**Homework 11**



**P10.1.2** Determine **VO** and **IS** in Figure P10.1.2.

**Solution:**  Ω; the source and resistance are reflected to the secondary side as shown. It follows that **VO** =  =  V.



2**IS** = A; **IS** = A.

**P10.1.7** Determine **ISRC** in Figure P10.1.7.



**Solution:** The voltages and currents of the ideal autotransformer may be assigned as shown. From KVL in the mesh involving R, C, and the autotransformer, 2**I2** + 2**V1** + **V1** – (-*j*2**I2**) = 0, or 3**V1** =-2(1 + *j*)**I2**. From KVL in the upper mesh, 2**I2** + 2**V1** = VSRC. Substituting for **V1**, 2**I2** – (4/3)(1 + *j*)**I2** = **VSRC** = (2/3)(1 – *j*2)**I2**, which gives, . Since **ISRC** = 3**I2**,  A.



**P10.1.9** Derive TEC looking into terminals ‘ab’ in Figure P10.1.9.

**Solution:** On open circuit, no current flows. The primary voltage is **VSRC** of the polarity shown. It follows that **VTh** = -4**VSRC** + **VSRC** = -3**VSRC** = -3∠0 V.



When the source is set to zero, the impedance looking into terminals ‘ab’ is 16×2 = 32 Ω.

**P10.1.12** Derive TEC looking into terminals ‘ab’ in Figure P10.1.12.



**Solution:** Since the 20 Ω resistor is in parallel with the terminals ab, TEC could be derived without this resistor and a new TEC derived with the 20 Ω resistor connected. When the resistor is removed, the transformer currents are zero. Hence, **Ix** = 0, **V1** = 40 V and = -4**V1** = −160 V.

When the terminals are short circuited, then on the primary side, 40 = 10**Ix** + **V1** + 5**Ix**, or **V1** + 15**Ix** = 40. On the secondary side, −4**V1** + (-*j*20)×0.25**Ix** + 5**Ix** = 0, or **V1**= **Ix**. Eliminating **V1** gives **Ix**=  A, so that **Isc** =A. It follows that = 20(13 – *j*) Ω. When the 20 Ω resistor is connected, **VTh** = = =  V, and *ZTh* = ||20 = Ω.



**P10.1.17** Determine *vO* in Figure P10.1.17, assuming *vSRC* =  V.



**Solution:** the impedance of the capacitor is  Ω. In reflecting the primary circuit to the secondary side, the 2.5 Ω is multiplied by 4 to become 10 Ω, and *ZC* becomes  Ω. **VSRC** is multiplied by 2, with sign reversal. Both the current source 2**Ix**and its controlling current **Ix**are divided by 2, with sign reversal. They become **Ix**and 0.5 **Ix**, respectively. They could just as well be designated as 2**Iy**and **Iy**, respectively. The circuit becomes as shown. From KCL at the upper right-hand node, , or **VO**(0.1+ *j*0.4) + 3**Iy** = 0. From KVL in the outer loop, , or **Iy** = 0.1**VO** + 0.2**VSRC**. Substituting for **Iy**, **VO**(0.4 + *j*0.4) + 0.6**VSRC** = 0, or = 3∠125° V, or *vO* = 3cos(10*t* + 125°) V.

**P10.1.22** Determine **I1**, **I2**,  **V1**, and **V2** in Figure P10.1.22.



**Solution:** KVL on the input side: (3 + *j*4)**I1** + **V1** = **VSRC**; KVL on the output side; (12 – *j*5)**Io** = **V2**; for the transformer, **V2** = 5**V1**; 400**Io** + 100**I2**= 0, **Io** = **I1** + **I2**.

These equations give: (12 – *j*5)**I1** -–25**V1** = 0. Solving with the first equation: **I1** = = 1.851 - *j*0.584 A; **V1** = 10(cos30° + *j*sin30°) = 0.772 – *j*0.651 V. **V2** = 5**V1** = 3.86 – *j*3.25 V, **I2** = *I*1 = -1.481 + *j*0.467 A. **Io = I1 + I2** = 0.37 – *j*0.117 ≡ 0.388∠-17.5° A.

**P10.1.27** Derive TEC looking into terminal ‘ab’ in Figure P10.1.27.



**Solution:** **V2** = *j*100**I2**, **VTh** = −*j*40**I3**, 50 = 50**I1** + 0.5**V2** – 2**VTh**. Moreover, **I1** = 2**I2** and **I3** = -2**I1** = -4**I2**. Substituting for **I1** and **V2** in terms of **VTh** gives: 50 =**VTh** + **VTh** – 2**VTh**; or, 50 = **VTh**, or, **VTh** = -26.1 + *j*9.65 V.

When terminals ‘a’ and ‘b’ are short circuited, the primary voltage of the lower transformer is zero. The *j*100 Ω impedance is reflected to the primary side as *j*25 Ω. **I1**=  A. **Isc** = -2**I3** = -1.6 + *j*0.8 A. It follows that *ZTh* = **VTh**/**Isc** = 15.44 + *j*1.69 Ω.

**P10.2.3** Determine *X* in Figure P10.2.3 so no current flows in the 5 Ω resistor.



**Solution:** For zero current in the 5 Ω resistor, the open-circuited voltage of the linear transformer is **V**, which means that the input current is **V**/*jωM* and the input voltage is  = **V**, since *M* = *L*1. The primary voltage of the ideal transformer is **V**/a, and the primary current is a**V**/*jωM.* It follows that , or *X* = 2.5 Ω.