An Najah University – Faculty of engineering
Electrical Eng. Department
System and Signals

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14/11/2009

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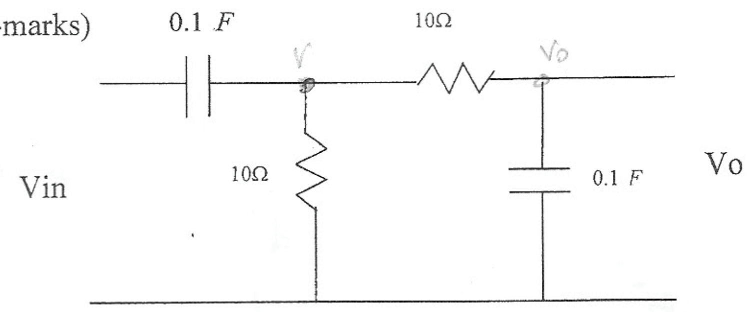
Question #1 (6 mark)

For circuit shown find:

1- Transfer function H(jw) = Vo(jw)/Vin(jw) (3-marks)
2- Kind of filter (1-marks)
3- Cutoff frequency/ies (2- mark)



$H(jw) = \frac{V_o(jw)}{V_{in}(jw)} =$

$\therefore H(jw) = \frac{\frac{jw}{20}}{\frac{100}{40} + jw - 5w^2}$

$|H(jw)| = \frac{\frac{1}{2}w}{\sqrt{(w)^2 + (\frac{10}{4} - 5w^2)^2}}$

$\angle H(jw) = \frac{\pi}{2} - \tan^{-1}$

w	|H|
0	0
$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$
∞	0

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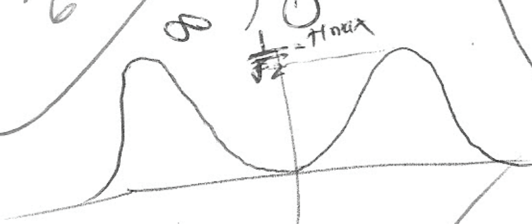


node V: $\frac{V - V_{in}}{0.1F} + \frac{V}{10\Omega} + \frac{V - V_o}{10\Omega} = 0$

$V = V_{in} \frac{10}{10 + 0.1F}$

$V_o = V \frac{0.1F}{0.1F + 10 + 10}$ $\frac{1}{jwC} = \frac{10}{jw}$

$V_o = V_{in} \frac{10}{10 + 0.1F} \cdot \frac{0.1F}{0.1F + 20}$

$\frac{V_o}{V_{in}} = \frac{\frac{20}{jw}}{\frac{20}{jw} + 200 + \frac{100}{(jw)^2} + \frac{20}{jw}}$

$= \frac{\frac{20}{jw}}{\frac{100}{(jw)^2} + \frac{40}{jw} + 200}$ $* jw^2$

$= \frac{20jw}{100 + 40jw + 200jw^2}$ $-200w^2$

to find w_c

$\frac{\frac{1}{2}w}{\sqrt{w^2 + (\frac{5}{2} - 5w^2)^2}} = \frac{1}{2}$

② the kind is Band Pass filter

~~③ $W_{C1,2} = \frac{R}{2L} \pm \sqrt{(\frac{R}{2L})^2 + \frac{1}{LC}}$~~

$H(jw) = \frac{H_{max}}{\sqrt{2}} = \frac{\frac{1}{\sqrt{2}}}{\sqrt{2}} = \frac{1}{2}$ →

$\frac{\frac{1}{4}w^2}{w^2 + (\frac{5}{2} - 5w^2)^2} = \frac{1}{4}$

$w^2 = w^2 + (\frac{5}{2} - 5w^2)^2$

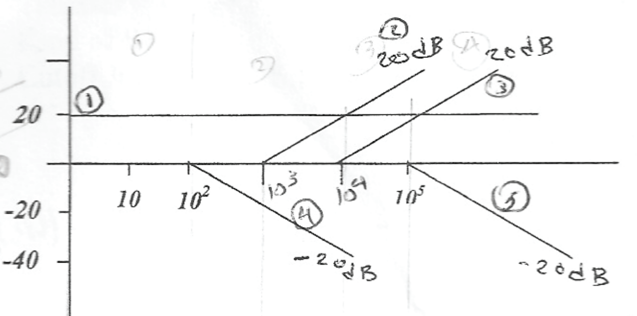
$5/2 - 5w_c^2 = 1$ $w^2 = \frac{1}{2}$ $\therefore w_c = \frac{1}{\sqrt{2}}$

Question # 2 (6 mark)

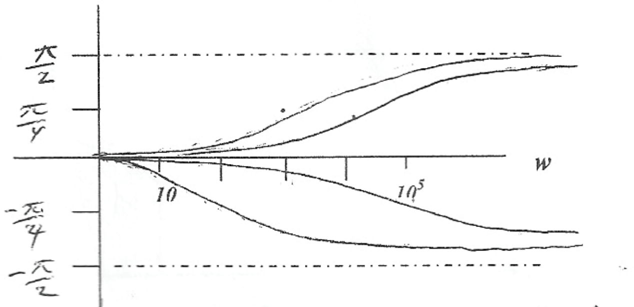
a) Ascertain has filter consist of 5 sections as shown in the following bode diagrams find:
   - Total magnitude and phase diagrams (3-marks)
   - If Vin (t) = 10 sin (200t) + 10 sin (2000t) + 10 sin (20000t) write an expression for Vo(t) (2-marks)
   - What is the bandwidth of the filter (1-mark)

2×10^2 2×10^3 2×10^4

Gain in dB



phase



① $|\,|_{dB} = 20\log_{10} K = 20\log_{10} 10 = 20$ ∴ $K = 10$

② $|\,|_{dB} = 20\log_{10}\frac{w}{10^3} \rightarrow \frac{jw}{10^3}+1 = H(jw)$

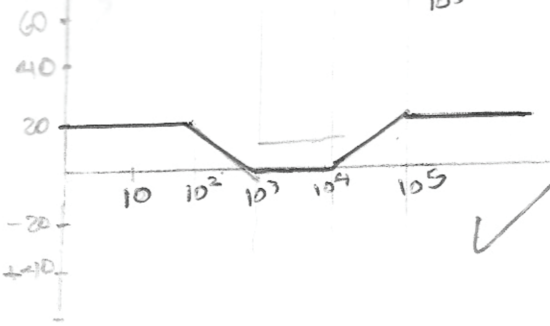
③ $|\,|_{dB} = 20\log\frac{w}{10^4} \rightarrow \frac{jw}{10^4}+1 = H(jw)$

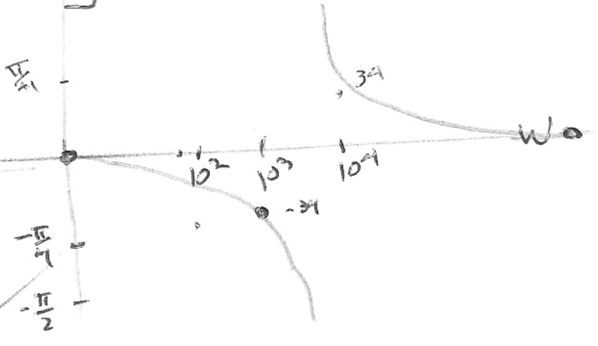
④ $|\,|_{dB} = -20\log\frac{w}{10^2} \rightarrow \frac{1}{\frac{w}{10^2}+1} = H(jw)$

⑤ $|\,|_{dB} = -20\log\frac{w}{10^5} \rightarrow \frac{1}{\frac{w}{10^5}+1} = H(jw)$

$\Rightarrow H(jw) = \dfrac{10\left(\frac{jw}{10^3}+1\right)\left(\frac{jw}{10^4}+1\right)}{\left(\frac{jw}{10^2}+1\right)\left(\frac{jw}{10^5}+1\right)}$

$\angle H(jw) = 0 + \tan^{-1}\frac{w}{10^3} + \tan^{-1}\frac{w}{10^4} - \tan^{-1}\frac{w}{10^2} - \tan^{-1}\frac{w}{10^5}$





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$w = 2\times10^2$, dB ≈ 20, $20 = 20\log(\text{gain})$, gain $= 10^1 = 10$, $\theta = -38$

$w = 2\times10^3$, dB ≈ 0, $0 = 20\log(\text{gain}_2)$, $\text{gain}_2 = 10^0 = 1$, $\theta_2 = -34$

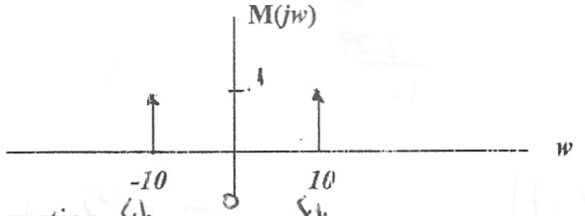
$w = 2\times10^4$, dB = 0, $0 = 20\log(\text{gain}_3)$, $\text{gain}_3 = 10^0 = 1$, $\theta_3 = 34°$

$V_o(t) = 10(10)\sin(20t - 38) + 10(1)\sin(200t - 34) + 10(1)\sin(200t + 34)$

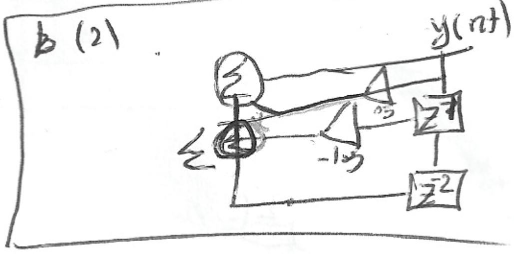
$BW = W_{c2} - W_{c1} = 10^4 - 10^3 = 9000$

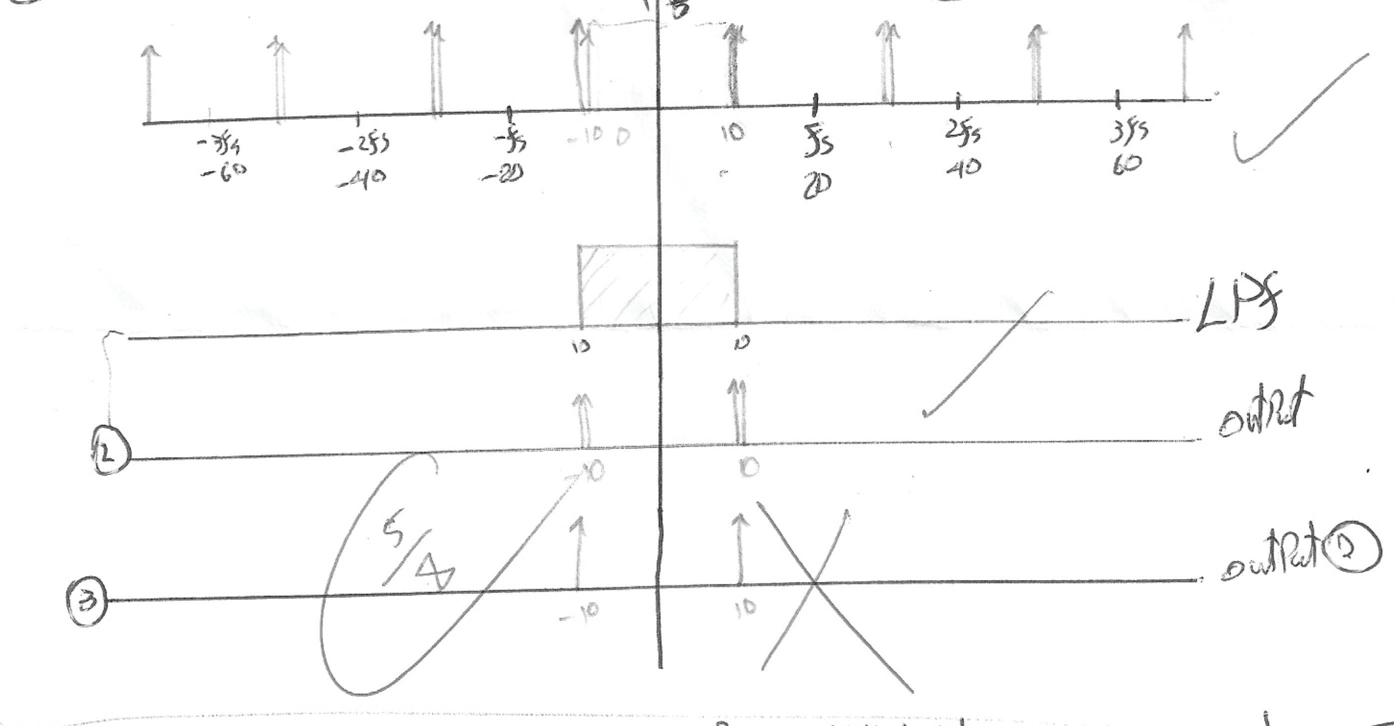
Question # 3 (8 mark)

a) A certain signal m(t) has the following spectrum is sampled by sampling frequency 20rad/sec
   1- sketch the sampled frequency
   2- if the sampled frequency applied to ideal LPF with cutoff 10rad/sec sketch the output of the filter
   3- if the signal sampled with frequency 15 rad/sec what is the output of low pass filter



b) A certain discrete system represent by the following equation
   $y(n-2) - 1.5\,y(n-1) + 0.5\,y(n) = (0.25)^n$
   1- Find y(nT)
   2- Draw block diagram represent the system





(b) ① transform to Y(z):

$$Y(z)z^{-2} - 1.5\,Y(z)z^{-1} + 0.5\,Y(z) = \frac{1}{1-0.25z^{-1}}$$

$$Y(z)\left[z^{-2} - 1.5z^{-1} + 0.5\right] = \frac{1}{1-0.25z^{-1}}$$

$$\therefore Y(z) = \frac{1}{[z^{-2}-1.5z^{-1}+0.5][1-0.25z^{-1}]} = \frac{z^2}{(0.5z^2-1.5z+0.5)} \cdot \frac{1}{[1-0.25z^{-1}]}$$

$$= \frac{z^2}{(z-2)(z-1)} \cdot \frac{1}{1-0.25z^{-1}} = \frac{1}{(1-2z^{-1})(1-z^{-1})(1-0.25z^{-1})}$$

$$= \frac{A}{1-2z^{-1}} + \frac{B}{1-z^{-1}} + \frac{C}{1-0.25z^{-1}} \Rightarrow A(1-z^{-1})(1-0.25z^{-1}) + B(1-2z^{-1})(1-0.25z^{-1}) + C(1-2z^{-1})(1-z^{-1}) = 1$$

$$B = \frac{1}{(1-2)(1-0.25)}\Bigg|_{z=+1} = -0.75$$

$$A\Bigg|_{z=\frac{1}{2}} = \frac{1}{(1-\frac{1}{2})(1-0.25(\frac{1}{2}))} = 2.28$$

$$C\Bigg|_{z=\frac{1}{0.25}} = \frac{1}{1-2(\frac{1}{0.25})(1-\frac{1}{0.25})} = K = 0.04$$