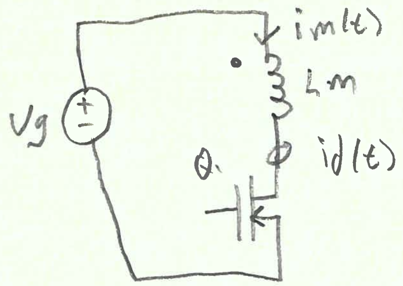
HW 4

"Flyback in CCM"

On state switch current

"1"



$id(t) = im(t)$

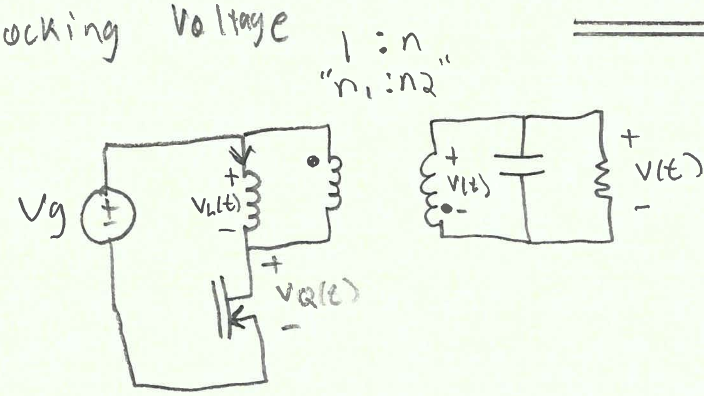
SRA

$id(t) = Im = \frac{nV}{D'R}$

b) $\underline{\underline{id(t) = \frac{nV}{D'R}}}$ +1

Blocking Voltage

"2"



$$-V_g + V_L(t) + V_Q(t) = 0$$

$$V_Q(t) = V_g - V_L(t)$$

$$\frac{V_L(t)}{n_1} = \frac{-v(t)}{n_2}$$

$$V_Q(t) = V_g + \frac{v(t)n_1}{n_2}$$

$$V_Q(t) = V_g + \frac{v(t)}{n}$$

SRA

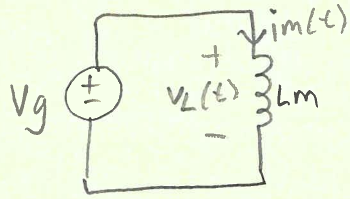
a) $\underline{\underline{V_Q(t) = V_g + \frac{V}{n}}}$ +1

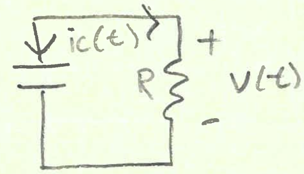
c) If applying small ripple approximation:

$$Idrms = \frac{nV}{D'R}\sqrt{D}$$ +0.5

HW4

a) "1"



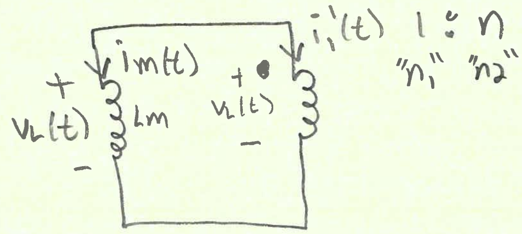


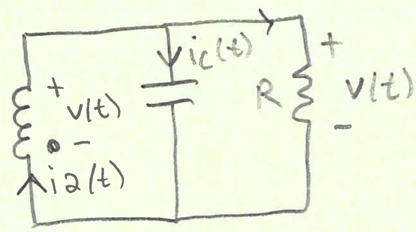
$$-Vg + V_L(t) = 0$$
$$V_L(t) = Vg$$
$$ic(t) + \frac{V(t)}{R} = 0$$
$$ic(t) = -\frac{V(t)}{R}$$

<u>SRA</u> $V_L(t) = Vg$

$$ic(t) = \frac{-V}{R}$$

"2"





"Transformer" voltage eqn

$$\frac{V_L(t)}{n_1} = \frac{-V(t)}{n_2}$$
$$V_L(t) = -\frac{V(t)n_1}{n_2}$$
$$V_L(t) = -\frac{V(t)}{n}$$

$$i_2(t) = ic(t) + \frac{V(t)}{R}$$

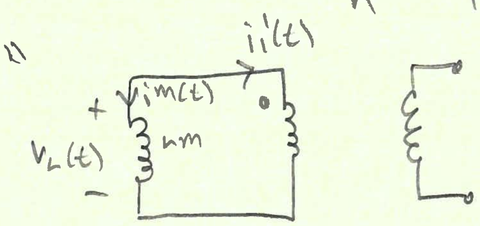
☆ $i_1'(t)n_1 + i_2(t)n_2 = 0$

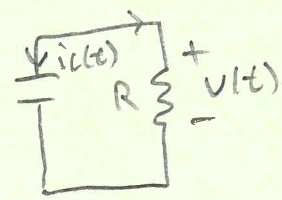
$$i_1'(t) = -im(t)$$
$$-im(t)n_1 + i_2(t)n_2 = 0$$
$$i_2(t) = \frac{im(t)n_1}{n_2}$$
$$i_2(t) = \frac{im(t)}{n}$$
$$ic(t) = \frac{im(t)}{n} - \frac{V(t)}{R}$$

<u>SRA</u> $V_L(t) = \frac{-V}{n}$

$$ic(t) = \frac{im(t)}{n} - \frac{V}{R}$$

"3"





$$V_L(t) = 0$$
$$ic(t) = \frac{-V(t)}{R}$$

SRA: $V_L(t) = 0$

$$ic(t) = \frac{-V}{R}$$

HW 4

a cont) Volt-Second Balance

$$0 = V_g D_1 + \frac{-V}{n} D_2 + 0(D_3)$$

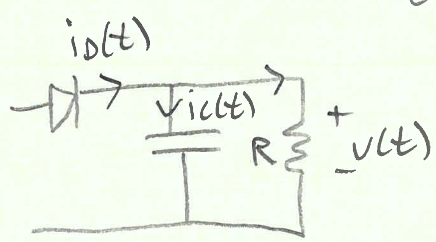
$$V_g D_1 = \frac{V}{n} D_2$$

$$\frac{V}{V_g} = \frac{D_1}{D_2} n$$

+2

b) In DCM, since you cannot apply SRA, apply charge balance in a manner that results in an expression in terms of average output current

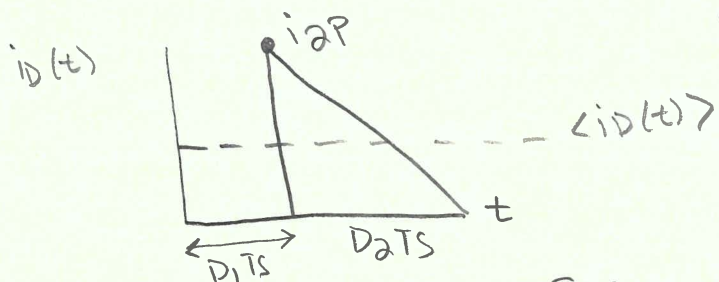
"Charge Balance"



$$i_C(t) = i_D(t) - \frac{v(t)}{R}$$

$$\langle i_C(t) \rangle = \langle i_D(t) \rangle - \frac{V}{R} = 0$$

$$\langle i_D(t) \rangle = \frac{V}{R}$$



$$\langle i_D(t) \rangle = \frac{1}{T_s}\left[\frac{1}{2} D_2 T_s \, i_{2P}\right] = \frac{V}{R} \quad (1)$$

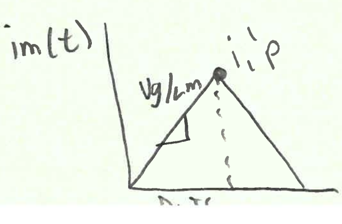
$i_2(t)$ relates to $i_1'(t)$ during "2"

$$i_{2P} = i_2(t = D_1 T_s)$$

$$0 = i_1'(t) n_1 + i_2(t) n_2$$

at $t = D_1 T_s$

$$0 = -\underbrace{i_m(t = D_1 T_s)}_{i_1' P} n_1 + i_2(t = D_1 T_s) n_2$$



$$0 = -i_1' P n_1 + i_{2P} n_2$$

HW 4

b cont)

$$i_1'p = \frac{V_g}{L_m} D_1 T_s$$

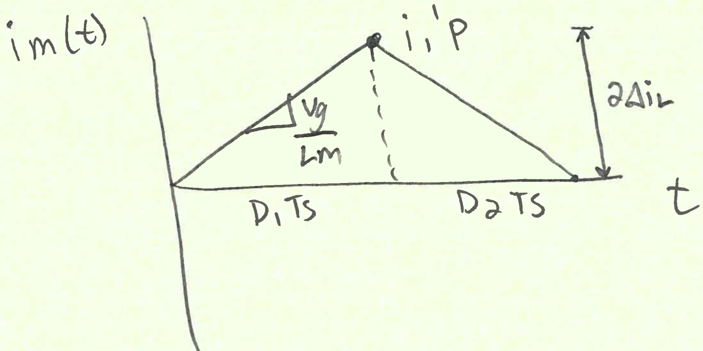
$$0 = -\frac{V_g}{L_m} D_1 T_s n_1 + i_{2p} n_2$$

$$i_{2p} = \frac{V_g}{L_m} D_1 T_s \frac{n_1}{n_2} = \frac{V_g}{L_m} \frac{D_1 T_s}{n} \quad (2)$$

solve (1) + (2) for i_{2p} + D_2

+2 $$\underline{\underline{D_2 = \frac{2 L_m V n}{D_1 R T_s V_g}}} \; ; \quad i_{2p} = \frac{D_1 T V_g}{L_m n}$$

c)



at boundary of CCM/DCM $D_3 = 0$

$$2\Delta i_L = i_1'p = \frac{V_g}{L_m} D_1 T_s$$

we know at boundary, $\langle i_m(t) \rangle = \frac{nV}{D'R}$

"since still in CCM right before DCM"

$$\Delta i_L = \langle i_m(t) \rangle$$

$$\frac{V_g}{2L_m} D_1 T_s = \frac{nV}{D' R_{crit}}$$

$$\underline{\underline{R_{crit} = \frac{2 L_m V n}{D_1 D' T_s V_g}}}$$ +2

HW 4

Simulink at critical conduction

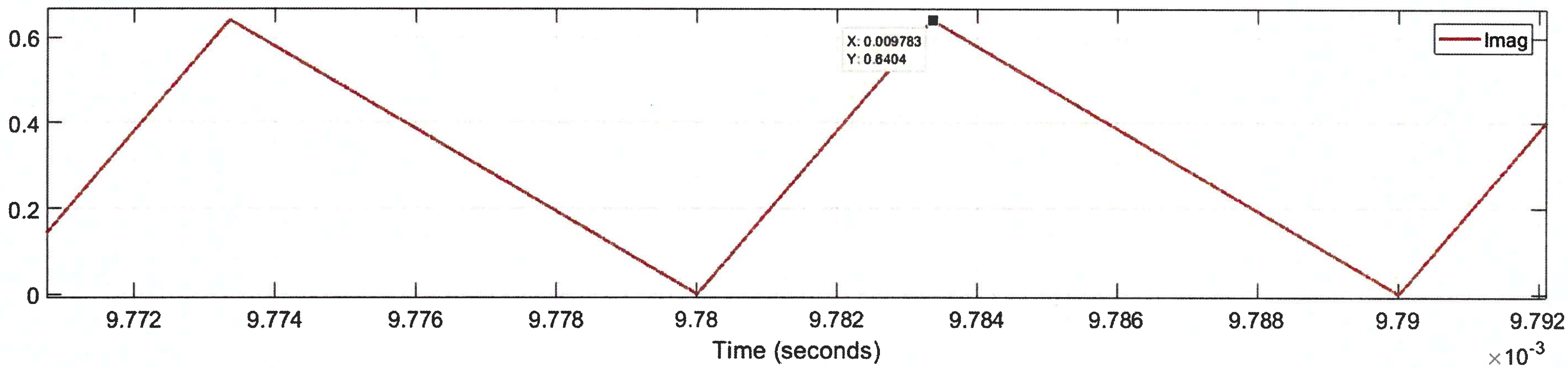
$D_1 = .3333$

+1.5

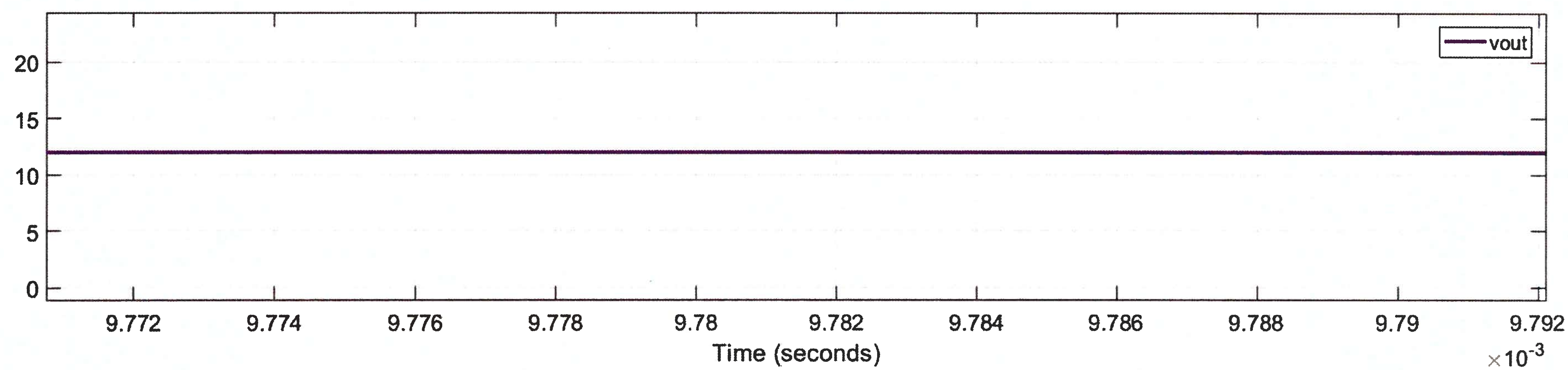
$D_2 = .6667$

$i_{peak} = i_{i,p} = 0.64\ A$

$R_{crit} = 28.125\ \Omega$



Imag
X: 0.009783
Y: 0.6404
0.6
0.4
0.2
0
9.772
9.774
9.776
9.778
9.78
9.782
9.784
9.786
9.788
9.79
9.792
Time (seconds)
×10^-3



vout
20
15
10
5
0
9.772
9.774
9.776
9.778
9.78
9.782
9.784
9.786
9.788
9.79
9.792
Time (seconds)
×10^-3