**Homework 7**

**P17.1.16** Three loads are supplied in parallel at 240 V rms, 50 Hz. L1 absorbs 240 W at 0.6 p.f. lagging, L2 absorbs 200 VAR at 0.5 p.f. lagging, and L3 absorbs 100 VA at 0 p.f. leading. Determine: (a) The total apparent power; (b) the p.f.; (c) magnitude of supply current; (d) the parallel capacitance that raises the p.f. to unity; and (e) the resulting magnitude of supply current.



**Solution:** L1: *P*1 = 240 W, *Q*1 = 240×0.8/0.6 = 320 VAR



L2: *P*2 = 200×0.5/0.5= 115.47 W, *Q*2 = 200 VAR

L3: *P*3 = 0, *Q*3 = -100 VAR

(a) *P*S = 240 + 115.47 = 355.47 W, *Q*S = 320 + 200 – 100 = 420 VAR; **SS** = 355.47 + *j*420 VA; |**SS**I = 550.24 VA.

(b) p.f. = 355.47/550.25 = 0.646 lagging.

(c) I**IS**| = 550.24/240 = 2.29 A.

(d) *-*420 = -(240)2×100*πC*; *C* = 23.2 μF.

(e) 355.47/240 = 1.48 A.



**P17.1.19** *R*1, *L*, *R*2, and *C* in Figure P17.1.19 are unknown. Load 1 absorbs a complex power of 100∠45° VA and load 2 absorbs a complex power of 50∠-45° VA. Determine *R*1.

**Solution:** **S1** =  VA

**S2** =  VA,

**S** = ; |**S**| = ; |**I**| = ; *P*1 = |**I**|2*R* =  = ,  Ω.

**P17.1.23** Given that the complex power absorbed by the inductive branch in Figure P17.1.23 is 12 + *j*16 VA, determine *C* so that the power factor at terminals ab is unity, assuming *ω* = 1 rad/s.



**Solution:** In the reactive branch, *QL* = 16 VAR, so that |**IL**I2(4) = 16, and |**IL**| = 2 A, and *R* = 12/I**IL**|2 = 3 Ω. It follows that |**Vab**| = |**IL**||*ZL*| = 2×5 = 10 V, |**IC**| = . To have an overall p.f. of unity, *QC* = -16 VAR; hence, -16 = |**IC**I2*X* = . This gives *X* = -5 or -1.25. It follows that *C* = 1/5 = 0.2 F, or, 1/1.25 = 0.8 F.



**P17.2.9** Determine  in Figure P17.2.9 for maximum power transfer and calculate this power.



**Solution:** On open circuit, there is no current in either transformer. The 2∠0° V source reflected to the primary side is 1∠0° V. The primary voltage of the lower transformer is 4∠0° V; *VTh* = 8∠0° V.



On short circuit, the voltage across the primary of the lower transformer is zero. The 2∠0° V source in series with 16 Ω is reflected to the primary side as 1∠0° V in series with 4 Ω. Hence, *IP* = 4/4.5 = 8/9 A and *ISC* = 4/9 A. This gives *Rmax* = *RTh* = 8×9/4 = 18 Ω. The power dissipated in this resistor is (8)2/(4×18) = 8/9 W.



**P17.2.17** Determine  in Figure



P17.2.15 for maximum power transfer and calculate this power.

**Solution:** When a test source is applied, **VT** = 4**I1** + 4(**I1** – 1.5**VT**)(1 + *j*);

**VT** + 6**VT**(1 + *j*) = 4**I1** + 4**I1**(1 + *j*);



**I1** = **VT**; =

;

*ZTh* = =

Ω; *ZLmax* = 0.8 + *j*0.4 Ω

If the output is short-circuited, the dependent source is set to zero, and **ISC** = . **VTh** =  V. It follows that the maximum power transferred is (5)2/(4×0.8) = 25/3.2 = 7.81 W.

**P17.2.23** Determine  in Figure P17.2.23 for maximum power transfer and calculate this power.



**Solution:** On open circuit, the circuit is a shown. Taking KVL around the outer loop, 10 – 5**I2** + 5**I2** – **VTh** = 0, which gives **VTh** = 10∠0° V.

On short circuit, the circuit is as shown. From KVL, 10 – 5(**ISC** + **I2**) – 5(**ISC** + **I2**) = 0. This gives **ISC** = 1∠0° A, so that *Rmax* = *RTh* = 10 Ω. The power transferred is =  W.



**P17.2.31** (a) Determine *YL* in Figure P17.2.31 that results in maximum power absorption in *YL* and the value of this power. (b) If *YL* consists of a resistor in parallel with an inductor, what values of these elements will result in maximum power absorption in*YL*, and how much is this power?.



**Solution:** (a) The primary circuit is reflected to the secondary side by multiplying the current by 1.5 and the admittances by (1.5)2 = 2.25. The circuit becomes as shown. **IN** = = 12 – *j*6 = A. *YN* = = S. *YLm* = 3.6 + *j*1.8 S; maximum power dissipated in *ZL* is  W.

(b) A parallel *RL* circuit for *YL* introduces a negative susceptance *BL* having the same sign as the susceptance *BN* of *YN*. Hence, for maximum power transfer, *BL* must be as small as possible, which in this case would be zero, or *L* → ∞. This leaves *GL* = |*YN*| =  S; |**VLm**|2 =  V, and power delivered is |**VLm**|2 = 11.8 W.

**P18.1.6** Evaluate:

(a) . (Hint: apply the procedure of P18.1.5).

(b) **

**Solution:** (a) Substituting *t*′ = 12*t*, the integral becomes:  .

(b) Substituting *t*′ = 2*t*, the integral becomes: **= *=  *