**Homework 3**

**P14.2.6** Determine *R*, *L*, and *C* In Figure P14.2.6 so that the



maximum response is 1 V, *ω*0 = 100 krad/s, and BW = 4 krad/s.

**Short Solution:** maximum response occurs when the

combined impedance of *L* and *C* is infinite. The source current flows through *R*. so that:

*R*×(0.1 mA) = 1 V, which gives *R* = 10 kΩ.

From the given data, *Q* = *ω*0/BW = 100/4 = 25 = *ω*0*CR*, so that *C* = 25/(*ω*0*R*) = 25/(105×104) = 25×10-9 F ≡ 25 nF.

Since , or,  H ≡ 4 mH.



**P14.2.7** Determine *ω*0 and *Q* in Figure

P14.2.7.

**Solution:** The first step is to account for the dependent source. The voltage across the

capacitor is 0.1 *VSRC*(*jω*). Hence, 



(0.1*VSRC*(*jω*))(*jωC*) = *VSRC*(*jω*)*jω*(0.1*C*).

In other words, the capacitor *C* in series

with the dependent source is

equivalent to a capacitor 0.1C. This is in

accordance with the source absorption

theorem, for the current through the dependent

source is *VSRC*(*jω*)*jω*(0.1*C*). Dividing this by the voltage 0.9**VSRC**, the dependent source is equivalent to an admittance *jωC/*9, or a capacitor *C*/9. This capacitor in series with *C* gives a capacitance *C*×(*C*/9)/(*C* + *C*/9) = 0.1*C*.

It follows that rad/s ≡ 100 krad/s. *Q* = *ω*0*RC* =

105×10-7×103 = 10.

**P14.2.10** Determine *Q* and BW in Figure P14.2.10.



**Solution:** If the independent source is set to zero, that is, replaced by a short circuit, the circuit reduces to a parallel GCL circuit.  =

106 rad/s; *Q* = *ω*0*RpCp* = 106×750×20×10-9 = 15.

BW = *ω*0/*Q* = 106/15 rad/s ≡ 103/(30*π*) krad/s = 10.61 kHz.



**P14.2.12** For the circuit of Figure P14.2.12, determine: (a) *ω*0;

(b) *Q*; (c) *V*O(*jω*0) if *VSRC*(*jω*0) = 1 V.

**Solution:** If the independent source is set to zero, that is, replaced by a short circuit, the circuit reduces to a parallel GCL circuit, with *Rp* = 10×40/50 = 8 kΩ;

(a)  = 104 rad/s.

(b) *Q* = *ω*0*RpCp* = 104×8×103×100×10-9 = 8

(c) If a 1 V source is applied at the resonant frequency, *L* and *C* in parallel at this frequency are equivalent to an open circuit. It follows from voltage division that the output is 1×40/50 = 0.8 V.

**P14.2.13** (a) Show that the response *VO*(*jω*)/*VSRC*(*jω*) in Figure P14.2.13 is an allpass response. (b) Determine the frequency at which the phase shift is 180°, assuming *R* = 10 kΩ, *L* = 1 μH, and *C* = 1 μF.



**Solution:** (a) *VO*(*jω*)= *Vac*(*jω*) – *Vbc*(*jω*). From voltage division:



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*VO*(*jω*) = , which is an allpass response.

(b) Substituting *s* = *jω*, *VO*(*jω*) = ; it is seen that ∠ *VO*(*jω*) =  == 180°; hence, = -90, or tan(-90°) → ∞. This occurs when *ω* = *ω*0 =  rad/s ≡ 1 Mrad/s ≡ 159.15 kHz.

**P14.2.17** Determine: (a) the nature of the response in



Figure P14.2.17; (b) *ω*0; (c) BW.

**Solution:** (a)The output is zero at *ω* = 0 and is

zero as *ω* → ∞. The response is therefore bandpass. The impedance of *R* and *C* in parallel is . It follows that:

 == . Substituting *ω*0 = 1/*CR*, . This can be put in standard form as: , which indicates a *Q* = 1/3 and a maximum gain of 1/3.

(b) *ω*0 = 1/*CR* = 1/(10-6×103) = 103 rad/s ≡ 1 krad/s.

(c) BW = *ω*0/*Q* = 1/(1/3) = 3 krad/s.

**P14.3.3** Given . Determine the smaller 3-db cutoff frequency.

**Short Solution:** , BW = 50 = *ω*2 – *ω*1; ;  = 0; ; *ω*1 = 40 rad/s.

**P14.3.8** Determine the transfer function whose asymptotic Bode magnitude plot is shown in Figure P14.3.8.



**Solution:** The first part, as shown, is a highpass response of corner frequency 2 rad/s. The transfer function is: =, and . If *ω* → ∞,



 and 20log10;

if *ω* → 0, , and 20log10 20log10(*ω*) – 20log10(2), which is the equation

of the LF asymptote.

The second part is the mirror image, with respect to the horizontal axis, of the low pass response shown, having a corner frequency 25 rad/s. The transfer function is: =, and ; if *ω* → 0, ; 20log10; if *ω* → ∞, , and 20log1020log10(25) – 20log10(*ω*),which is the equation of the HF asymptote. The transfer function of the mirror image with respect to the horizontal axis is the reciprocal on a log scale. The transfer function of the given part is therefore =. The overall Bode plots is the sum of the Bode plots of the two parts on a log scale, which corresponds to the product of the transfer functions, that is: .

