HW 7

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1) 14) $i_L(0^+) = i_L(0^-) = 4$

$i_T = 4A$

$\frac{V_T}{I_T} = 0.25 \qquad R_{th} = 0.25$

$\tau = \frac{L}{R} = \frac{5 \cdot 10^{-3}}{25} = 20\,ms$

$i_o = i_L(0^-)e^{-t/\tau} = 4e^{-t/.002} = 4e^{-50t}$

$V_o = L\frac{di_o}{dt} = (5 \cdot 10^{-3})\frac{d}{dt}(4e^{-50t}) = \boxed{1 - e^{-50t}\,V}$

2) a) $i_{1.25H}(0^-) = i_{10H}(0^-) = -2A$

$i_o(0^-) = 0A$

$L_{eq} = 1.25 + \frac{10 \cdot 6}{10+6} = 5\,H$

$\frac{1}{\tau} = \frac{R}{L} = \frac{7500}{5} = 1500$

$i_L(t) = i_L(0)e^{-t/\tau} = -2e^{-1500t}\,A$

$V_o(t) = L\frac{di_L}{dt} = (3.75)\frac{d}{dt}(-2e^{-1500t}) = 11250e^{-1500t}\,V$

b) $i_o(t) = -\frac{1}{L}\int_0^t V_o(t)dt + i_o(0) = -\frac{11250}{6}\left(\frac{e^{-1500t}}{-1500}\Big|_0^t\right)$

$= 1.25(e^{-1500t} - 1)\,A$

3) 26) a) $v(0^-) = \frac{12\|68}{12\|68 + 1.8}(-120) = -102\ V$

$v(t) = v(0^-)e^{-\frac{t}{RC}} = -102e^{-25t}\ V$

$P_{12k\Omega} = \frac{(-102e^{-25t})^2}{12600} = 0.867e^{-50t}\ W$

$W_{12k\Omega} = \int_0^{0.012} 0.867e^{-50t}dt = 7824\mu J$

b) $w(0) = \frac{1}{2}(\frac{10}{2}\cdot 10^{-6})(-102)^2 = 17340\mu J$

$= \int_0^t P_{12k\Omega}dt = \int_0^t 0.867e^{-50t}dt =$

$17340(1-e^{-50t})\ \mu J$

$e^{-50t} = 1 - 0.25$

$t = 27.73\ ms$

4) 30) a) $v(0^-) = -18\ V$

$-V_t + 20000(i_t + \alpha V_\Delta) + 5000i_t = 0$

$V_\Delta = 5000i_t$

$R_{th} = \frac{V_t}{i_t} = 25000 + 1000\cdot 10^6\alpha$

$\tau = R_{th}C = 40\ ms$

$R_{th} = \frac{\tau}{C} = 50k\Omega$

$\alpha = \frac{50000 - 25000}{10^8 \cdot 10^6} = 0.25\cdot 10^{-3}\ A/V$

b) $v(t) = v(0^-)e^{-\frac{t}{\tau}} = -18e^{-25t}\ V$

$$\frac{V_\Delta}{5000} + \frac{V_\Delta - V(t)}{20000} + \alpha V_\Delta = 0 = \frac{-18e^{-25t}}{20000}$$

$$V_\Delta = -1.8e^{-25t}\ V$$

5) 44) $i_L(0^-) = i_L(0^+) = 15\ mA$

$$\frac{V_a}{15} + \frac{V_a - V_a(0^+)}{5} = 20 \cdot 10^{-3}$$

$$V_a = 0.75 V_o(0^+) + 0.075$$

$$i_\Delta = \frac{V_o(0^+)}{40} + 0.005$$

$$V_o(0^+) = -0.08 = -80\ mV$$

$$V_o(\infty) = 0$$

$$i_\Delta = \frac{V_T}{8} - 9 i_\Delta \qquad i_\Delta = \frac{V_T}{80}$$

$$i_T = \frac{V_T}{20} + \frac{V_T}{8} - 9 i_\Delta$$

$$\frac{i_T}{V_T} = \frac{1}{16} \qquad \frac{V_T}{i_T} = 16 \quad R_{th} = 16\ \Omega$$

$$\tau = \frac{L}{R_{th}} = \frac{4 \cdot 10^{-3}}{16} = 0.25\ ms$$

$$V_o(t) = 0 + (-80)e^{-t/(0.25 \cdot 10^{-3})} = -80e^{-4000t}\ mV$$

6) 4a) $\tau = \frac{L_{eq}}{R} = \frac{24 \cdot 10^{-3}}{120} = 0.2\,ms$

$i_L(\infty) = -50\,mA$

$i_L(t) = -50 + 75e^{-5000t}\,mA$

$V_o = -9e^{-5000t}\,V$

b) $0.4 \cdot (-50 + 75e^{-5000t}\,mA) = -20 + 30e^{-5000t}\,mA$

c) $(0.6)(-50 + 75e^{-5000t}) = -30 + 45e^{-5000t}\,mA$

7) 5a) $V_o = 75\frac{10}{10+5} = 50V$

$V_o(\infty) = -100 \cdot \frac{40}{50} = -80V$

$R_{eq} = 40 \,//\, 10 = 8\,k\Omega$

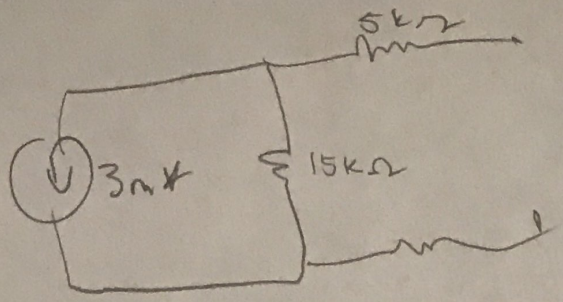
$\tau = 3.2 \cdot 10^{-4} = 0.32\,ms$

$V_o(t) = -80 + 130e^{-3125t}\,V$

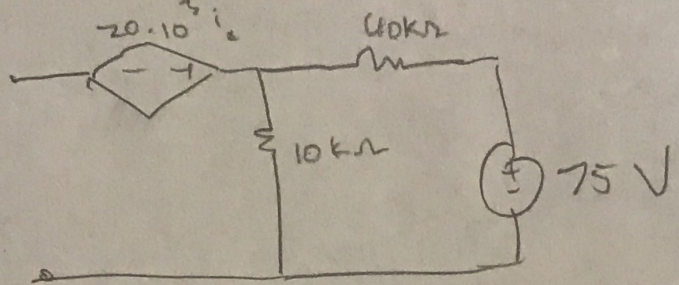
b) $i_o(t) = \frac{-80 + 130e^{-3125t} + 100}{10 \cdot 10^3} =$

$2 + 13e^{-3125t}\,mA$

8) 61)



$$V(0^-) = (3\cdot10^{-3})(15\cdot10^{3}) = 45\ V$$



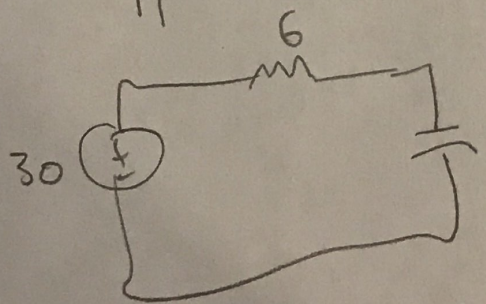
$$V_\infty = -10\cdot10^{3}\left(\frac{15-75}{40k}\right) + 15 = 30\ V$$

$$i_\Delta = \frac{10}{10+40} i_T = 0.2\, i_T$$

$$V_T = (-10\cdot10^{3})(0.2\, i_T) + \left(\frac{(10)(40)}{50}\right) i_T =$$

$$-2000\, i_T + 8000\, i_T = 6000\, i_T$$

$$\frac{V_T}{i_T} = 6000 \qquad R_{Th} = 6k\Omega$$



$$\tau = (6\cdot10^{3})(62.5\cdot10^{-9})$$

$$= -3.75\cdot10^{-4}\ s$$

$$-3.75\ ms$$

$$V_o(t) = 30 + (45-30)\left(e^{\frac{-t}{-0.375m}}\right)$$

$$= 30 + 15\, e^{2.67t}$$

a) 63) $V_c(0^+) = 0$

$i_b = 120 \frac{330\Omega}{3000 + 4700\Omega} = 49.5\ mA$

$I_{1\Omega} = 1237.5\ mA$

$V_c(\infty) = -19.8\ V$

$\tau = RC = 4 \cdot 10^{-3}\ s \therefore 4\ ms$

$V_c(t) = -19.8 + 19.8 e^{-250t}\ V$

$W(t) = 4.9 \cdot 10^{-5}\ J$

$w(t_0) = 1.764 \cdot 10^{-5}\ J$

$V_c^2(t_0) = 11.86\ V$

$-11.88 = -19.8 + 19.8 e^{-250 t_0}$

$t_0 = 3.665\ ms$

10) 65) a) $V_{3mF}(t) = 120\ V$

$V_0(\infty) = 90 \frac{60}{60+120} = 30\ V$

$R_{eq} = \frac{60 \cdot 120}{60+120} = 40\ k\Omega$

$C_{eq} = \frac{30.00}{90} = 20\ nF$

$\tau = 0.8\ ms$

$V_c(t) = 30 + 90 e^{-1250t}\ V$

b) $-i_c + \frac{V_0}{60000} + \frac{V_0 - 90}{120,000} = 0$

$i_0 = 2.25 \cdot 10^{-3} \cdot e^{-1250t}\ A$

$V_1(t) = \frac{1}{60 \cdot 10^{-9}} \int_0^t 2.25 \cdot 10^{-3} e^{-1250x}\, dx =$

$30 - 30 e^{-1250t}\ V$