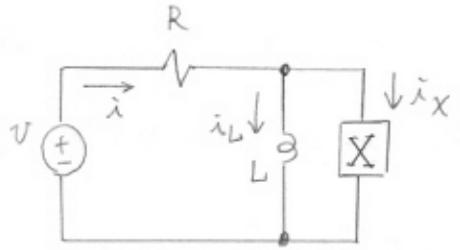
5.42



$X = R_1$

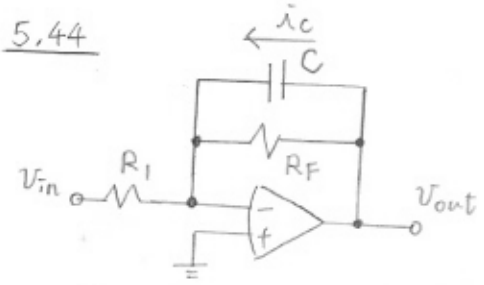
$V_L + R \cdot i = V$, $V_L = L\frac{di_L}{dt}$

$i = i_L + V_L/R_1$

$\Rightarrow L\frac{di_L}{dt} + R\left(i_L + V_L/R_1\right) = V$

$\Rightarrow \left(L + \frac{RL}{R_1}\right)\frac{di_L}{dt} + Ri_L = V$

5.44

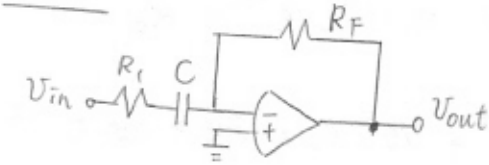


$V_{out} = V_C$, $i_C + \frac{V_{out}}{R_F} = -i_{in}$, $i_C = C\frac{dV_C}{dt}$

$i_{in} = V_{in}/R_1$

$\Rightarrow C\frac{dV_C}{dt} + \frac{V_{out}}{R_F} = -\frac{V_{in}}{R_1} \Rightarrow C\frac{dV_{out}}{dt} + \frac{V_{out}}{R_F} = -\frac{V_{in}}{R_1}$

5.45



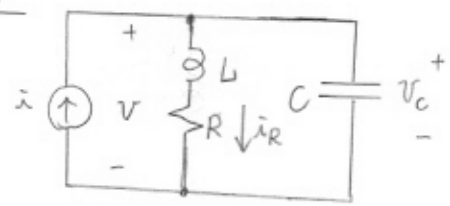
$i_{in} = -i_f = -\frac{V_{out}}{R_F}$

$V_{in} = R_1 i_{in} + \frac{1}{C}\int_{-\infty}^{t} i_{in}(\tau)\,d\tau$

$\Rightarrow \frac{dV_{in}}{dt} = R_1\frac{di_{in}}{dt} + \frac{i_{in}}{C}$

$\Rightarrow \frac{R_1}{R_F}\frac{dV_{out}}{dt} + \frac{V_{out}}{R_F C} = -\frac{dV_{in}}{dt}$

5.48



$V_L = L\frac{di_R}{dt}$, $V = V_L + R\cdot i_R = L\frac{di_R}{dt} + R\cdot i_R$

$i_C = C\frac{dV}{dt} = CL\frac{d^2 i_R}{dt^2} + CR\frac{di_R}{dt}$

$i_C + i_R = i \Rightarrow CL\frac{d^2 i_R}{dt^2} + CR\frac{di_R}{dt} + i_R = i$

$\Rightarrow CL\cdot\frac{d}{dt}\frac{di_R}{dt} + CR\frac{d}{dt}\cdot\frac{di_R}{dt} + \frac{di_R}{dt} = \frac{di}{dt}$

$\Rightarrow C\frac{d^2 V_L}{dt^2} + \frac{CR}{L}\frac{dV_L}{dt} + \frac{V_L}{L} = \frac{di}{dt}$

5.54

$4\cdot 10^4\frac{di_F}{dt} + 10^4\cdot i_F = \frac{dV}{dt} = 100t + 200$

$\Rightarrow$ try $i_F = K_1 t + k_0$

$\Rightarrow 4\cdot 10^4 K_1 + 10^4(K_1 t + k_0) = 10^4 K_1 t + 10^4(4k_1 + k_0) = 100t + 200$

$K_1 = 0.01$, $k_0 = -0.02$

$\Rightarrow i_F = 0.01t - 0.02$

5.61 $L\frac{di_N}{dt} + R\cdot i_N = 0 \Rightarrow 0.25\frac{di_N}{dt} + 5\cdot i_N = 0 \Rightarrow S = -20$

$0.25\frac{di_F}{dt} + 5\cdot i_F = 10t(e^{-20t}) \Rightarrow$ try $i_F = t(k_1 t + k_0)e^{-20t}$

$\Rightarrow 0.25(2k_1 t e^{-20t} - 20k_1 t^2 e^{-20t} + k_0 e^{-20t} - 20t k_0 e^{-20t})$

$+ \quad 5(k_1 t^2 + k_0 t)e^{-20t} = 10te^{-20t}$

$\Rightarrow \quad 0.5k_1 t + 0.25k_0 = 10t \Rightarrow k_1 = 20,\ k_0 = 0$

$i_F = 20t^2 e^{-20t}$

5.64 $400\frac{di_N}{dt} + 10^4 i_N = 0 \Rightarrow S = -\frac{10^4}{400} = -25$

$400\frac{di_F}{dt} + 10^4 i_F = \frac{dv}{dt} = 200 + 100e^{25t} \Rightarrow$ try $i_F = K_2 e^{25t} + K_0$

$\Rightarrow 400\cdot 25K_2 e^{25t} + 10^4(K_2 e^{25t} + K_0) = 2\cdot 10^4 K_2 e^{25t} + 10^4 K_0 = 200 + 100e^{25t}$

$\Rightarrow K_2 = 0.05,\ K_0 = 0.02$

$i(t) = 0.05e^{25t} + 0.02 + Ae^{-25t},\ i(0^+) = 0.07 + A = 0 \Rightarrow A = -0.07$

$i(t) = 0.05e^{25t} + 0.02 - 0.07e^{-25t}$