**Homework 8**



**P18.3.5** Determine *i*1 and *i*2 for *t* = 0+ in Figure P18.3.5

given *vSRC* = 4*δ*(*t*) V and assuming initial currents; *i*1 = 1 A and *i*2 = 1A.

**Solution:** Assume the inductors are initially uncharged. *Leq* = 2 + 3||6 = 4 H. The voltage impulse appears across *Leq* resulting in a current *iS*(0+) = 4/4 = 1 A. The flux linkage across the 3||6 = 2 H is *LiS* = 2 Wb-T and appears across both inductors. It follows that *i*11(0+) = 2/3 A, and *i*21(0+) = 2/6 = 1/3 A. These currents add to those already present, so that *i*1(0+) = 2/3 + 1 = 5/3 A, and *i*2(0+) = 1/3 + 1 = 4/3 A.



**P18.4.3** Determine *iL* and *vC* at *t* = 0+ in Figure P18.4.3,

given *iSRC* = 20*δ*(*t*) μA, and assuming the inductor and capacitor are initially uncharged.

**Solution:** The inductor presents an open circuit to the current impulse and the capacitor a short circuit. The current impulse flows through the capacitive branch resulting in a voltage impulse of 20×1 = 20*δ*(*t*) mV and depositing a charge of 20 μC on the capacitor. The capacitor charge produces *vC*(0+) = 10 V, and the voltage impulse results in *iL*(0+) = 20 mV/0.5 H = 40 mA.

**P18.4.11** Repeat Problem P13.4.10 assuming the inductor is initially uncharged and the voltage across the capacitor is initially *vX* = 2 V.



**Solution:** The voltage across the

capacitor and the current through



the inductor are not forced to change.

The dependent source voltage is

1 V, so that 1 V is dropped across the 2 Ω resistor. It is seen that *vx*(0+) = 2 V, *vO*(0+) = 1 V, *iL* = 0, *vL*(0+) = 1 V.

**P19.1.4** The capacitors in Figure P19.1.4 have initial voltages *V*10 = -5 V and *V*20 = 30 V. If the switch is closed at *t* = 0, determine: (a) *v*1, *v*2, and *v*O for *t* ≥ 0+, and (b) the energy trapped in the circuit.



**Solution:** (a) The 6 μF capacitor has a voltage



of -5 V and a charge of

-6×5 = -30 μC. The

1 μF capacitor in parallel with the 2 μF capacitor is a 3 μF capacitor having an initial voltage of 30 V and an initial charge of 30×3 = 90 μC. *Ceq* = 6×3/(6 +3) = 2 μF, having a voltage of 25 V, and a charge of 2×25 = 50 μC. When *Ceq* discharges, this charge flows CW in the circuit, as shown. The final charge on the 6 μF capacitor is 80 μC, and the final voltage is 80/6 = -40/3 V. The time constant is 2×10-6×250×103 = 0.5 s. It follows that  =  V, *t* is in s.

The final charge on the 2 μF capacitor is 40 μC, and the final voltage is 40/3 V. It follows that  V, *t* is in s.

The initial value of *vO* is 25 V and its final value is zero. It follows that  V, *t* is in s.

(b) The final energy on the capacitors is =  mJ.

**P19.1.7** The initial voltages on the capacitors in



Figure P19.1.7, before the switch is closed are: 2 V on C1, 6 V on *C*2, and

0 V on *C*3. The switch is closed at *t* = 0. Determine: (a) the charges on the three capacitors at *t* = 0+; (b) *vR*(*t*), *t* ≥ 0+;

c) the final voltages on the capacitors.

**Solution:** (a) At *t* = 0+, current just begins to flow through the 1 kΩ resistor but no charge has yet flowed through the resistor. The three capacitors can be considered in series, so that *Ceqs* = 0.5 μF, with 8 V cross it, corresponding to a charge of 4 μC, as shown. When the switch is closed, the 4 μC circulates CW. The initial charge on *C*1 is 4 μC and the



charge at *t* = 0+ is *q*1(0+) = 0. The initial charge on *C*2 is 12 μC and the charge at *t* = 0+ is *q*2(0+) = 8 μC, corresponding to a voltage of 4 V. The initial charge on *C*3 is 0 and the charge at *t* = 0+ is



*q*3(0+) = 4 μC, corresponding to a voltage of 4 V, a shown. The circuit reduces at *t* = 0+ to a *Ceqp* = 2 μF, with a voltage of 4 V across it, corresponding to a charge of 8 μC, as shown.

Alternatively, and before the switch is closed, *C*1 and *C*2, can be combined into a capacitance *C*12 = 1 μF having 8 V across it, corresponding to a charge of 8 μC. When paralleled with *C*3, charge is conserved at *t* = 0+, resulting in 8 μC on a capacitor *Ceqp* = 2 μF, the voltage being 4 V, as before.



(b) *Ceqp* discharges with a time constant of 2 ms. It follows that  V, *t* is in ms.

(c) When *Ceqp* discharges, 8 μC circulate CW. These divide into -4 μC through *C*3 (bottom plate positive), reducing the charge to zero; The 4 μC through *C*1 and *C*2, result in -4 μC on *C*1 (bottom plate positive) and -4 + 8 = 4 μC on *C*2. The final voltages are *v*1 = -2 V and *v*2 = +2 V, adding up to zero, with *v*3 = 0.

**P19.2.1** Given the two inductors of Figure P19.2.1 having the initial currents indicated. If the switch is closed at *t* = 0, determine *i* for *t* ≥ 0+.



**Solution:** Flux linkage is conserved at the instant of switching. Initial flux linkage = 2×1 + 3×2 = 8 Wb-T, since the two currents are in the same sense. The final current just after the switch is closed is therefore 8/(2 + 3) = 1.6 A. The time constant is (2 + 3)/(5 + 5) = 0.5 s. It follows that A.