10.15 from 10.14,

$$\frac{V_2}{V_1} = \frac{\dfrac{j\omega(1)\left(\frac{1}{j\omega(1)}\right)}{j\omega(1) + \frac{1}{j\omega(1)}}}{10 + \dfrac{j\omega(1)\left(\frac{1}{j\omega(1)}\right)}{j\omega(1) + \frac{1}{j\omega(1)}}} = \frac{\dfrac{1}{j\omega + 1/j\omega}}{10 + \dfrac{1}{j\omega + 1/j\omega}}$$

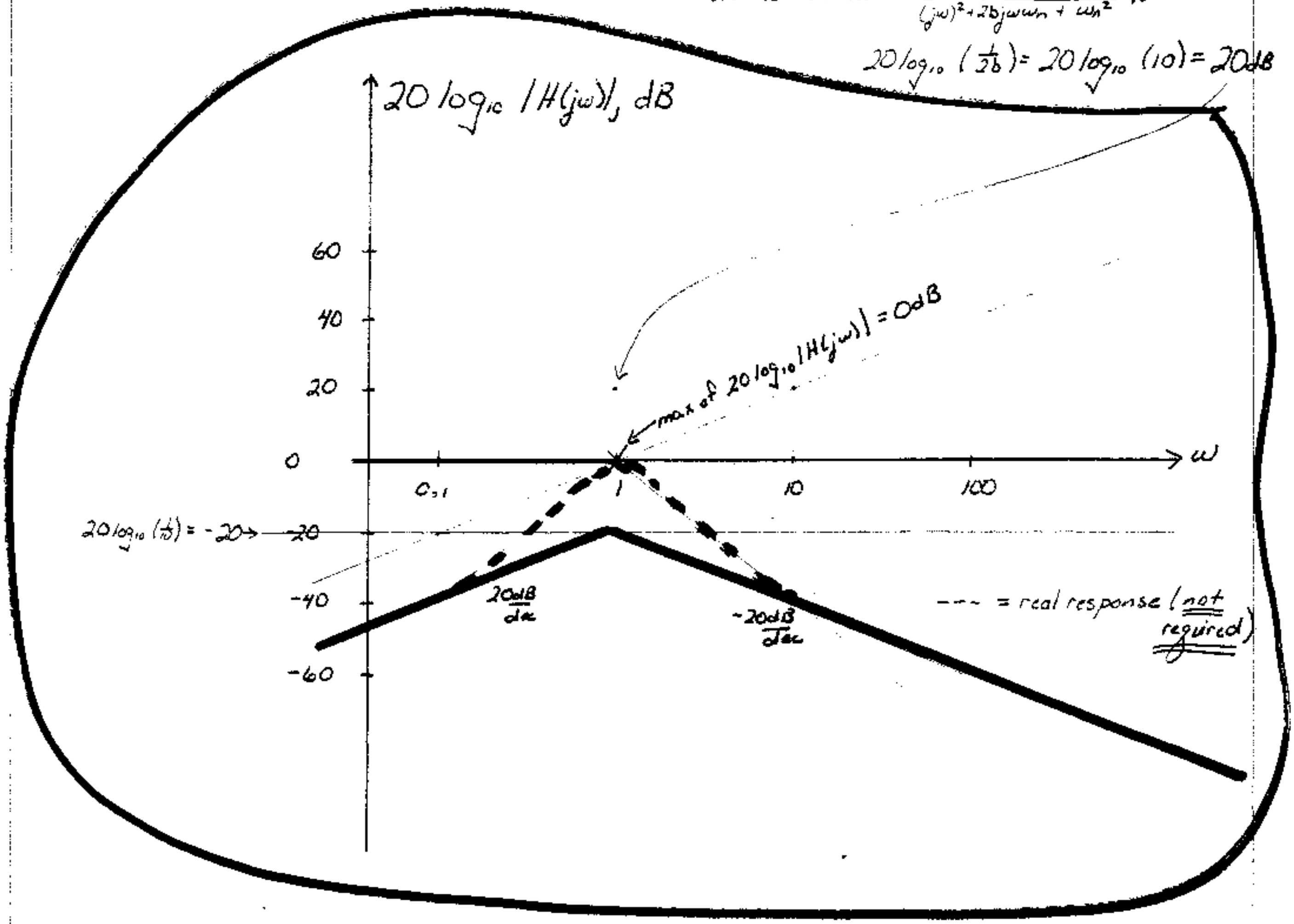
$$= \frac{1}{10(j\omega + 1/j\omega) + 1} = \frac{j\omega}{10(j\omega)^2 + j\omega + 10}$$

$$= \frac{\frac{1}{10} j\omega(1)}{(j\omega)^2 + \frac{1}{10} j\omega + 1} = H(j\omega) \quad \text{w/ complex poles}$$

$\Rightarrow \omega_n^2 = 1$ for quadratic w/complex poles

$2b = \frac{1}{10} \Rightarrow$ max of $\frac{\omega_n^2}{(j\omega)^2 + 2bj\omega\omega_n + \omega_n^2}$ is

$20\log_{10}\left(\frac{1}{2b}\right) = 20\log_{10}(10) = 20\,dB$

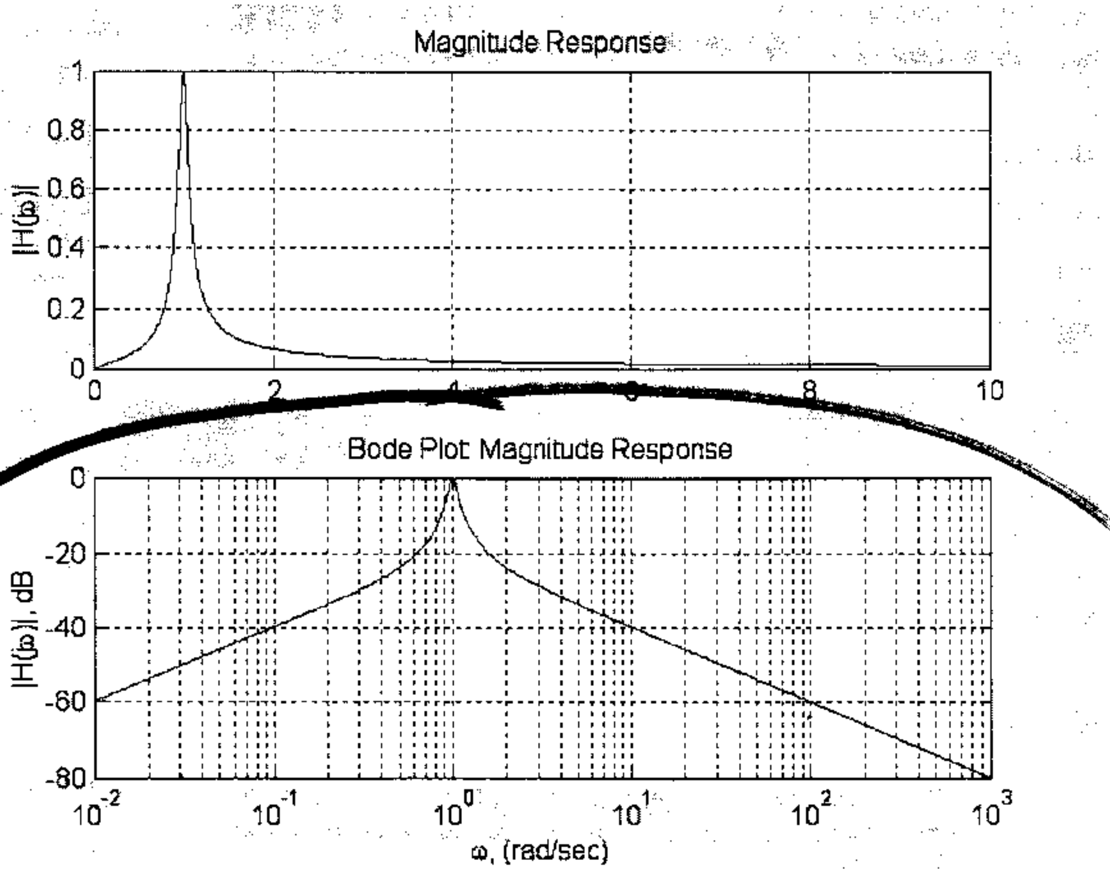


see MATLAB AMP/MAG plots on next page

Commands Typed At MATLAB Prompt:

```
>> clear all; close all;

w = linspace(0.01,10,1000);
H = j*w./(10*j*w*j.*w + j*w +10);

figure(1);

subplot(2,1,1);
plot(w,abs(H));
grid; ylabel('|H(j\omega)|'); title('Magnitude Response');

w = logspace(-2,3,1000);
H = j*w./(10*j*w*j.*w + j*w +10);

subplot(2,1,2);
semilogx(w,20*log10(abs(H)));
grid; ylabel('|H(j\omega)|, dB'); title('Bode Plot: Magnitude
Response');
xlabel('\omega, (rad/sec)');
>>
```

Plot Generated:



10.17 from 10.16: $(4+j\omega 2)V - 2V_1 - V_2 = 0$ from node eqn @ V

@ '-': $\frac{0-V}{2} + \frac{0-V_2}{\frac{400}{j\omega}} = 0 \Rightarrow -200V - j\omega V_2 = 0 \Rightarrow V = \frac{-j\omega V_2}{200}$

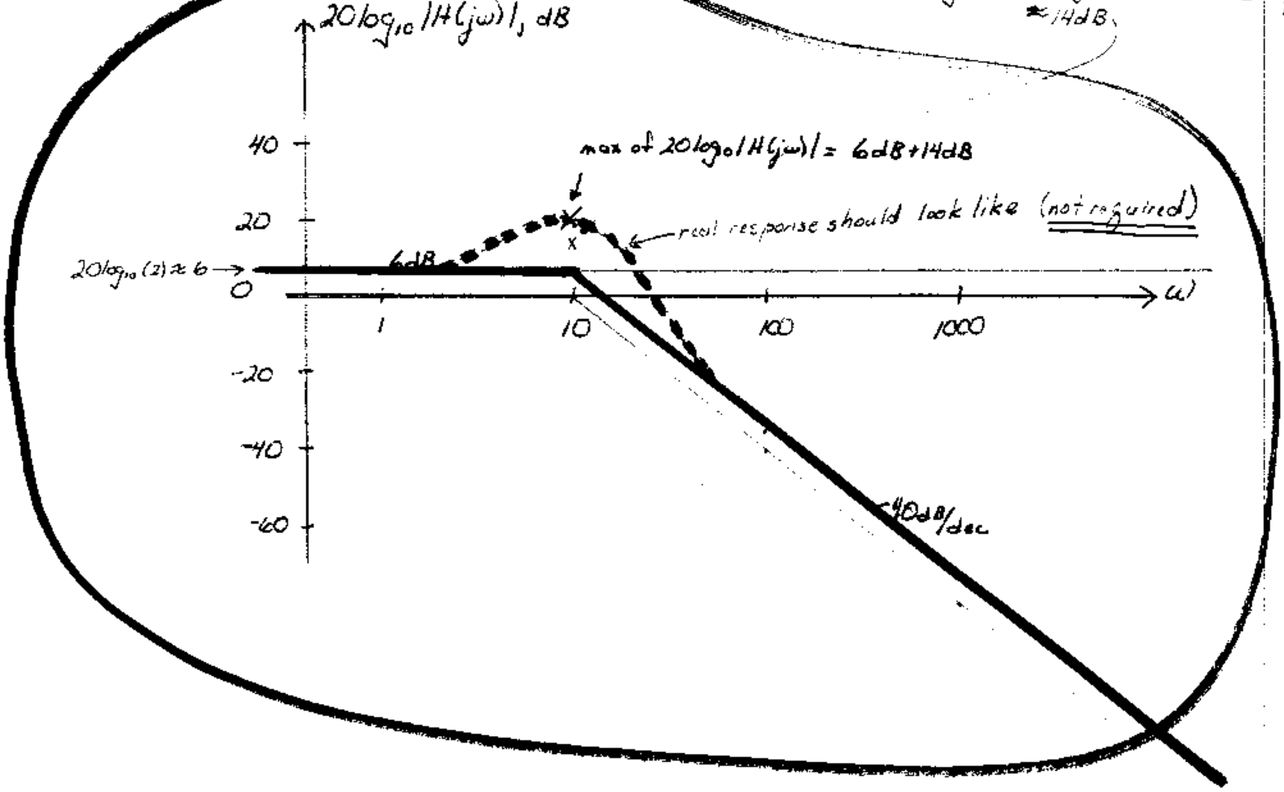
$$(4+j\omega 2)\left(\frac{+j\omega V_2}{200}\right) + 2V_1 + V_2 = 0$$

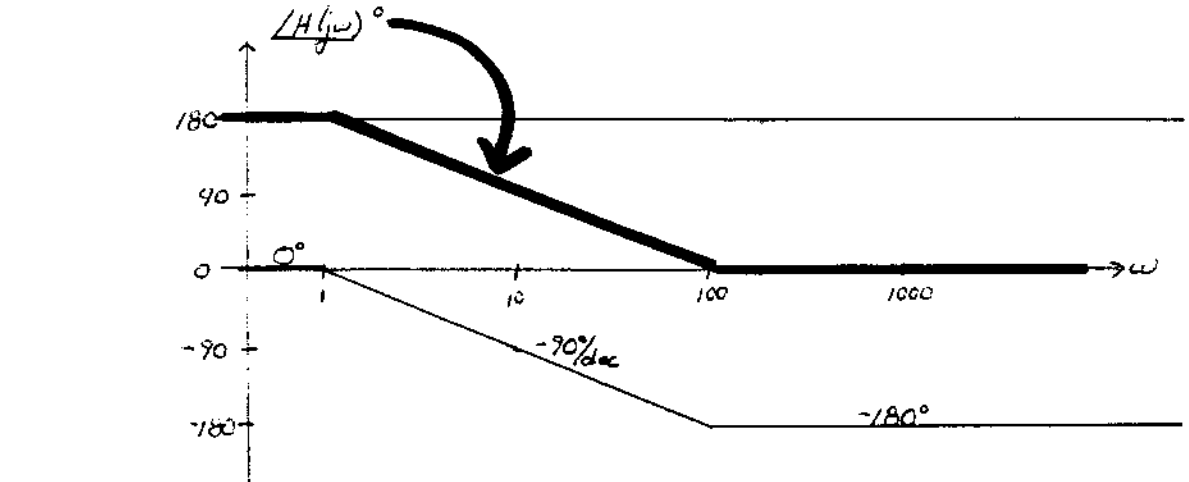
$$\Rightarrow (4j\omega + (j\omega)^2 2 + 200)V_2 = -400V_1$$

$$\Rightarrow \frac{V_2}{V_1} = \frac{-400}{2(j\omega)^2 + 4j\omega + 200} = \frac{-200}{(j\omega)^2 + j\omega 2 + 100} = \frac{-2(100)}{(j\omega)^2 + 2j\omega + 100}$$

which has complex poles w/ $\omega_n = 10$ rad/sec, max of $\frac{100}{(j\omega)^2 + 2j\omega + 100}$ is $20\log_{10}\left(\frac{1}{2b}\right) = 20\log_{10}(5) \approx 14\text{dB}$

$2b\omega_n = 2b(10) \Rightarrow 2b = \frac{2}{10} = \frac{1}{5}$





→ see matlab plots on next page

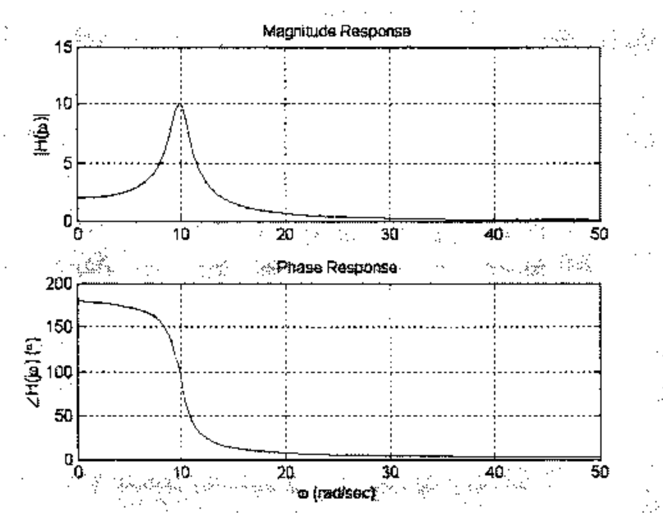
EE212

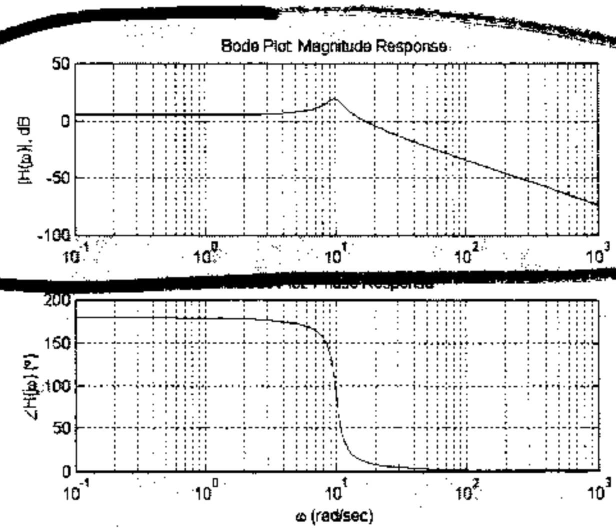
HW9 SOLN

Commands Typed At MATLAB Prompt:

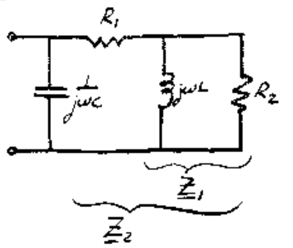
```
>> clear all; close all;

w = linspace(0.1,50,500);
H = -200./(j*w*j.*w + j*w*2 + 100);

figure(1);
subplot(2,1,1);
plot(w,abs(H));
grid; ylabel('|H(j\omega)|'); title('Magnitude Response');
subplot(2,1,2);
plot(w,unwrap(angle(H))*180/pi);
grid; xlabel('\omega (rad/sec)'); ylabel('\angleH(j\omega) (\circ)'); title('Phase Response');

w = logspace(-1,3,1000);
H = -200./(j*w*j.*w + j*w*2 + 100);

figure(2);
subplot(2,1,1);
semilogx(w,20*log10(abs(H)));
grid; ylabel('|H(j\omega)|, dB'); title('Bode Plot: Magnitude Response');
subplot(2,1,2);
semilogx(w,unwrap(angle(H))*180/pi);
grid; xlabel('\omega (rad/sec)'); ylabel('\angleH(j\omega) (\circ)'); title('Bode Plot: Phase
Response');
```

Plots Generated:





PR10.22



$$Z_1 = \frac{j\omega L R_2}{R_2 + j\omega L}, \quad Z_2 = Z_1 + R_1 = \frac{j\omega L R_2}{R_2 + j\omega L} + \frac{R_1(j\omega L + R_2)}{j\omega L + R_2} = \frac{j\omega L(R_1+R_2) + R_1R_2}{j\omega L + R_2}$$

$$Z_{eq} = \frac{\frac{1}{j\omega C}\left(\frac{j\omega L(R_1+R_2)+R_1R_2}{j\omega L + R_2}\right)}{\frac{1}{j\omega C} + \frac{j\omega L(R_1+R_2)+R_1R_2}{j\omega L+R_2}}$$

$$= \frac{j\omega L(R_1+R_2)+R_1R_2}{j\omega L + R_2 + (j\omega)^2 LC(R_1+R_2) + j\omega C R_1 R_2}$$

$$\Rightarrow \angle Z_{eq} = \tan^{-1}\left(\frac{\omega L(R_1+R_2)}{R_1R_2}\right) - \tan^{-1}\left(\frac{\omega C R_1R_2 + \omega L}{R_2 - \omega^2 LC(R_1+R_2)}\right) = 0$$

$$\Rightarrow \frac{\omega L(R_1+R_2)}{R_1R_2} = \frac{\omega C R_1 R_2 + \omega L}{R_2 - \omega^2 LC(R_1+R_2)}$$

$$\Rightarrow \omega L R_2(R_1+R_2) - \omega^3 L^2 C(R_1+R_2)^2 = \omega C(R_1R_2)^2 + \omega L R_1 R_2$$

$$\Rightarrow L R_2(R_1+R_2) - \omega^2 L^2 C(R_1+R_2)^2 = C(R_1R_2)^2 + L R_1 R_2$$

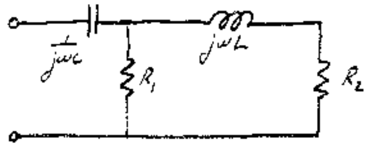
$$\Rightarrow \omega^2 L^2 C(R_1+R_2)^2 = \cancel{LR_1R_2} + LR_2^2 - C(R_1R_2)^2 - \cancel{LR_1R_2}$$

$$\rightarrow \omega^2 = \frac{R_2^2(L - CR_1^2)}{L^2C(R_1+R_2)^2}$$

$$\Rightarrow \omega = \oplus\sqrt{\left(\frac{R_2}{R_1+R_2}\right)^2 \frac{(L-CR_1^2)}{L^2C}}$$

$$\Rightarrow \boxed{\omega_r = \frac{R_2}{R_1+R_2}\sqrt{\frac{1}{LC} - \frac{R_1^2}{L^2}}}$$

PR10.23



$$Z_{eq} = \frac{1}{j\omega C} + \frac{R_1(j\omega L + R_2)}{R_1 + R_2 + j\omega L}$$

$$= \frac{(R_1 + R_2 + j\omega L) + (j\omega)^2 LCR_1 + j\omega CR_1R_2}{j\omega C(R_1+R_2) + (j\omega)^2 LC}$$

$$\Rightarrow \angle Z_{eq} = \tan^{-1}\left(\frac{\omega L + \omega CR_1R_2}{R_1 + R_2 - \omega^2 LCR_1}\right) - \tan^{-1}\left(\frac{\omega C(R_1+R_2)}{-\omega^2 LC}\right) = 0$$

$$\Rightarrow \frac{\omega L + \omega CR_1R_2}{R_1 + R_2 - \omega^2 LCR_1} = \frac{\cancel{\omega}\cancel{C}(R_1+R_2)}{-\omega^{\cancel{2}} L\cancel{C}}$$

$$\Rightarrow -\omega^2 L^2 - \omega^2 \cancel{LCR_1R_2} = (R_1+R_2)^2 - \omega^2 LCR_1(R_1 + \cancel{R_2})$$

$$\Rightarrow \omega^2(LCR_1^2 - L^2) = (R_1 + R_2)^2$$

$$\Rightarrow \omega^2 = \frac{(R_1+R_2)^2}{LCR_1^2 - L^2}$$

$$\Rightarrow \boxed{\omega = \omega_r = (R_1+R_2)\sqrt{\frac{1}{L(CR_1^2 - L)}} = \left(\frac{R_1+R_2}{R_1}\right)\frac{1}{\sqrt{LC - L^2/R_1^2}}}$$