A} = 16.88\,\Omega.$$

iii. $$i_{D1,ripple} = i_{L,max} - i_{L,min}$$

$$= i_L(t_{ON}) - i_L(0)$$

$$= 2.58 - 0.5 = 2.08A.$$

$$\Rightarrow V_{ripple} = (i_{D1,ripple})\, R_{ESR} = 0.0208\,V$$

$$= 20.8\,mV$$

2. $D = 0.25.$ $\quad N_1/N_2 = 6$ $\quad V_{OR} = \frac{N_1}{N_2} V_o = 6V_o.$

a. $$\Delta_2 = D \frac{V_d}{V_{OR}} \frac{L_M}{L_M + L_L} \overset{\downarrow}{=} D \frac{V_d}{6V_o} \frac{L_M}{L_M + L_L}$$

$$0.7 = (0.25)\frac{200}{6V_o}\frac{1200\mu H}{1300\mu H} \Rightarrow V_o = 10.989V$$

b. $$\Delta_1 = D \frac{V_d}{V_Z - V_{OR}} \cdot \frac{L_L}{L_M + L_L} = (0.25) \cdot \frac{200}{V_Z - 65.9} \cdot \frac{100\cancel{\mu H}}{1300\cancel{\mu H}} = 0.02$$

$$V_{OR} = \frac{N_1}{N_2} V_o = 65.93. \qquad \Rightarrow \qquad V_Z = 258.2V$$

c. $P_Z = V_Z \dfrac{D_1 T_S V_d}{L_M + L_L} \cdot D_1 = 258.2 \cdot \dfrac{(0.25)\cdot 40\cancel{\mu}s \cdot 200}{1300\,\cancel{\mu}H} \cdot (0.02)$

$P_Z = 7.94W$

d. $I_o = \dfrac{1}{2T_S} \left(\dfrac{D\,T_S V_d}{L_M + L_L} \right)^2 \left(\dfrac{L_M}{V_{oR}} - \dfrac{L_L}{V_Z - V_{oR}} \right) \dfrac{N_1}{N_2}$

$= (12500)\,(2.367)\,(18.2\mu - 0.52\mu)\,6.$

$= 3.14A$

$R = \dfrac{V_o}{I_o} = \dfrac{20.09V}{3.14A} = 6.4\Omega.$