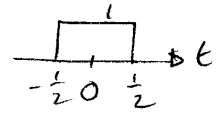
(1) Text 12-5 a,b,d

(a) $H(f) = \text{sinc}(f) \longleftrightarrow h(t) = \text{rect}(t)$



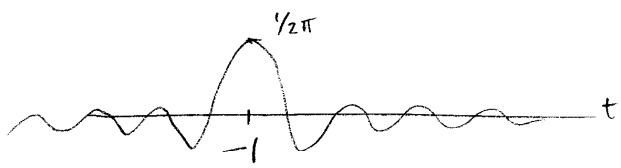
Not causal – $h(t)$ not zero for $t < 0$

(b) $H(f) = \text{sinc}(f)\, e^{-j\pi f} \longleftrightarrow \text{rect}(t - \frac{1}{2})$

Causal – $h(t)$ is zero for $t < 0$

(d) $H(j\omega) = \text{rect}(\omega)\, e^{-j\omega} \longleftrightarrow h(t) = \frac{1}{2\pi}\,\text{sinc}\left(\frac{t-1}{2\pi}\right)$

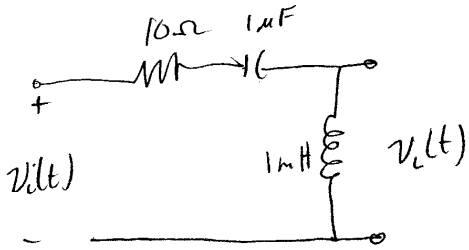
$= \text{rect}(2\pi f)\, e^{-j2\pi f}$



not causal – $h(t)$ is not 0 for $t < 0$

(2) Text, 12-6a,b

(a)



$$v_L(f) = v_i(f)\,\frac{Z_L}{Z_R + Z_L + Z_C}$$

$$H(f) = \frac{Z_L(f)}{Z_L(f) + Z_R(f) + Z_C(f)}$$

$$= \frac{j\omega L}{j\omega L + R + \frac{1}{j\omega C}}$$

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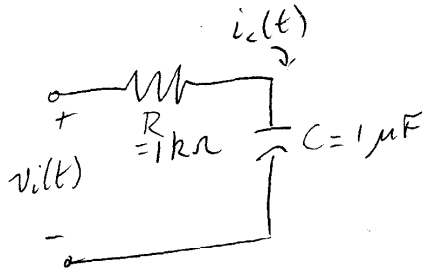
$$H(f) = \frac{j\omega C}{j\omega C}\left(\frac{j\omega L}{j\omega L + R + \frac{1}{j\omega C}}\right) = \frac{-\omega^2 LC}{-\omega^2 LC + j\omega RC + 1}$$

MATLAB Code & plots are at the end

(b)



$$i_c(f) = \frac{v_i(f)}{Z_{Total}(f)}$$

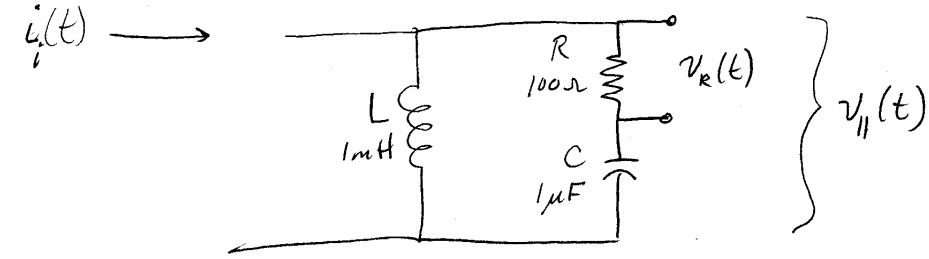
so $$H(f) = \frac{i_c(f)}{v_i(f)} = \frac{1}{Z_{total}(f)}$$

$$H(f) = \frac{1}{R + \frac{1}{j\omega C}} = \frac{j\omega C}{j\omega CR + 1}$$

MATLAB Code & plots are at the end

TOPS. 35500

(d)



- Find voltage across parallel components:

$$v_{\parallel}(f) = i_i(f)\, Z_{\parallel}(f)$$

$$Z_{\parallel}(f) = \frac{Z_L(f)\, Z_{RC}(f)}{Z_L(f) + Z_{RC}(f)}$$

$Z_L(f) = \omega L$

$Z_R(f) = R$

$Z_C(f) = \frac{1}{j\omega C}$

$Z_{RC}(f) = R + \frac{1}{j\omega C}$

$$\text{so } v_{\parallel}(f) = i_i(f)\, \frac{Z_L(f)\, Z_{RC}(f)}{Z_L(f) + Z_{RC}(f)}$$

- Using $V_{\parallel}(f)$, determine $v_R(f)$ using voltage divider.

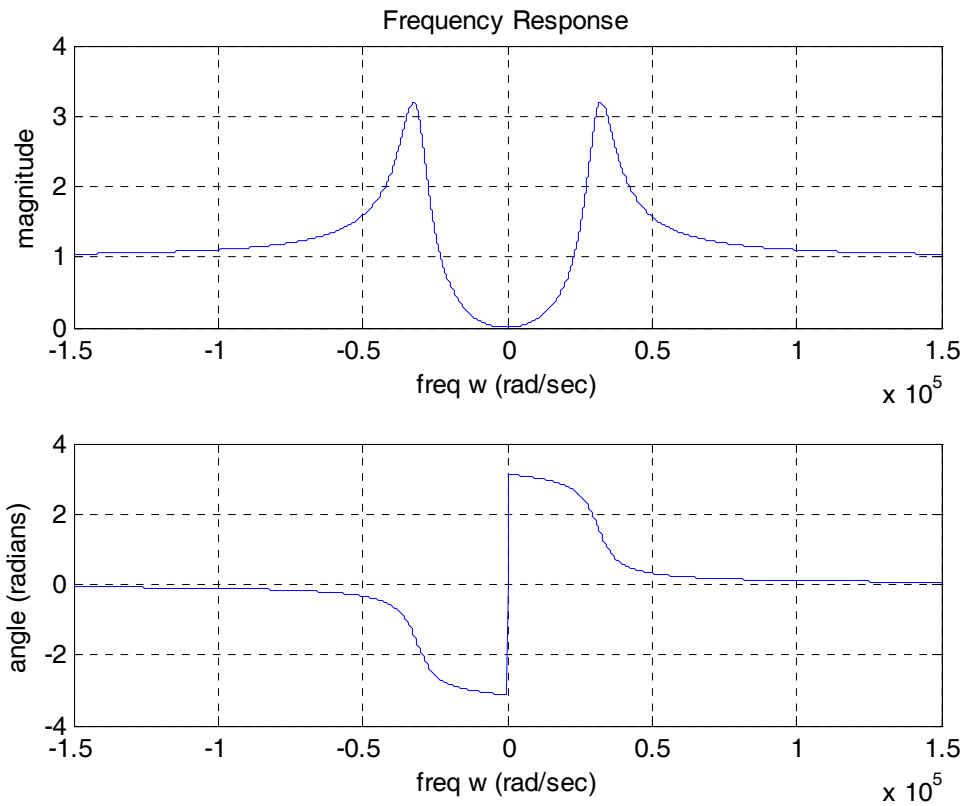
$$v_R(f) = v_{\parallel}(f)\, \frac{Z_R(f)}{Z_{RC}(f)}$$

$$v_R(f) = \overbrace{i_i(f)\, \frac{Z_L(f)\, \cancel{Z_{RC}(f)}}{Z_L(f) + Z_{RC}(f)}}^{v_{\parallel}(f)}\, \frac{Z_R(f)}{\cancel{Z_{RC}(f)}} = \frac{Z_L(f)\, Z_R(f)}{Z_L(f) + Z_{RC}(f)}$$

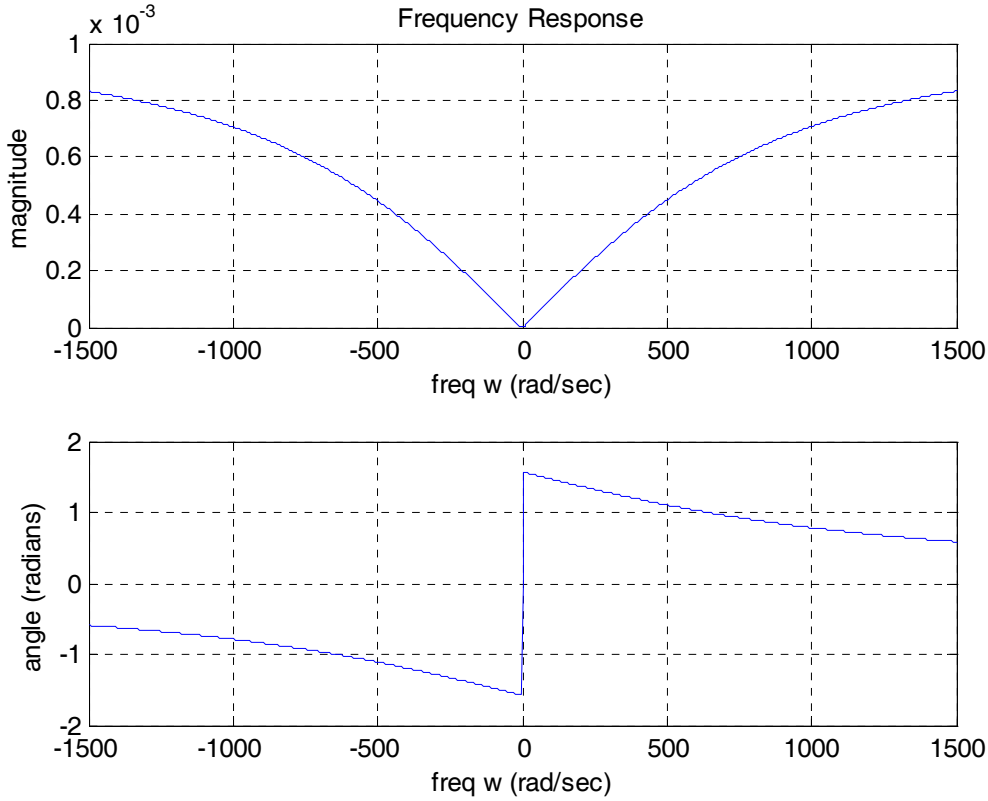
$$\text{so } H(f) = \frac{v_R(f)}{i_i(f)} = \frac{Z_L(f)\, Z_R(f)}{Z_L(f) + Z_{RC}(f)} = \frac{j\omega L R}{j\omega L + R + \frac{1}{j\omega C}} \left(\frac{j\omega C}{j\omega}\right.$$

$$= \frac{-\omega^2 LRC}{-\omega^2 LC + j\omega CR + 1}$$

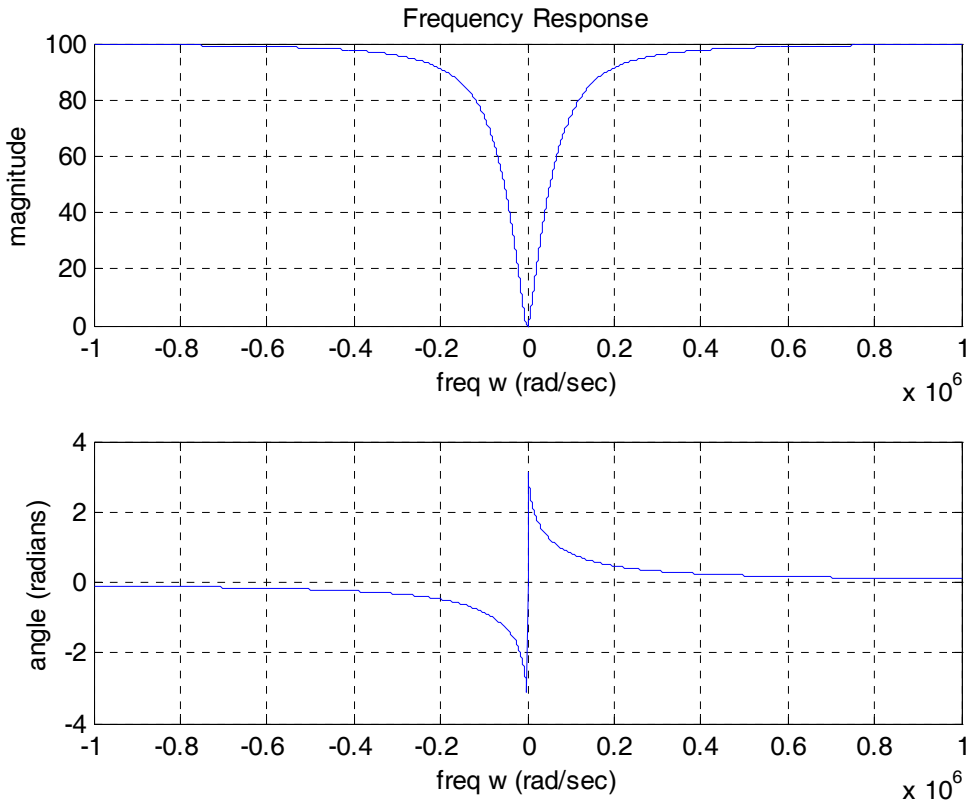
```
% Text, 12-6(a)
W=150e3;
w=-W:W;

L=1e-3;
C=1e-6;
R=10;

H=-w.^2*L*C ./ (-w.^2*L*C + j*w*R*C+1)
figure(1),subplot(2,1,1),plot(w,abs(H)),xlabel('freq w
(rad/sec)'),ylabel('magnitude'),title('Frequency Response'),grid on
subplot(2,1,2),plot(w,angle(H)),xlabel('freq w (rad/sec)'),ylabel('angle
(radians)'),grid on
```




```
% Text, 12-6(b)
W=1500;
w=-W:W;

C=1e-6;
R=1000;

H=j*w*C./(j*w*C*R+1);
figure(2),subplot(2,1,1),plot(w,abs(H)),xlabel('freq w
(rad/sec)'),ylabel('magnitude'),title('Frequency Response'),grid on
subplot(2,1,2),plot(w,angle(H)),xlabel('freq w (rad/sec)'),ylabel('angle
(radians)'),grid on
```




```
% Text, 12-6(c)
W=1e6
w=-W:100:W;

L=1e-3;
C=1e-6;
R=100;

H=(-w.^2*R*L*C)./(-w.^2*L*C+j*w*R*C+1);
figure(3),subplot(2,1,1),plot(w,abs(H)),xlabel('freq w
(rad/sec)'),ylabel('magnitude'),title('Frequency Response'),grid on
subplot(2,1,2),plot(w,angle(H)),xlabel('freq w (rad/sec)'),ylabel('angle
(radians)'),grid on
```


Frequency Response
magnitude
100
80
60
40
20
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
freq w (rad/sec)
x 10^6
angle (radians)
4
2
0
-2
-4
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
freq w (rad/sec)
x 10^6