**Homework 12**

**P22.1.14** A source of unknown voltage is applied to the circuit shown in Figure P22.1.9. Determine *iC* given that *i* = (1 + *t*)*u*(*t*) A.



**Solution:** *Ic*(*s*) = *I*(*s*); ; ;  A.

**P22.1.17** Derive the transfer function *VO*(*s*)/*VSRC*(*s*) in Figure P22.1.12.



**Solution:** 

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. Hence,











If *s*′ is in Mrad/s, then *s*′ = *×*106. This gives:



**P22.1.18** Determine the transfer function *Vo*(*s*)/*Ii*(*s*) in Figure P22.1.18 assuming and



**Solution:**  ; ; .



**P22.1.21** Determine the transfer function *IO*(*s*)/*ISRC*(*s*) in Figure P22.1.21, assuming no initial energy storage.

**Solution:** TEC seen by the capacitor will be derived. It follows from current division that ; *VTh* = .



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; . It follows that

. .

**P22.1.23** Determine *VL*(*s*) in Figure P22.1.23, assuming that the voltage sources are applied at *t* = 0, with zero initial energy storage in the capacitors.



**Solution:** The circuit in the *s*-domain is a shown. The 6/*s* voltage source and the 1/s impedance are transformed to a current source  in parallel with 1/*s*. This, in parallel with 1/*s* is an impedance of 1/2*s* Ω. The current source in parallel with this impedance is transformed to a voltage source 3/s in series with 1/2*s*. the circuit becomes as shown. The current *I*(*s*) is: , and .



**P22.2.5** Both switches in Figure P22.2.5 are opened at *t* = 0 after being closed for a long time. Determine *iO*(*t*).



**Solution:** At *t* = 0-, the source current divides into 25×12/20 = 15 mA through the 8 kΩ resistor and 25×8/20 = 10 mA through the 12 kΩ resistor. The voltage across the 0.15 μF capacitor is 120 V, and that across the 0.3 μF capacitor is 100 V. The circuit for *t* ≥ 0+ becomes as shown. It follows that: ; ;  As ≡ mAs, where *s*′ is in krad/s. It follows that  mA, *t* is in ms.



**P22.2.13** Both switches are opened at *t* = 0 after being closed for

a long time. Determine *I*2(*s*), *V*2(*s*), and the corresponding ILTs.

**Solution:** = 1.6 A; *I*20 = = 0.4 A; The circuit for *t* ≥ 0+ becomes as shown. It follows that: ; A.



 Vs;

V.



**P22.3.16** Determine *vO* in Figure P22.3.15 if the initial current in the inductor is zero and the initial voltage across the capacitor is 3 V and of the same polarity as *vO*.

**Solution:** The *s*-domain circuit is as shown, from which, *Ix* = 20/(5*s*) = 4/*s*, so that the dependent source can be replaced by an independent source 8/*s*, as shown. *VO* can now be obtained by superposition.



When the 0.6 source is applied with the other sources set to zero, *VO*1 = 0.6×(0.1*s*||5/*s*) = .



When the ideal voltage source is applied alone, *VO*2 = (20/*s*)×(5/*s*)/(5/*s* + 0.1s) = .

. When the 8/*s* source is applied alone, *VO*3 = (8/*s*)×(0.1*s*||5/*s*) = . It follows that:

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. Multiplying by *s* and setting *s* = 0 gives, *K*1 = 20. Multiplying out and equating numerators: 3*s*2 + 40*s* + 1000 = 20(*s*2 + 50) + *s*(*K*2*s* + *K*3). Comparing the coefficients of *s*2: 3 = 20 + *K*2, or *K*2 = -17. Comparing the coefficients of *s*: 40 = *K*3. The ILT of 20/*s* is 20*u*(*t*); the ILT of -17*s*/(*s*2 + 50) is ; the last term is . It follows that:  V.

**22.3.22** The switch in Figure P22.3.22 is opened at *t* = 0 after being closed for a long time. Determine *I*(*s*).



**Solution:** At *t* = 0-, the capacitor is fully charged. The total resistance in series with the battery is 30 + (100||150) + 10 = 50+ 100×150/250 + 10 = 30 + 60 + 10 = 100. Hence, *I*0 = 500/100 = 5 A. The current in the 100 Ω resistor in series with the 50 Ω is 5×100/250 = 2 A. The voltage across th capacitor is 500 – 5×30 – 2×100 = 150 V. The circuit in the *s* domain becomes a shown, where 50||200 = 40 Ω and is combined with the 10 Ω to give 50 Ω. It follows that: = = = .



**P22.3.26** the double switch in Figure p22.2.26 is opened at *t* = 0 after being closed for a long time. Determine *vO*(*t*).

**Solution:** At *t* = 0-, there will be an initial current of 2 A in each winding and an initial voltage of 4 V across the capacitor as shown. The circuit in the *s* domain is shown for *t* ≥ 0+. The secondary inductor is *L*2 – *M* = 2 H and the source is (2 H)×(-2 A) = -4. The current in the 4 H mutual inductor is 2 + 2 = 4 A directed downwards, and the source is (4 H)×(4 A) = 16.



From KVL: (6*s* + 2 + 1/4*s*)*I*2 +16 + 4 + 4/*s* = 0, which gives:;



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. It follows that  V.