**Homework 9**



**P8.4.4** Derive TEC looking into terminals ‘ab’ in Figure P8.4.4.

**Solution:** On open circuit, *vx* = 0, so the current source is zero and *vab* = *vTh* = 5cos(10*t*) V.

In the frequency domain, the impedance of the capacitor is

-*j*/(10×0.5) = -*j*0.2 Ω, and that of the inductor is *j*10×0.2 = *j*2 Ω. When a test source **VT** is applied, with the independent source set to zero, the circuit is as shown. **VX** = -*j*2**IT**, so the dependent source is *j*0.5**IT**, with reversed polarity. The capacitor current is **IT**(1 + *j*0.5) and the voltage across the capacitor is **IT**(1 + *j*0.5)(-*j*0.2) = **IT**(0.1 – *j*0.2) and **VT** = **IT**(0.1 – *j*0.2 + *j*2) = **IT**(0.1 + *j*1.8). It follows that *ZTh* = (0.1 + *j*1.8) Ω.



**P8.5.2** Determine **ISRC** and **VL** in Figure P8.5.2



using the node-voltage method.



**Solution:** With the lower node as a reference, the

node-voltage equations are:

**Va** **Vb** **Vc** 

**Va** **Vb** **Vc** 

**Va** **Vb** **Vc** 

These equations simplify to:

**Va** **Vb** **Vc** 

**Va** **Vb** **Vc** 

**Va** +**Vb** **Vc** 

The solution to these equations are: **Va** =  ∠1° V; **Vb**∠8° V; and **Vc** = **VO**  ∠41.1° V.

**ISRC** = 10 – 0.5**Va** =  ∠19.3° A.

**P9.1.1** Two coils are wound on a high-permeability core (Figure P9.1.1). Coil 1 has 1000 turns and carries a current *i*1 = 1 A. Coil 2 has 500 turns. Determine the magnitude and direction of the current in coil 2 so that the net flux in the core is zero.



**Solution:** The mmf due to *i*1 is 1000*i*1, and the mmf due to *i*2 is 500*i*2. To have zero mmf acting on the core, 1000*i*1 = 500*i*2, or *i*2 = 2*i*1, and *i*2 should enter at terminal 2′.

**P9.1.4** Two coils *L*1 and *L*2, having 1000 turns and 500 turns, respectively, are wound on a core of high permeability. When current is applied to one coil, with the other coil open circuited, the effective leakage flux of either coil is 5% of the core flux. Determine the coefficient of coupling between the two coils.

**Solution:** .

**P9.1.9** Two magnetically-coupled coils have *k* = 0.5. When connected in series, the total inductance is 80 mH. When the connection to one of the coils is reversed, the total inductance is 40 mH. Determine the inductances of the two coils.

**Solution:** , and . Adding, ; subtracting, , or *L*1*L*2 = 20, or *L*2 = 400/*L*1. Substituting for *L*2, , or . Solving,  52.36 and 7.64 mH.

**P9.1.16** Determine *Leq* in Figure P9.1.16.



Ans. 4 H.

**Solution:** If a current I flows in the inductors, the voltage induced in the 3 H inductor is *jω***I**(3 – 1 + 1) = *jω*3**I**; the voltage induced in the 2 H inductor is *jω***I**(2 – 1 – 1) = 0; the voltage induced in the 1 H inductor is *jω***I**(1 – 1 + 1) = *jω***I**; **V** = *jω*3**I** + *jω***I** = *jω*4**I**. It follows that *Leq* = 4 H.



**P9.2.3** Determine **Is** in Figure P9.2.3.



**Solution:** KVL on the input side:

(1 + *j*7)**Is** – *j*2**IL** = 10

KVL on the output side:

(*j*9 –*j*25/3)**IL** – *j*2**Is** = 0

This gives: **IL** = 3**Is**. Substituting for **IL** In the first equation: (1 + *j*)*Is* = 10, or **Is** A.

**P9.2.6** The open-circuit (**I2** = 0) voltage ratio of the linear transformer in Figure P9.2.6 is  and the short-circuit (**V2** = 0) current ratio is = 1. If the same coils are perfectly coupled, the mutual inductance is 8 H. Determine *L*1, *L*2, and *k* for the given coils.



**Solution:** When the output is open circuited, **V1** = *jωL*1**I1** and **V2** = *jω*M**I1**. . When the output is short circuited, KVL on the output side gives: *jωL*2**I2** – *jω*M**I1** = 0. . Multiplying the two ratios: , or , so that *k* = 0.5. Dividing the two ratios, M cancels out and *L*1 = 4*L*2, independently of *M*. If the coils are perfectly coupled, . Substituting for *L*2, , or *L*2 = 4H, which gives *L*1 = 16 H.