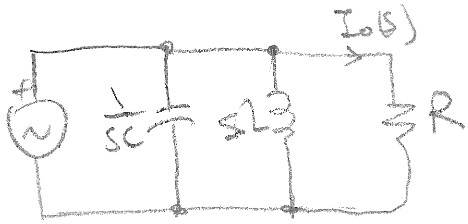
(P.2)

(P.12-22) in text



$C = 20\,nF \quad Q = 10 \quad \omega_0 = 1\,M\,rad\,s^{-1}$

Find R, L, ω_{c1} & ω_{c2}.

$$B = \frac{\omega_0}{Q} = \frac{1\times10^6}{10} = 100\,k\,rad\,s^{-1}$$

$$\boxed{L = \frac{1}{\omega_0^2 \cdot C} = \frac{1}{(1\times10^6)^2\cdot(20\times10^{-9})} = 50\,\mu H}$$

$$B = \omega_{c2} - \omega_{c1} = \frac{1}{RC} \quad \text{(Eq 12-23 text)}$$

$$\boxed{R = \frac{1}{BC} = \frac{1}{(10)(20\times10^{-9})} = 500\,\Omega}$$

$\because \omega_0^2 = \omega_{c1}\omega_{c2} = (10^6)^2$
$= 10^{12}$ —— ①

also $B = \omega_{c2} - \omega_{c1} = 100\times10^3$

$\omega_{c2} = \omega_{c1} + 100\times10^3$ — ②

sub ② into ①

$\omega_{c1}^2 + 100\times10^3\,\omega_{c1} - 10^{12} = 0$

$= -50\times10^3 \pm \frac{1}{2}\sqrt{(100\times10^3)^2 - 4(-10^{12})}$

$= -50\times10^3 \pm 6.325\times10^6$

$\omega_{c1} = 951.25\,k\,rad\,s^{-1}$ or ~~$-1.05\,M\,rad\,s^{-1}$~~ unrealistic!

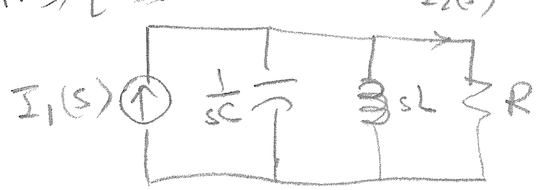
OR $\omega_{c1} = -\frac{1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$

$\boxed{\omega_{c1} = 951.25\,k\,rad\,s^{-1}}$

$\omega_{c2} = \omega_{c1} + 100\times10^3$

$\boxed{\omega_{c2} = 1.051\,M\,rad\,s^{-1}}$

(P.3) [24]



3(a) (3) Find $T(s) = \dfrac{I_2(s)}{I_1(s)}$

$$I_2(s) = I_1(s)\,\frac{1/R}{1/R + sC + \frac{1}{sL}}$$

current divider using admittances

$$\boxed{\frac{I_2(s)}{I_1(s)} = \frac{s\frac{1}{RC}}{s^2 + s\frac{1}{RC} + \frac{1}{LC}}}$$ (1) (2) (3) (−2 if coefficient of s^2 term is not 1.)

3(b) (10) Parallel RLC circuit

$L = 50\,\mu H$
$C = 20\,nF$
$R = 500\,\Omega$

$$\boxed{\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(50\times10^{-6})(20\times10^{-9})}} = 1\ \text{Mrads}^{-1}}$$ (2)

$$\boxed{B = \omega_{c2} - \omega_{c1} = \frac{1}{RC} = \frac{1}{(500)(20\times10^{-9})} = 100\ \text{krads}^{-1}}$$ (2)

$$\boxed{Q = \frac{\omega_0}{B} = \frac{1\times10^6}{100\times10^3} = 10}$$ (2)

note: B = BW = bandwidth

$$\omega_{c2} - \omega_{c1} = B = 100k$$
$$\omega_{c2} = 100k + \omega_{c1}$$

$$\omega_0^2 = \omega_{c1}\cdot\omega_{c2} = \omega_{c1}(100k + \omega_{c1}) = (1\times10^6)^2$$

$$\omega_{c1}^2 + (100\times10^3)\omega_{c1} - 1\times10^{12} = 0$$

$$\omega_{c1} = 951.25\ \text{krads}^{-1}$$

or $\omega_{c1} = -1.0\cancel{5}1$ Mrads^{-1} unrealizable

$W_{c2} = W_{c1} + 100 \times 10^3$

If $W_{c1} = 951.25 \times 10^3$ rads^{-1}

then $W_{c2} = 1.051 \times 10^6$ rads^{-1}

OR

$W_{c1} \cdot W_{c2} = \omega_0^2 = 1 \times 10^{12}$

$$W_{c2} = \frac{1 \times 10^{12}}{951.25 \times 10^3}$$

$W_{c2} = 1.051 \times 10^6$ rads^{-1}

OR

$$W_{c1} = -\frac{1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$$

$= 9.512 \times 10^5$ rads^{-1}

i.e. $W_{c1} = 951.2$ k rads^{-1} (2)

$W_{c2} = 1.051$ M rads^{-1} (2)

3(c) (11)

net list file (3)

Magnitude plot (1)

W_{c1} (1)

W_{c2} (1)

Phase plot (1)

W_{c1} (1)

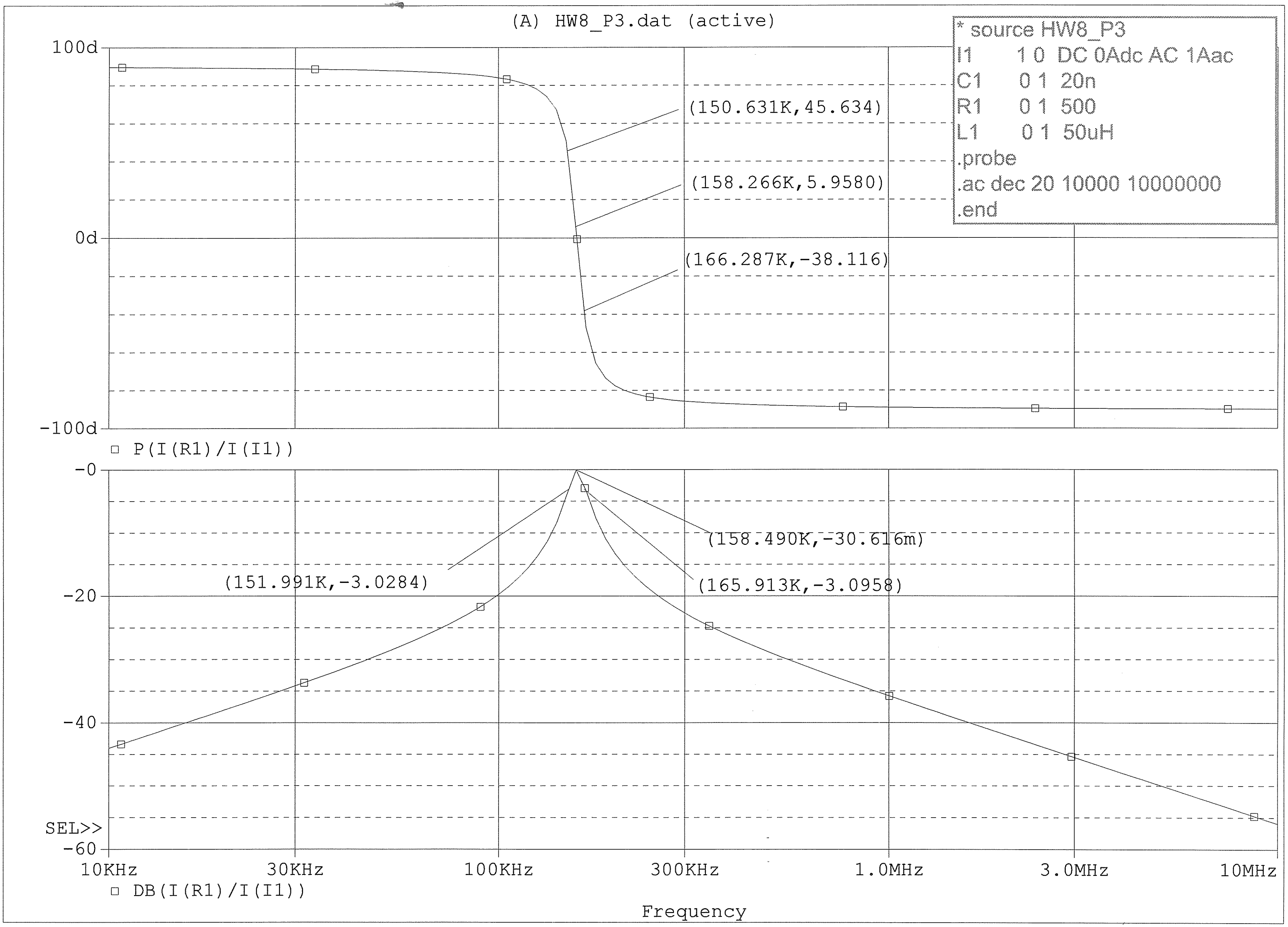
W_{c2} (1)

H(s) is a band pass filter (2)

$\omega \ll \omega_0$ $|H(j\omega)| \to -\infty$ dB $= 0$

$\omega \gg \omega_0$ $|H(j\omega)| \to -\infty$ dB $= 0$

$\omega = \omega_0$



(A) HW8_P3.dat (active)
* source HW8_P3
I1 1 0 DC 0Adc AC 1Aac
C1 0 1 20n
R1 0 1 500
L1 0 1 50uH
.probe
.ac dec 20 10000 10000000
.end
100d
0d
-100d
(150.631K,45.634)
(158.266K,5.9580)
(166.287K,-38.116)
P(I(R1)/I(I1))
-0
-20
-40
-60
SEL>>
(151.991K,-3.0284)
(158.490K,-30.616m)
(165.913K,-3.0958)
10KHz
30KHz
100KHz
300KHz
1.0MHz
3.0MHz
10MHz
DB(I(R1)/I(I1))
Frequency

(P.4) (P 12-24 in text)

(I) Series RLC circuit:

$$B = \frac{R}{L} \qquad \omega_0 = \frac{1}{\sqrt{LC}}$$

(Eqn 12-17 in text) (Eqn 12-15 in text)

(I)(a) Replace R by 2R — doubles B w/out Δing ω_0

(b) Replace C by C/4 — doubles ω_0 w/out Δing B

(II) Parallel RLC circuit

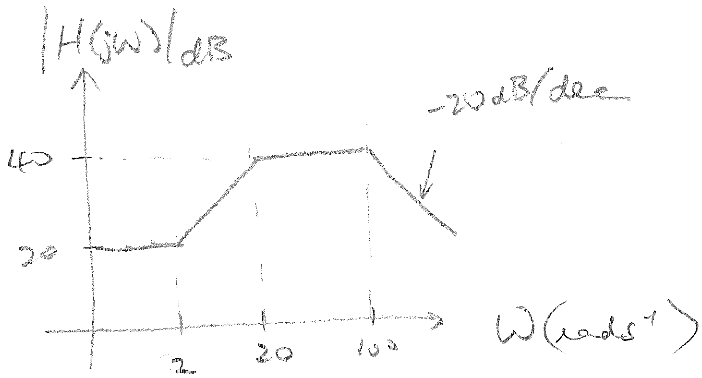
$$B = \frac{1}{RC} \qquad \omega_0 = \frac{1}{\sqrt{LC}}$$

(Eqn 12-23 in text) (Eqn 12-21 in text)

(II)(a) Replace R by 0.5R (or R/2)

(b) Replace L by L/4 — doubles ω_0 w/o Δing B.

(P.5) (10)



$20 = 20 \log_{10} k \longrightarrow k = 10.$ (2)

A zero caused a slope of + 20 dB/dec @ ω = 2 rads⁻¹

$\Rightarrow \left(1 + j\frac{\omega}{2}\right)$ (2)

A pole caused a slope of −20 dB/dec @ ω = 20 rads⁻¹

$\Rightarrow \left(\frac{1}{1 + j\frac{\omega}{20}}\right)$ (2)

A pole caused a slope of −20 dB/dec @ ω = 100 rads⁻¹

$\Rightarrow \left(\frac{1}{1 + j\frac{\omega}{100}}\right)$ (2)

Hence:

$$H(j\omega) = \frac{10\left(1 + j\frac{\omega}{2}\right)}{\left(1 + j\frac{\omega}{20}\right)\left(1 + j\frac{\omega}{100}\right)}$$

let $j\omega = s$

$$H(s) = \frac{10\left(1 + \frac{s}{2}\right)}{\left(1 + \frac{s}{20}\right)\left(1 + \frac{s}{100}\right)} = \frac{5(2+s)\,2000}{(20+s)(100+s)}$$

$$\boxed{H(s) = \frac{10000(s+2)}{s^2 + 120s + 2000}}$$ (2)

(−5 if coefficient of s^2 not equal 1)