**Homework 15**

**P24.1.7** (a) Determine the *z* parameters and *y* parameters of the circuit shown in Figure P24.1.7 from the direct definition of these parameters. (b) Verify that the *z* and *y* matrices are the inverse of one another.



**Solution:** With port 2 open circuited, **V1** = 2**I1** + **Vx**, where **Vx** = -**I1**. Hence, **V1** = **I1,** and *z*11=1 Ω; **V2** = -0.5**Vx**, so that *z*21= -0.5 Ω.



With port 1 open circuited, **I1** = 0, so that **V2** = 0.5**Vx** where **Vx** = **V1** = **I2**. It follows that *z*22= 0.5 Ω and *z*12= 1 Ω. The *z*-parameter matrix is .



With port 2 short circuited, 0.5**Vx** = **Vx**, so that **Vx** = 0 and **I2** = **I1**. This gives **V1** = 2**I1**; hence *y*11= 0.5 S and *y*21= 0.5 S.

With port 1 short circuited, the currents are as shown, where **Vx** = 2**I** and 0.5**Vx** = **I**. Hence, **V2** = 0.5**Vx** = **I**, *y*22= 1S, and *y*12 = -1S. The *y*-parameter matrix is . Using Matlab, or Eq. (14.2.9), or Table 14.2.2, it can be readily verified that , or conversely.

**P24.1.12** (a) Determine the *h* parameters and *g* parameters of the circuit in Figure P24.1.11 from the definition of these parameters. (b) Verify that the *h* and *g* matrices are the inverse of one another.



**Solution:** With port 2 short circuited, *h*11 = , *h*21 = . With port 1 open circuited, *h*12 = , *h*22 = . With port 2 open circuited, *g*11 = =

*j* S, *g*21 = = -2. With port 1 short circuited, *g*12 = = 2, and *g*22 = *j*4 Ω.



**P24.2.3** Determine *k* so that the circuit in Figure P24.2.2 is reciprocal.

**Solution:** With the output open circuited, *I*1 = -0.1*V*2, so that *V*2 = -10*I*1, and *z*21 = -10 Ω. With the input open circuited, *I*2 = -0.1*V*2, and *V*2 = *V*1 + 10*I*2 + *kV*1, or *V*2 = 10*I*2 + (*k* + 1)*V*1, or



-10*I*2 = 10*I*2 + (*k* + 1)*V*1, or *V*1 = , so that . Equating *z*12 and *z*21, , which gives *k* = 1.

**P24.2.5** Given a symmetric two-port circuit (Figure P24.2.5) having *y*11 = 2/*s* S and *y*12 = 1/*s* S. determine the input admittance *I*1/*V*1 when a load of 3/*s* S is connected at the output.



**Solution:** Since the circuit is symmetric, and referring to Figure 24.3.3, it follows that *Y*2 = -*y*12 = -*y*21, and *Y*1 = *Y*3 = *y*11 + *y*12. The circuit with the load becomes as shown. The input admittance is:  S



**P24.2.8** Determine the *z* parameters of the circuit in Figure P24.2.8, assuming *ω* = 103 rad/s.



**Solution:** The coupled coils are equivalent to 3 H, resulting in an impedance of *j*3 kΩ, the circuit becoming as shown. It follows that =  kΩ. From current division, *V*2 =



1×, so that   kΩ.