

HW #6

D) a) $i(t) + \angle 0$
 $i = 0$

$$0 \leq t < 5 \text{ ms}$$

$$i = \frac{250}{5} + = 50 + A$$

$$5 \leq + \leq 10$$

$$i = 0.5 - \frac{250}{5} +$$

$$+ \angle 10$$

$$j = 0$$

b)

$$V = L \frac{di}{dt} = 20 \cdot 10^{-3} \frac{d(50t)}{dt} =$$

$$+ \angle 0 \quad r = 0$$

$\boxed{0 \text{ V}}$
 $P = 0 \cdot 0 = 0$

$$0 \leq t < 5$$

$$V = 20 \cdot 10^{-3} \left(\frac{d(50t)}{dt} \right) = 1000 \cdot 10^{-3} \cdot \boxed{IV} \quad \boxed{P = 50t \text{ W}}$$

$$5 \leq t \leq 10$$

$$V = 20 \cdot 10^{-3} \cdot \frac{d(0.5 - 50t)}{dt} = \boxed{-IV} \quad \boxed{P = -0.5 + 50t \text{ W}}$$

$$t > 0$$

$$V = \boxed{0} \quad P = Vi = 0$$

$$+ \angle 0$$

$\boxed{W=0}$

$$0 \leq t \leq 5$$

$$W = \int_0^t 50 + dt = \boxed{25t^2 \text{ J}}$$

$$5 \leq t \leq 10$$

$$W = \int_{5 \cdot 10^{-3}}^t (50t - 0.5)t + 50t$$

$$= 25t^2 - 0.5t + 25 \cdot 10^{-3} \text{ J}$$

$$+ > 10$$

$$W=0$$

2) $i(0)=400 \text{ mA}$ $C=250 \text{ nF}$

$$V = \begin{cases} 50 \text{ V} & t < 0 \\ A_1 e^{-4000t} + A_2 t e^{-4000t} \text{ V} & t \geq 0 \end{cases}$$

a) $W_i = \frac{1}{2} (z_0 \cdot 10^{-6}) (50)^2 = 312.5 \text{ mJ}$

b) $50 = A_1 e^{-4000(0)} + A_2(0) e^{-4000(0)} = A_1 = 50$

$$i(t) = C \frac{dV(t)}{dt} = 250 \cdot \frac{1}{t} [A_1 e^{-4000t} + A_2 t e^{-4000t}] \cdot 10^{-9}$$

$$t = 0$$

$$= 400 \cdot 10^{-3} : 250 \cdot 10^{-9} \cdot [-4000 A_1 - 0 + A_2]$$
$$A_2 = 180000$$

c)

$$i(t) = C \frac{dV(t)}{dt} = -0.05 e^{-4000t} - 1800 t e^{-4000t} + 0.45 e^{-4000t}$$

$$= 0.4 e^{-4000t} - 1800 t e^{-4000t}$$

$$3) \quad G_1 \parallel L_2 = \frac{L_1 \cdot L_2}{L_1 + L_2}$$

$$15 \parallel 30 = 15 \quad 10 + 10 = 20$$

$$20 \parallel 20 = 10$$

$$12 \parallel 24 = 8 \quad 10 + 8 = 18$$

$$18 \parallel 9 = 6 \quad 6 + 9 = 15$$

$$\boxed{L_{ab} = 14 \text{ mH}}$$

$$b) \quad 12 + 8 = 20$$

$$30 \parallel 20 = 12$$

$$12 + 38 = 50$$

$$50 \parallel 75 = 30$$

$$30 \parallel 30 = 15$$

$$15 + 15 = 30$$

$$30 \parallel 60 = 20$$

$$20 + 25 = 45$$

$$\boxed{L_{ab} = 45 \text{ mH}}$$

$$4) \quad a) \quad i_o(0) = -(i_1(0) + i_2(0)) = -(-6 + 1) = 5 \text{ A}$$

$$b) \quad L_{ab} = 1114 = 0.9 \text{ H}$$

$$L_{ab} + 3.2 = 4 \text{ H}$$

$$i_1(t) = \frac{1}{L} \int_0^t 2000 e^{-100t} dt + 5 = \boxed{\left[5e^{-100t} \right] A}$$

$$c) V_{3,2} = 3.2(-100(5)e^{-100t}) = -1600e^{-100t} \text{ V}$$

$$V_{L_{eq}} = V_{3,2} \cdot N_o = 400e^{-100t} \text{ V}$$

$$i_1(t) = \int_0^t 400e^{-100\tau} d\tau - 6 = \boxed{-4e^{-100t} + 2 \text{ A}}$$

$$d) i_2(t) = \frac{1}{4} \int_0^t 400e^{-100\tau} d\tau + 1 = \boxed{e^{-100t} + 2 \text{ A}}$$

$$e) W(0) = \frac{1}{2}(1)(-6)^2 + \frac{1}{2}(4)(1)^2 + \frac{1}{2}(3.2)(5)^2 = \boxed{160 \text{ J}}$$

$$\text{f)} W_{dec} = \frac{1}{2}(L_a + 3.2)(i(\infty))^2 = \frac{1}{2}(4)(5)^2 = \boxed{50 \text{ J}}$$

$$g) = W = 60 - 50 = \boxed{10 \text{ J}}$$

$$5) a) i(t) = -\frac{1}{2} \int 12e^{-t} dt + C = -6e^{-t} + C$$

$$i(0) = i_1(0) + i_2(0) = 2 + 4 = 6 \text{ A}$$

$$t=0 \quad i(0)=6 \quad C=6+C \quad C=0$$

$$i(t) = 6e^{-t} \text{ A}$$

$$b) i_1(t) = -\frac{1}{3} \int 12e^{-t} dt + C = 4e^{-t} + C$$

$$i_1(0) = 2 \quad 2 = 4 + C \quad C = -2$$

$$i_1(t) = 4e^{-t} - 2 \text{ A}$$

$$c) i_2(t) = -\frac{1}{6} \int 12e^{-t} dt + C = 2e^{-t} + C$$

$$i_2(0) = 1 \quad 4 = 2 + C \quad C = 2$$

$$2e^{-t} + C$$

$$d) P = Vi = 12e^{-t}(6e^t) = 72e^{-2t}$$

$$E = \int_0^\infty P dt = 72 \int_0^\infty e^{-2t} dt = 72 \left[\frac{e^{-2t}}{-2} \right]_0^\infty = 36J$$

$$e) E = \frac{1}{2} \cdot 3 \cdot 4 + \frac{1}{2} \cdot 6 \cdot 16 = 54J$$

$$f) = 54 - 36 = 18J$$

$$6) a) \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_1} = \frac{1}{20} + \frac{1}{48} = \frac{1}{16}$$

$$16 + 4 = 20$$

$$\frac{1}{C_2} = \frac{1}{20} + \frac{1}{30} = \frac{1}{12}$$

$$C_2 = 12$$

$$\frac{1}{C_3} = \frac{1}{20} + \frac{1}{20} + \frac{1}{10} = \frac{1}{5} \quad C_{eq} = 5nF$$

$$b) \frac{1}{C_1} = \frac{1}{36} + \frac{1}{18} + \frac{1}{12} = \frac{1}{6} \quad C_1 = 6$$

$$6+24=30$$

$$25+5=30$$

$$\frac{1}{C_2} = \frac{1}{30} + \frac{1}{30} + \frac{1}{30} = \frac{1}{10} \quad C_{eq} = \boxed{10 \text{ nF}}$$

$$\rightarrow a) C_{eq} = \frac{3 \cdot 6}{3+6} = 2 \text{ nF}$$

$$i(t) = -20e^{-t} \text{ mA}$$

$$V_o(t) = \frac{1}{2 \cdot 10^{-1}} \int_0^t -20e^{t-10^{-6}} dt + 10 = \boxed{10e^{-t} \text{ V}}$$

$$\begin{aligned} b) V_i(t) &= \frac{1}{4} \int_0^t i(t) dt + 4 \\ &= \frac{1}{3 \cdot 10^{-6}} \int_0^t -20e^{-t-10^{-6}} dt + 4 \\ &= 6.67e^{-t} - 2.667 \text{ V} \end{aligned}$$

$$c) V_2(t) = \frac{1}{6 \cdot 10^{-1}} \int_0^t -20e^{-t-10^{-6}} dt + 6 = \boxed{3.3e^{-t} + 2.67 \text{ V}}$$

$$d) \int_0^4 -200e^{-t} dt \cdot 10^{-6} = 100 \text{ nJ}$$

$$e) \frac{1}{2}(3)(10^{-6})(16) + \frac{1}{2}(6 \cdot 10^{-6})(36) = 132 \text{ nJ}$$

$$f) 132 - 100 = 32 \text{ nJ}$$

$$8) \text{ a) } W(0) = \frac{1}{2}(5 \cdot 10^{-6})(20)^2 + \frac{1}{2}(1.25 \cdot 10^{-6})(30)^2 + \frac{1}{2}(0.2 \cdot 10^{-6})(250)^2 + \frac{1}{2}(0.8 \cdot 10^{-6})(250)^2 = 32.8125 \text{ mJ}$$

$$\text{b) } W(\infty) = \frac{1}{2}(5 \cdot 10^{-6})(40)^2 + \frac{1}{2}(1.25 \cdot 10^{-6})(110)^2 + \frac{1}{2}(0.2 \cdot 10^{-6})(150)^2 + \frac{1}{2}(0.8 \cdot 10^{-6})(150)^2 = 22.8125 \text{ mJ}$$

$$\text{c) } W_{\text{tot}} = \frac{1}{2}(0.5 \cdot 10^{-6})(200)^2 = 10 \text{ mJ}$$

$$\text{d) } \frac{10 \text{ mJ}}{32.8125 \text{ mJ}} \cdot 100 = 30.48\%$$

$$\text{e) } W = \int_0^+ e^{-100t} dt = 10(1 - e^{-100t}) \text{ mJ} \\ t = -\frac{\ln(0.25)}{100} = 13.86 \text{ ms}$$

$$9) V_C = -\frac{1}{C} \left[\int_0^+ i(t) dt + V_C(0) \right] = 150 e^{-16000t} - 200(e^{-4000t}) \text{ V}$$

$$V_L = L \frac{di_o}{dt} = -600 e^{-16000t} + 50 e^{-4000t} \text{ V}$$

$$V_o = V_C - V_L = 750 e^{-16000t} - 250 e^{-4000t} \text{ V}$$

$$(0) + 20^+$$

$$\frac{di_0(0^+)}{dt} = 1 \left[-50000 \sin(0) \right] = 0 \text{ A}$$

$$V_2(0^+) = L \frac{di_0(0^+)}{dt} = (10 \cdot 10^{-3})(0) = 0 \text{ V}$$

$$V_1(0^+) = 40(5(1)(2\cos(0) + 5\sin(0))) =$$

100V