**Homework 9**



**P8.2.17** Determine *Zeq* between terminals ‘ab’ in Figure P8.2.17.

**Solution:** By current division, the current **IX** in the *j*20 impedance is  directed upwards; **VX** = -*j*20**IX** = *j*40**VX**. This means that **VX** = 0, so that the dependent source is equivalent to an open circuit. It follows that: Ω.



**P8.3.5** Determine *C* in Figure P8.3.5 so that *vO* has the same magnitude as *vI* but lags it by 90°, assuming *ω* = 400 rad/s.

**Solution:** From voltage division: = 

∠**VO** = −2tan–1(0.5*ωC*) = -90°; hence, tan-10.5*ωC* = 45° or 0.5*ωC* = 1, *C* = = 5μ F.



**P8.3.11** |**I|** in Figure P8.3.11 remains the same irrespective of whether the switch is open or closed. Show that under these conditions 2*ω*2*LC* = 1.

**Solution:** When the switch is open, |**I**| = *ωCVm*. when the switch is closed, the admittance of the *RL* branch is , and the total admittance is ; |*Y*| = , and |**I**| = |*Y|Vm*. It follows that |*Y| = ωC.* Simplifying gives: .

**P8.3.21** Determine **IX** in Figure P8.3.21.



**Solution: Initialize.** All given values and **IX** are entered. The nodes are labelled.

**Simplify.** Elements in parallel with the 2∠0° V source do not affect the voltage across the source



and are therefore redundant as far as **IX** is concerned. Elements in series with the 1∠90° A source do not affect the current through the branch and are redundant as far as **IX** is concerned. The circuit in the frequency domain reduces to that shown.

**Deduce.** The circuit is a two-essential node circuit that can be solved using KCL. , and the current through the capacitor is . KCL gives . This gives 2 – **Vbc** – 2**Vbc**, or **Vbc** = 0. It follows that = -*j* A



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

**Solution:** In the frequency domain, the voltage source is represented as a phasor 5∠0° V, the controlling voltage as a

phasor **VX**, and the dependent source



as a phasor 0.25**VX**. 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.

On open circuit, **VX** = 0, so the

current source is zero and **Vab** = **VTh** = 5∠0° V.

To determine *ZTh*, 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); **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 **VO** in Figure P8.5.2



using the node-voltage method.

**Solution:** Assigning node voltages as shown, the node-voltage equations are:

Node ‘a’:

(0.5 + *j*0.05 – *j*0.05)**Va** + *j*0.05**Vb** – *j*0.05**Vc** = 10, or

0.5**Va** + *j*0.05**Vb** – *j*0.05**Vc** = 10 (1)



Node ‘b’:

*j*0.05**Va** + (0.02 – *j*0.1)**Vb** + *j*0.05**Vc** = 0 (2)

Node ‘c’:

*-j*0.05**Va** + *j*0.05**Vb** +0.01**Vc** = 0 (3)

Solving these equations, **VO** = **Vc** = 13.4 + *j*11.7 V, **ISRC** = 10 – 0.5**Va** = 0.469 + *j*0.164 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 flux is proportional to the current and the number of turns (Equation 7.2.11). Thus, 1000*i*1 = 500*i*2, or *i*2 = 2*i*1; and *i*2 should enter at terminal 2′.



**P9.1.2** The terminal of one coil in Figure P9.1.2 is marked with a dot. Mark one terminal of the other coils with a dot and connect the coils in series for maximum total inductance.

**Solution:** The dots on the windings should be such that current entering at the dotted terminals produces flux in the same direction in the core. To produce maximum inductance, the coils have to be connected so that fluxes are additive.



**P9.1.3** Two coils are magnetically coupled through a core of high permeability. A current of 0.5 A in coil 1, with coil 2 open circuited, results in a flux of 0.1 Wb in the core, whereas a current of 0.25 A in coil 2, with coil 1 open circuited, results in a flux of 0.2 Wb in the core. If coil 1 has 100 turns, determine the number of turns of coil 2.

**Solution:** *Method 1: Equality of mutual conductance*: The flux linkage of coil 2 due to current in coil 1 is 0.1*N*2, and the flux linkage of coil 2 per unit current in coil 1 is 0.1*N*2/0.5.

The flux linkage in coil 1 due to current in coil 2 is 0.2*N*1 Wb-turns, and the flux linkage in coil 1 per unit current in coil 2 is 0.2*N*1/0.25 = 0.8*N*1 H.

By equality of mutual conductance between the two coils, 0.8*N*1 = 0.1*N*2/0.5, which gives *N*2 = 4*N*1 = 400 turns.

*Method 2: Ampere’s circuital law*: = *NI*. Coil1 has 100 turns and if *I*1 = 0.5 A, *N*1*I*1 = 100×0.5 = 50 AT. These 50 AT result in *H*, *B* and a flux in the core of 0.1 Wb. To produce a flux of 0.2 Wb due to *I*2, the AT should be doubled, since the system is linear. This means that *N*2*I*2 = 100 AT. Since *I*2 is 0.25 A, then *N*2 = 100/0.25 = 400 turns. In other words, to produce twice the flux in the core with half the current as in coil 1, coil 2 should have 4 times the number of turns, that is, 400 turns.