بنام خدا

رضا دینی دیزج
۹۸۱۴۳۰۳۵
تمرین سری ۶ الکترونیک

#6-4

$V_S = 24^V$
$D = 0.65$
$L = 25\,\mu H$
$C = 15\,\mu F$
$R = 10\,\Omega$

a) output Voltage?

b) Max and Min Inductor current?

c) output Voltage ripple?

a) $V_o = DV_S = 24(0.65) = 15.6^V$

b) $I_L = I_R = \frac{V_o}{R} = \frac{15.6}{10} = 1.56^A \Rightarrow \Delta i_L = \frac{V_o}{L}(1-D)T = \frac{15.6}{25\times10^{-6}}(1-0.65)\times\frac{1}{100000}$

$= 2.18\,A$

$I_{L,max} = I_L + \frac{\Delta i_L}{2} = 1.56 + \frac{2.18}{2} = 2.65^A$, $i_{L,min} = I_L - \frac{\Delta i_L}{2} = 1.56 - \frac{2.18}{2} = 0.47^A$

c) $\Delta V_o = \frac{V_o(1-D)}{8LCf^2} = \frac{15.6(1-0.65)}{8(25\times10^{-6})\times15\times10^{-6}(100000)} = 0.182$ OR $\frac{\Delta V_o}{V_o} = 1.17\%$

#6-7

$V_{input} = 6^V$
$V_{out} = 1.5^V$
$R_L = 3\,\Omega$
switching freq $= 400^{KHZ}$
$L = 5\,\mu H$, $C = 10^{PF}$

a) duty ratio?

b) average, Peak, rms Inductor current

c) average source current?

d) Peak and average Diode current

a) $D = \frac{V_o}{V_S} = \frac{1.65}{6} = 0.25$

b) average : $I_L = I_R = \frac{V_o}{R} = \frac{1.5}{3} = 0.5^A$, rms : $I_{L,rms} = \left[(0.5)^2 + \left(\frac{\frac{0.5625}{2}}{\sqrt{3}}\right)^2\right]^{\frac{1}{2}} = 0.526^A$

$\Delta i_L = 0.5625$

Peak : $I_{L,max} = V_o\left(\frac{1}{R} + \frac{1-D}{2Lf}\right) = 1.5\left(\frac{1}{3} + \frac{1-0.25}{2(5)\times10^{-6}(400000)}\right) = 0.781^A$

$I_{L,min} = V_o\left(\frac{1}{R} - \frac{1-D}{2Lf}\right) = 0.219\,A$

c) $P_s = P_o = V_s I_s = V_o I_R \Rightarrow I_s = \frac{V_o I_R}{V_s} = \frac{1.5(0.5)}{6} = 0.125^{A}$

d) $I_{D,max} = I_{L,max} = 0.781^{A} \Rightarrow I_D = I_o - I_s = 0.5 - 0.125 = 0.375^{A}$

#6-10 $L_{min} = \frac{(1-D)R}{2f}$ $f = 200^{KHZ}$, $V_o = 5^{V}$

V_s (V)	D	I (A)	R (Ω)	L_{min} (μH)
10	0.5	0.5	10	12.5
10	0.5	1	5	6.25
15	1/3	0.5	10	16.7
15	1/3	1	5	8.33

$L = \frac{(1-D)_{min} R_{max}}{2f}$

$L_{min} = \frac{(1-\frac{1}{3})10}{2(200)} = 16.67^{\mu H}$

6-15 $V_n = \frac{\sqrt{2}V_s}{n\pi}\sqrt{1-\cos(2\pi nD)}$ $n = 1, 2, 3, \ldots$

if $n=1 \Rightarrow V_1 = 30.27 \Rightarrow V_{o1} = 0.048^{V} = 2(0.048) = 0.096\ V_{P-P}$

$\frac{0.096}{V_o} = \frac{0.096}{20} = 0.48\% \Rightarrow \frac{\Delta V_o}{V_o} = 0.469\%$

6-19 $V_{in} = 5^{V}$, $P_{out} = 25^{W}$, $V_{out} = 15\ V$

$V_o = \frac{V_s}{1-D} \Rightarrow D = 1 - \frac{V_s}{V_o} = 1 - \frac{5}{15} = 0.667$

$R = \frac{V_o^2}{25} = \frac{15^2}{25} = 9\ \Omega$

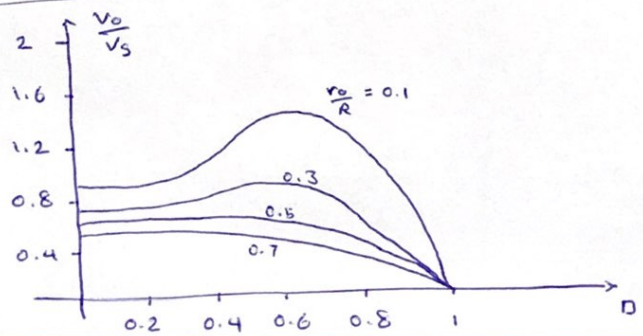
$I_L = \frac{V_s}{(1-D)^2 R} = \frac{5}{(1-0.667)^2 \cdot 9} = 5\ A$

$I_{L,min} = 0.5(5) = 2.5^{A} \Rightarrow \Delta I_L = 5^{A}$

$\Delta I_L = \frac{V_s DT}{\Delta I_L} = \frac{5(0.667)/300}{5} = 2.22^{\mu H}$

$\Rightarrow C = \frac{0.667}{9(0.01)(300000)} = 24.7^{\mu F}$

6-22



#6-25

$V_S = 24^V$
$V_o = -36$
$R_L = 10\,\Omega$
switching freq. $= 100^{KHZ}$

a) if Minimum Inductance Current is 40% of the average $\rightarrow$ L = ?

b) C = ? $\rightarrow$ ripple = 0.5%

a) $D = \frac{|V_o|}{V_S + |V_o|} = \frac{36}{24+36} = 0.6$ $\qquad I_L = \frac{V_S \cdot D}{R(1-D)^2} = \frac{24(0.6)}{10(1-0.6)^2} = 9^A$

$I_{L,min} = 0.4(9) = 3.6^A$, $\Delta I_L = 2(9-3.6) = 10.8^A$

$\Rightarrow L = \frac{V_S\, DT}{\Delta I_L} = \frac{24(0.6)}{10.8(100000)} = 13.3\,\mu H$

b) $C = \frac{D}{R(\frac{\Delta V_o}{V_o})f} = \frac{0.6}{10(0.005)(100000)} = 12^{\mu F}$

#6-28

$D = \frac{|V_o|}{V_S + |V_o|}$, $R = \frac{V_o^2}{P}$, $I_{min} = \frac{(1-D)^2 R}{2f}$, $I_L = \frac{P}{DV_S}$

$C = \frac{D}{R(\frac{\Delta V_o}{V_o})f}$ $\xrightarrow{\text{if } f = 100^{KHZ}}$

$V_S = 14^V$
$P = 10\,W$
$L = 20.9^{\mu H}$
$C = 56.8^{\mu F}$

V_S (V)	P (W)	D	R (Ω)	L_{min} (μH)	I_L (A)	C (μF)
10	10	0.545	14.4	14.9	1.83	37.9
10	15	0.545	9.6	9.9	2.75	56.8
14	10	0.462	14.4	20.9	1.55	32.1
14	15	0.462	9.6	13.9	2.32	48.1

#6-31

$\frac{V_o}{V_S} = -\frac{D}{1-D} = \frac{-30}{25} = -1.2 \Rightarrow D = 0.5455$

$I_{L2} = \frac{P}{V_o} = \frac{60}{30} = 2^A$ $\qquad i_{L2} = 0.4(2) = 0.8\,A$,

6-35

$$I_{L_1} = I_S = \frac{V_o^2}{V_s R} = \frac{6^2}{15 \times 2} = 1.2^{A}$$

$$D = \frac{V_o}{V_o + V_s} = \frac{6}{6+15} = 0.286 \quad , \quad L_1 = \frac{V_s D}{(\Delta i_{L_1}) f} = \frac{15(0.286)}{0.4(1.2)\cdot 250000}$$

$$= 35.7\ \mu H \quad , \quad I_{L_2} = I_o = \frac{V_o}{R} = \frac{6}{2} = 3^{A}$$

$$L_2 = \frac{V_s D}{(\Delta i_{L_2}) f} = \frac{15(0.286)}{0.4(3)(250000)} = 14.3^{\mu H} \quad , \quad V_{C_2} = V_o = 6^{V}$$

$$\Delta V_{C_2} = \Delta V_o = \frac{V_o D}{R C_2 f} \quad \text{OR} \quad C = \frac{D}{R\left(\frac{\Delta V_o}{V_o}\right) f} = \frac{0.286}{2(0.2)\cdot 250000} = 28.6^{\mu F}$$

$$\Rightarrow C_1 = C_2 = 28.6^{\mu F}$$

6-38

If switch closed : $V_L = V_s - V_Q$

If switch open : $V_L = V_o - V_D$

$$\text{avg}\{V_L\} = 0 \ : \ (V_s - V_Q) DT + (V_o - V_D)(1-D)T = 0$$

$$V_o = V_D - (V_s - V_Q)\frac{D}{1-D}$$