$Q_{RR} \cdot 10^6 = 6.667 \times 10^3$ μC

$Q_{RR} := \cdot\left(I_{fall\_rate} \cdot t_a\right) \cdot \left(t_a + t_b\right)$

$Q_{RR} \cdot 10^6 = 6.667 \times 10^3$

$Q_{RR} := \frac{1}{2} \cdot I_{RR} \cdot \left(t_a + t_b\right)$

Using Eq. (2-6),

(b) $I_{RR} := I_{fall\_rate} \cdot t_a$ $I_{RR} = 2.667 \times 10^3$ μC

Prob 2.3

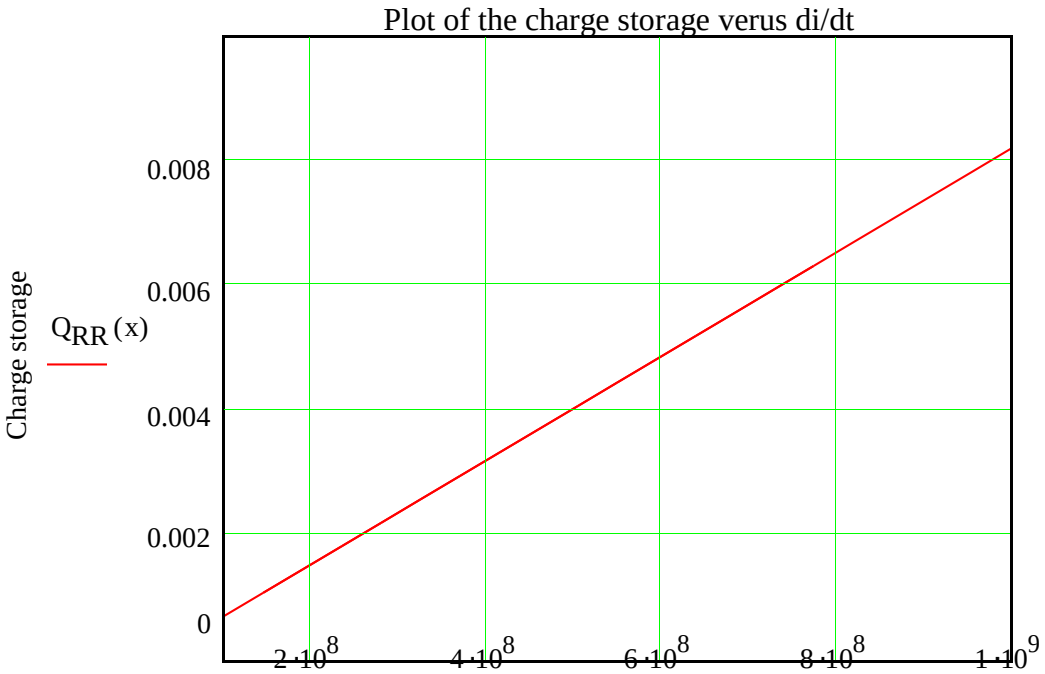
$t_{rr} := 5 \cdot 10^{-6}$ $\quad SF := 0.5$

$t_a := \dfrac{t_{rr}}{1 + SF}$ $\quad t_a = 3.333 \times 10^{-6}$

$t_b := SF \cdot t_a$ $\quad t_b = 1.667 \times 10^{-6}$

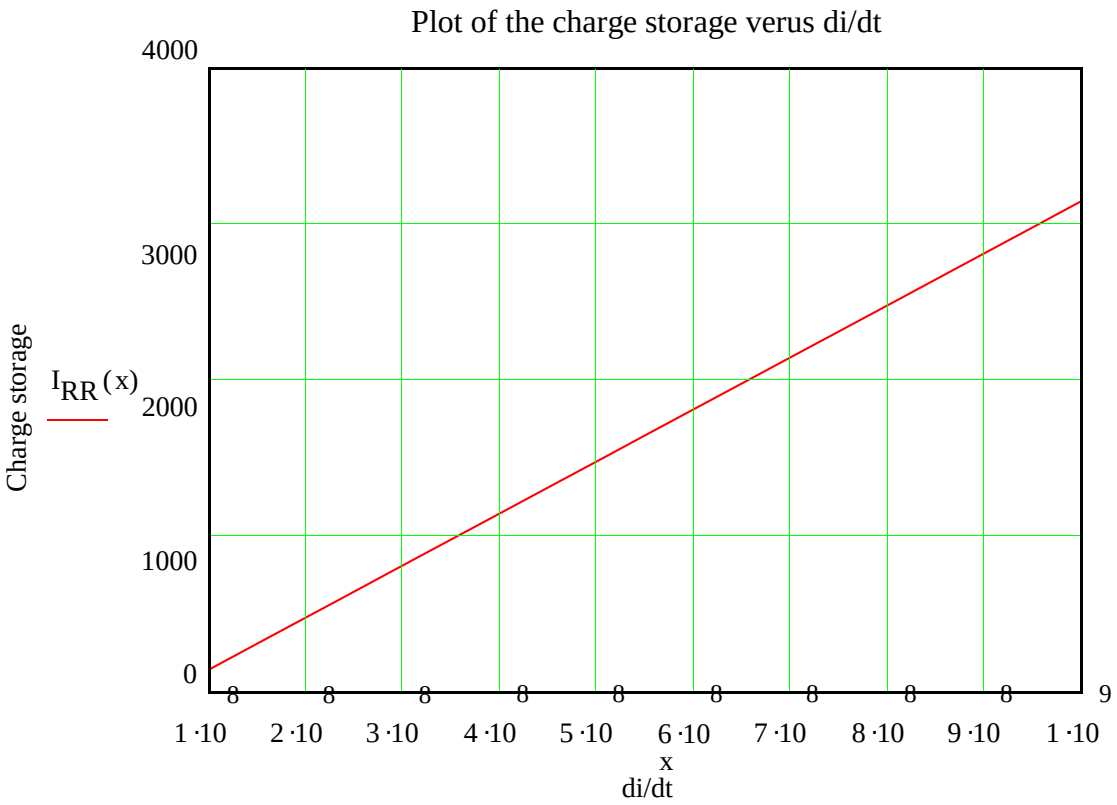
$m := \dfrac{1}{2} \cdot t_a \cdot t_{rr}$ $\quad m = 8.333 \times 10^{-12}$

$Q_{RR}(x) := m \cdot x$



x
di/dt

$I_{RR}(x) := t_a \cdot x$



Prob 2.5 $V_T := 25.8 \cdot 10^{-3}$

$V_{D2} := 1.6$ $V_{D1} := 1.2$ $I_{D2} := 1500$ $I_{D1} := 100$

Using Eq. (2-3),

(a) $$\eta := \frac{V_{D2} - V_{D1}}{V_T \cdot \ln\left(\frac{I_{D2}}{I_{D1}}\right)}$$ $\eta = 5.725$

(b) $$x := \frac{V_{D1}}{\eta \cdot V}$$ $x = 8.124$

T

Using Eq. (2-3), $I_S := \frac{I_{D1}}{e^x}$ $I_S = 0.03$

$V_T \cdot \eta \cdot \ln\left(\frac{I_{D1}}{I_S}\right) = 1.2$

Prob 2-7

$V_{D1} := 2200$ $V_{D2} := 2200$ $R_1 := 100 \cdot 10^{3}$

-3 -3

$I_{S1} := 20 \cdot 10$ $I_{S2} := 35 \cdot 10$

(a)

$$I_{R1} := \frac{V_{D1}}{R_1} \qquad I_{R1} = 0.022$$

Using Eq. (2-13),

(b) $I_{R2} := I_{S1} + I_{R1} - I_{S2}$ $I_{R2} = 7 \times 10^{-3}$

$\underline{V_{D2}}$ 5

$$R_2 := \frac{}{I_{R2}} \qquad R_2 = 3.143 \times 10$$

Prob 2.11

$I_T := 300$ $V_D := 2.8$

$$I_1 := \frac{I_T}{2} \qquad I_1 = 150$$

$I_2 := I_1$

$V_{D1} := 1.4$

$I_2 = 150$

Prob 2-7

$V_D -$

V_{D1}

$V_{D2} := 2.3$

$R_1 :=$ $\frac{V_D - V_{D2}}{I_1}$ $R_1 = 9.333 \times 10^{-3}$

$R_2 :=$ $\frac{V_D - V_{D2}}{I_2}$ $R_2 = 3.333 \times 10^{-3}$

$I_1 := \frac{I_T}{2}$

Prob 2-13

$R_1 := 50 \cdot 10^{3}$ $R_2 := 50 \cdot 10^{3}$ $V_S := 10 \cdot 10^{3}$

$I_{s1} := 20 \cdot 10^{-3}$ $I_{s2} := 30 \cdot 10^{-3}$

Using Eq. (2-14),

$$V_{D2} := \frac{I_{S1} - I_{S2} + \frac{V_S}{R_1}}{\frac{1}{R_1} + \frac{1}{R_2}} \qquad V_{D2} = 4.625 \times 10^{3}$$

$V_{D1} := V_S - V_{D2}$ $V_{D1} = 5.375 \times 10^{3}$

Prob 2-15

$I_p := 500$ $f := 500$ $t_1 := 100 \cdot 10^{-6}$

$T := \frac{1}{f}$ $T \cdot 1^{3} = 2$

$$I_{AVG} := \frac{I_p}{T} \cdot \int_0^{t_1} \sin(2 \cdot \pi \cdot f \cdot t)\, dt \qquad I_{AVG} = 3.895$$

$$I_{RMS} := I_p \sqrt{\frac{1}{0} \int_0^{t_1} \quad 2}$$

$$I_{peak} := I_p \quad \frac{1}{T} \cdot \int_0 \sin(2 \cdot \pi \cdot f \cdot t)\, dt \qquad I_{RMS} = 20.08$$

Prob 2-13

3 3 3

$$I_{peak} = 500$$

Prob 2-16

$I_{RMS} := 120 \qquad f := 500 \qquad t_1 := 100 \cdot 10^{-6}$

$T := \frac{1}{f} \qquad T \cdot 10^3 = 2$

$$I_p := \frac{I_{RMS}}{\sqrt{\frac{1}{T} \cdot \int_0^{t_1} \sin(2 \cdot \pi \cdot f \cdot t)^2 \, dt}} \qquad I_p = 2.988 \times 10^3$$

$$I_{RMS} := I_p \sqrt{\frac{1}{T} \cdot \int_0^{t_1} \left(\sin(2 \cdot \pi \cdot f \cdot t)\right)^2 dt} \qquad I_{RMS} = 120$$

$$I_{AVG} := \frac{I_p}{T} \cdot \int_0^{t_1} \sin(2 \cdot \pi \cdot f \cdot t) \, dt \qquad I_{AVG} = 23.276$$

Prob 2-17

$I_{AVG} := 100 \qquad f := 500 \qquad t_1 := 100 \cdot 10^{-6}$

$T := \frac{1}{f} \qquad T \cdot 10^3 = 2$

$$T \cdot 10 = 2$$

$$f$$

$$I_p := \left(\frac{I_{AVG}}{t_1} \right) \qquad 4$$

$$\left| \frac{1}{\int_0^T} \right. \sin(2 \cdot \pi \cdot f \cdot t)\, dt \qquad I_p = 1.284 \times 10$$

$$\left(\frac{I_p}{T} \right) \cdot \int_0^{t_1} \sin(2 \cdot \pi \cdot f \cdot t)\, dt \qquad I_{AVG} = 100$$

$$I_{AVG} :=$$

$$I_{RMS} := I_p \sqrt{\frac{1}{T} \cdot \int_0^{t_1} (\sin(2 \cdot \pi \cdot f \cdot t))^2\, dt} \qquad I_{RMS} = 515.55$$

Prob 2-18

$t_1 := 100 \cdot 10^{-6}$ $t_2 := 200 \cdot 10^{-6}$ $t_3 := 400 \cdot 10^{-6}$ $t_4 := 800 \cdot 10^{-6}$

$t_5 := 1 \cdot 10^{-3}$ $f := 250$ $I_a := 150$ $I_b := 100$ $I_p := 300$

(a) $I_{AVG} := I_a \cdot f \cdot t_3 + I_b \cdot f \cdot (t_5 - t_4) + 2 \cdot (I_p - I_a) \cdot f \cdot \frac{(t_2 - t_1)}{\pi}$

$\overline{I_{AVG}} = 22.387$

$I_{r1} := (I_p - I_a) \cdot$

(b) $I_{r1} = 16.771$

$\sqrt{f \cdot \frac{(t_2 - t_1)}{2}}$

$I_{r2} := I_a \cdot \sqrt{f \cdot t_3}$ $I_{r2} = 47.434$

$I_{r3} := I_b \cdot \sqrt{f \cdot (t_5 - t_4)}$ $I_{r3} = 22.361$

$I_{rms} := \sqrt{I_{r1}^2 + I_{r2}^2 + I_{r3}^2}$ $I_{rms} = 55.057$

Prob 2-19

$t_1 := 100 \cdot 10^{-6}$ $t_2 := 200 \cdot 10^{-6}$ $t_3 := 400 \cdot 10^{-6}$ $t_4 := 800 \cdot 10^{-6}$

$t_5 := 1 \cdot 10^{-3}$

$t_5 := 1 \cdot 10$ $\quad f := 250$ $\quad I_a := 150$ $\quad I_b := 100$ $\quad I_p := 150$

(a) $I_{AVG} := I_a \cdot f \cdot t_3 + I_b \cdot f \cdot \left(t_5 - t_4\right) + 2 \cdot \left(I_p - I_a\right) \cdot f \cdot \dfrac{\left(t_2 - t_1\right)}{\pi}$ $\quad I_{AVG} = 20$

(b) $I_{r1} := \left(I_p - I_a\right) \cdot \sqrt{f \cdot \dfrac{\left(t_2 - t_1\right)}{2}}$ $\quad I_{r1} = 0$

$I_{r2} := I_a \cdot \sqrt{f \cdot t_3}$ $\quad I_{r2} = 47.434$

$I_{r3} := I_b \cdot \sqrt{f \cdot \left(t_5 - t_4\right)}$ $\quad I_{r3} = 22.361$

$I_{rms} := \sqrt{I_{r1}^2 + I_{r2}^2 + I_{r3}^2}$ $\quad I_{rms} = 52.44$

Prob 2-20

$t_1 := 100 \cdot 10^{-6}$ $t_2 := 200 \cdot 10^{-6}$ $t_3 := 400 \cdot 10^{-6}$ $t_4 := 800 \cdot 10^{-6}$

$t_5 := 1 \cdot 10^{-3}$ $f := 250$ $I_a := 150$ $I_b := 100$ $I_p := 150$

$I_{rms} := 180$

$I_{r2} := I_a \cdot \sqrt{f \cdot t_3}$ $I_{r2} = 47.434$

$I_{r3} := I_b \cdot \sqrt{f \cdot (t_5 - t_4)}$ $I_{r3} = 22.361$

$I_{r1} := \sqrt{I_{rms}^2 - I_{r2}^2 - I_{r3}^2}$ $I_{r1} = 172.192$

(a) $I_p := \dfrac{I_{r1}}{\sqrt{f \cdot \frac{(t_2 - t_1)}{2}}} + I_a$ $I_p = 1.69 \times 10^3$

$I_{r1} := (I_p - I_a) \cdot \sqrt{f \cdot \frac{(t_2 - t_1)}{2}}$ $I_{r1} = 172.192$

$I_{rms} := \sqrt{I_{r1}^2 + I_{r2}^2 + I_{r3}^2}$ $I_{rms} = 180$

(b)

$$I_{AVG} := I_a \cdot f \cdot t_3 \qquad \frac{\left(t_2 - t_1\right)}{\pi}$$

$$+ I_b \cdot f \cdot \left(t_5 - t_4\right) +$$

$$2 \cdot \left(I_p - I_a\right) \cdot f \cdot$$

$$I_{AVG} = 44.512$$

Prob 2-21

$t_1 := 100 \cdot 10^{-6}$ $t_2 := 200 \cdot 10^{-6}$ $t_3 := 400 \cdot 10^{-6}$ $t_4 := 800 \cdot 10^{-6}$

$t_5 := 1 \cdot 10^{-3}$ $f := 250$ $I_a := 150$ $I_b := 100$ $I_p := 150$

$I_{AVG} := 180$

(a)

$I_{av1} := I_a \cdot f \cdot t_3$ $I_{av1} = 15$

$I_{av2} := I_b \cdot f \cdot (t_5 - t_4)$ $I_{av2} = 5$

$I_{av3} := I_{AVG} - I_{av1} - I_{av2}$ $I_{av3} = 160$

$$I_p := \left[\frac{I_{av3}}{2f \cdot \frac{(t_2 - t_1)}{\pi}} \right] + I_a \qquad I_p = 1.02 \times 10^4$$

$$I_{AVG} := I_a \cdot f \cdot t_3 + I_b \cdot f \cdot (t_5 - t_4) + 2 \cdot (I_p - I_a) \cdot f \cdot \frac{(t_2 - t_1)}{\pi}$$

$I_{AVG} = 180$

(b)

$\frac{(t_2 - t_1)}{2}$ 10

$$I_{r1} := \left(I_p - I_a\right) \cdot \sqrt{f \cdot \qquad}$$ $I_{r1} = 1.124 \times 10^{3}$

$I_{r2} := I_a \cdot f \cdot t_3$ $I_{r2} = 47.434$

$I_{r3} := I_b \cdot \sqrt{f \cdot \left(t_5 - t_4\right)}$ $I_{r3} = 22.361$

$I_{rms} := \sqrt{I_{r1}^2 + I_{r2}^2 + I_{r3}^2}$ $I_{rms} = 1.125 \times 10^{3}$

Prob 2-22

$V_S := 220$ $R := 4.7$ $C := 10 \cdot 1^{-6}$ $t := 2 \cdot 1^{-6}$

0

0 –

$\tau = 4.7 \times 10^{5}$

$\tau := R \cdot C$

Using Eq. (2-20),

(a) $I_p := \frac{V_S}{R}$ $I_p = 46.809$

(b) $V_O := V_S$

$W := 0.5 \cdot C \cdot V_O^{2}$ $W = 0.242$

Using Eq. (2-21), $\left(\quad \frac{-t}{\tau} \right)$

(c) $V_c := V_S \cdot \left(1 - e \quad \right)$ $V_c = 9.165$

Prob 2-24

$V_S := 110$ $R := 4.7$ $L := 6.5 \cdot ^{-3}$

R

10

$\tau := \frac{L}{}$ $\tau = 723.077$

Using Eq. (2-25),

(a) $I_D := \frac{V_S}{R}$ $I_D = 23.404$

(b) $I_O := I_D$

$W := 0.5 \cdot L \cdot I_O^{\,2}$ $\qquad W = 1.78$

Using Eq. (2-27),

(c) $di := \frac{V_S}{L}$ $\qquad di = 1.692 \times 10^4$

Prob 2-25

$V_S := 220$ $R := 4.7$ $L := 6.5 \cdot 10^{-3}$

$$\tau := \frac{L}{R} \qquad \tau = 723.077$$

Using Eq. (2-25),

(a) $$I_D := \frac{V_S}{R} \qquad I_D = 46.809$$

(b) $I_O := I_D$

$$W := 0.5 \cdot L \cdot I_O^2 \qquad W = 7.121$$

Using Eq. (2-27),

(c) $$di := \frac{V_S}{L} \qquad di = 3.385 \times 10^4$$

Prob 2-29

$V_S := 110$ $C := 10 \cdot 10^{-6}$ $L := 50 \cdot 10^{-6}$

Using Eq. (2-32),

(a) $$I_p := V_S \cdot \sqrt{\frac{C}{L}} \qquad I_p = 49.193$$

(b) $$t_1 := \pi \cdot \sqrt{L \cdot C} \qquad t_1 = 7.025 \times 10^{-5}$$

Using Eq. (2-35),

(c) $V_C := 2 \cdot V_S$ $V_C = 220$

Example 2.31

L 4 10 3 − 6 $V_s := 220$

:= · − $C := 0.05 \cdot 10$

(a) $R := 160$ $\alpha := \frac{R}{2 \cdot L}$ $\alpha = 2 \times 10^4$

Using Eq. (2-41),

$\omega_o := \frac{1}{\sqrt{L \cdot C}}$ $\omega_o = 7.071 \times 10^4$

$\omega_r := \sqrt{\omega_o^2 - \alpha^2}$ $\omega r = 6.782 \times 10^4$

$\frac{V_s}{}$

$A_2 := \frac{}{\omega_r \cdot L}$ $A_2 = 0.811$

(b) $t_1 := \frac{\pi}{\omega_r}$ $t_1 \cdot 10^6 = 46.32$ μs

$v_c(t) := e^{-\alpha \cdot t} \cdot A_2 \cdot \sin\left(\omega_r \cdot t\right)$

Probl 2-32

L 2 10 3 − 6 $V_s := 220$

:= · ⁻ C := 0.5·10

(a) R := 160 $\alpha := \frac{R}{2 \cdot L}$ $\alpha = 4 \times 10^4$

1

$\omega_o := \frac{}{\sqrt{L \cdot C}}$ $\omega_o = 3.162 \times 10^4$ $\alpha > \omega_o$

$s_1 := -\alpha + \sqrt{\alpha^2 - \omega_o^2}$ $s_1 = -1.551 \times 10^4$

$s_2 := -\alpha - \sqrt{\alpha^2 - \omega_o^2}$ $s_2 = -6.449 \times 10^4$

at t = 0 i := 0 $0 \equiv A_1 + A_2$

V_s

at t = 0 di := 0 —

L $\equiv A_1 \cdot s_1 + A_2 \cdot s_2$

$$A_1 := \frac{V_s}{L\cdot\left(s_1 - s_2\right)} \qquad A_1 = 2.245$$

(b) $A_2 := -A_1 \qquad A_2 = -2.245$

$v_c(t) := e^{-\alpha\cdot t}\cdot A_1\cdot\left(e^{s_1\cdot t} - e^{s_2\cdot t}\right)$

Probl 2-33

$L := 2\cdot 10^{-3} \qquad V_s := 220$

$C := 0.05\cdot 10^{-6}$

(a) $R := 16 \qquad \alpha := \frac{R}{2\cdot L} \qquad \alpha = 4\times 10^3$

$\omega_o := \frac{1}{\sqrt{L\cdot C}} \qquad \omega_o = 1\times 10^5$

$\omega_r := \sqrt{\omega_o^2 - \alpha^2} \qquad \omega_r = 9.992\times 10^4$

$A_2 := \frac{V_s}{\omega_r\cdot L} \qquad A_2 = 1.101$

(b) $t_1 := \frac{\pi}{\omega_r}$ $t_1 \cdot 10^6 = 31.441$ μs

$v_c(t) := e^{-\alpha \cdot t} \cdot A_2 \cdot \sin(\omega_r \cdot t)$ 0 3 10

Prob 2-34 $V_S := 110$ $L := 1 \cdot 1^{-}$ $t_1 := 100 \cdot^{-6}$

$I_O := \frac{V_S}{L} \cdot t_1$ $I_O = 11$

$W := 0.5 \cdot L \cdot I_O^{\ 2}$ $W = 7.121$

Example 2.36

$V_s := 220$ $L_m := 450 \cdot 10^{-6}$ $N_1 := 10$ $N_2 := 100$ $t_1 := 50 \cdot 10^{-6}$

N_2

$a := \frac{}{N_1}$ $a = 10$

Using Eq. (2-52),

(a) $v_D := V_s \cdot (1 + a)$ $v_D = 2.42 \times 10^3$

Using Eq. (2-55), $I_o = 24.444$

(b) $I_o := \frac{V_s}{L_m} \cdot t_1$

I_o

(c) $I_{o\_peak} := \frac{}{a}$ $I_{o\_peak} = 2.444$

Using Eq. (2-58),

(d) $\frac{a \cdot L_m}{I_o} t_2 := \frac{}{V_s}$ $t_2 \cdot 10^6 = 500$ μs

$\frac{1}{}$ 2

(e) $W := \frac{}{2} \cdot L_m \cdot I_o$ $W = 0.134$ J

10

Example 2.37

$V_s := 220$ $L_m := 250 \cdot$ $^{-6}$ $N_1 := 10$ $N_2 := 10$ $t_1 := 50 \cdot$ $^{-}$

N_2

$a := \frac{}{N_1}$ $\quad a = 1$

Using Eq. (2-52),

(a) $v_D := V_s \cdot (1 + a)$ $\quad v_D = 440$

Using Eq. (2-55), $\cdot t_1$ $\quad I_o = 44$

(b) $I_o := \frac{V_s}{L_m}$

(c) $I_{o\_peak} := \frac{I_o}{a}$ $I_{o\_peak} = 44$

Using Eq. (2-58),

(d) $t_2 := \frac{a \cdot L_m \cdot I_o}{V_s}$ $t_2 \cdot 10^6 = 50$ μs

(e) $W := \frac{1}{2} \cdot L_m \cdot I_o^2$ $W = 0.242$ J

Example 2.38

$V_s := 220$ $L_m := 250 \cdot 10^{-6}$ $N_1 := 10$ $N_2 := 1000$ $t_1 := 50 \cdot 10^{-6}$

N_2

$a := \frac{N_2}{N_1}$ $a = 100$

(a) $v_D := V_s \cdot (1 + a)$ $v_D = 2.222 \times 10^4$

V_s

(b) $I_o := \frac{L_m \cdot t_1}{I_o}$ $I_o = 44$

(c) $I_{o\_peak} := a$ $I_{o\_peak} = 0.44$

(d) $t_2 := \frac{a \cdot L_m \cdot I_o}{V_s}$ $t_2 \cdot 10^6 = 5 \times 10^3$ μs

(e) $W := \frac{1}{2} \cdot L_m \cdot I_o^2$