**Homework 10**



**P9.2.9** Determine TEC looking into terminals ‘ab’ in Figure P9.2.9, assuming *vSRC* = 2cos(103*t* - 60°) V and *k* = 0.75.

Ans. 6∠120° V, -*j*0.5 Ω.

**Solution:** The impedances are: -*j*/*ωC* =



-*j*/(103×2×10-3) = -*j*0.5 Ω; *jωL*1 =

*j*(103×1×10-3) = *j* Ω; *jωL*2 = *j*(103×4×10-3) = *j*4 Ω; *jωM* = *j*(103×0.75×2×10-3) = *j*1.5 Ω. The circuit in the frequency domain with the linear transformer replaced by its T-equivalent circuit is as shown. The series impedances are (*jωL*1 + *jωM*) = *j*2.5 Ω and (*jωL*2 + *jωM*) = *j*5.5 Ω, the shunt impedance being -*jωM* = -*j*1.5 Ω.

**VTh** ** .**

If the source is replaced by a short circuit, the impedance looking into terminals ‘ab’ is ****= -*j*0.5 Ω.



**P9.2.10** Determine  in Figure P9.2.10.

Ans. *j*20 Ω.



**Solution:** The impedance encountered by the current **I** is *jωL*1 + *jωL*2 –

*j*2*ωM* – *j*/*ωC* = *j*20 + *j*20 – *j*20 – *j*20 = 0. Hence, *Zin*= 0.

**P9.2.14** Determine the frequency at which the current  in Figure P9.2.14 has the same magnitude when the connections of one coil are reversed.



**Solution:** *M* = 0.75 = 45 mH. Since the current magnitude remains the same when one coil is reversed, the impedance reverses sign. Thus: *jω*(30 + 120 + 90) –  = -*jω*(30 + 120 - 90) + , or 300*ω* = . *ω*2 = ; *ω* =  krad/s.



**P9.2.16** Given *vSRC* = 6cos*ωt* V and *k* = 0.9 in Figure P9.2.16. Determine *X* so that no power is dissipated in the circuit.



**Solution:** For no power dissipation, the current in the 10 Ω resistor should be zero. From the T-equivalent circuit, **I2** = 0 if the shunt branch is a short circuit. This requires *X* = -*ωM*, where 

-0.9×20 = -18 Ω.

**P9.2.19**  in Figure P9.2.19 is initially charged to  and  is uncharged. The switch is closed at  Calculate the total energy dissipated in the resistor.



**Solution:** The energy that is eventually dissipated in the resistor is that initially stored in . This energy is 0.5×10–6×(6)2 = 18 μJ.



**P9.2.20** Given *vSRC* = 200sin(103*t*)V in Figure P9.2.20. Determine .

**Solution:** Considering **I1** to be a mesh current and **IO** to be the current in the outer loop, KVL gives:



(6 + *j*4000)**I1** + (*j*3000 +6)**Io** = -*j*200, and (*j*3000 +6)**I1** + (9 +*j*7000)**Io** = -*j*200. Solving, gives **Io** = -0.0105 ≡ -0.0105cos(1,000*t*) A.

**P9.2.23** Determine **VO** in Figure P9.2.23.



**Solution:** Replacing the linear transformer by its T-equivalent circuit and writing the mesh-current equations:



*j*8**I1** – *j*5**I2** – *j*3**I3** = 20∠30°,

-*j*5**I1** + (20 + *j*10)**I2** – *j*5**I3** = 0,

-*j*3**I1** – *j*5**I2** + *j*8**I3** = 10(**I1** – **I2**),

or, -(10 + *j*3)**I1** + (10 – *j*5)**I2** + *j*8**I3** = 0.

Solving, **I2** = 0.897 – *j*0.777 A; hence, **VO** = 20**I2** = 17.94 – *j*15.53 V.

**P9.2.24** Given  V in Figure P9.2.24. Determine .



**Solution:** *j*500×2×10–3 = *j* Ω; *j*500×8×10–3 = *j*4 Ω; mH; *j*500×3.2×10–3 = *j*1.6 Ω;



-*j*/(500×10×10–6) = *-j*200 Ω. Replacing the linear transformer by its T-equivalent circuit, the mesh current equations are:

(5 + *j*4 – *j*200)**I1** – (*j*1.6 – *j*200)**I2** = 50; -(*j*1.6 – *j*200)**I1** + (10 + *j* – *j*200)**I2** = 0. This gives **Io** = **I2** = 3.29 – *j*0.455 = 3.33∠-7.87° ≡ 3.33cos(500t – 7.87°) A.