EE 481/581 Microwave Engineering Quiz #10 (Fall 2024)

Name Key A

Instructions: Open notes/text. Place answers in indicated spaces. **Show** & **clearly label** *all* work for partial credit.

Design an equal-ripple low-pass filter prototype with a ripple of 0.5 dB in the passband and an attenuation of at least 12 dB at 170% of the cutoff frequency that is matched to the same impedance at the load and source. I.e., give the minimum order N and the immittance values g_0 to g_{N+1}. Then, draw the actual filter with all components labeled when the cut-off frequency is 800 MHz in a system with 65 Ω load and source for a design with the use of capacitors maximized.

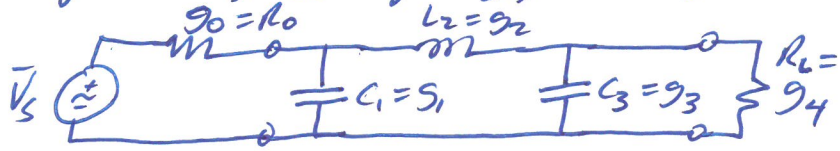
Find normalized frequency $\left|\frac{\omega}{\omega_c}\right|-1 = \left|\frac{1.7\omega_c}{\omega_c}\right|-1 = 0.7$

and plot on Fig. 8.27. Draw horizontal line at 12 dB.

Based on Fig 8.27, $N=3$ is the lowest order filter to meet spec.

From Table 8.4, $g_0 = g_4 = 1$, $g_1 = g_3 = 1.5963$, & $g_2 = 1.0967$.

To maximize capacitors, use topology of Fig. 8.25a for prototype:



Per (8.64a) & (8.64d), $R_s' = R_0 = 65\,\Omega$ and $R_L' = R_0 g_4 = 65(1) = 65\,\Omega$

Per (8.67a) & (8.67b), $C_1' = C_3' = \frac{C_1}{R_0 \omega_c} = \frac{1.5963}{65(2\pi)800\times10^6}$

$= 4.88575\ \text{pF}$

$L_2' = \frac{R_0 L_2}{\omega_c} = \frac{65(1.0967)}{2\pi(800\times10^6)} = 14.1818\ \text{nH}$

Prototype: $N =$ 3 immittances: $g_0 = g_4 = 1$, $g_1 = g_3 = 1.5963$, & $g_2 = 1.0967$

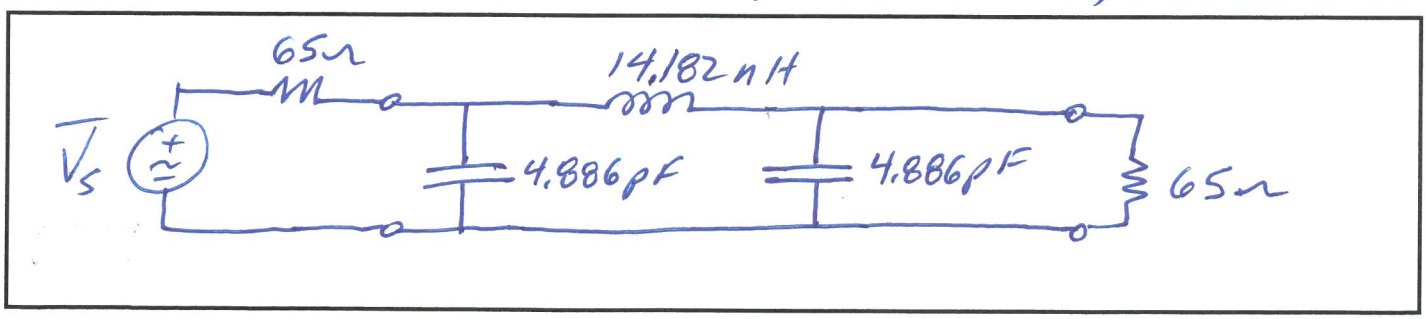
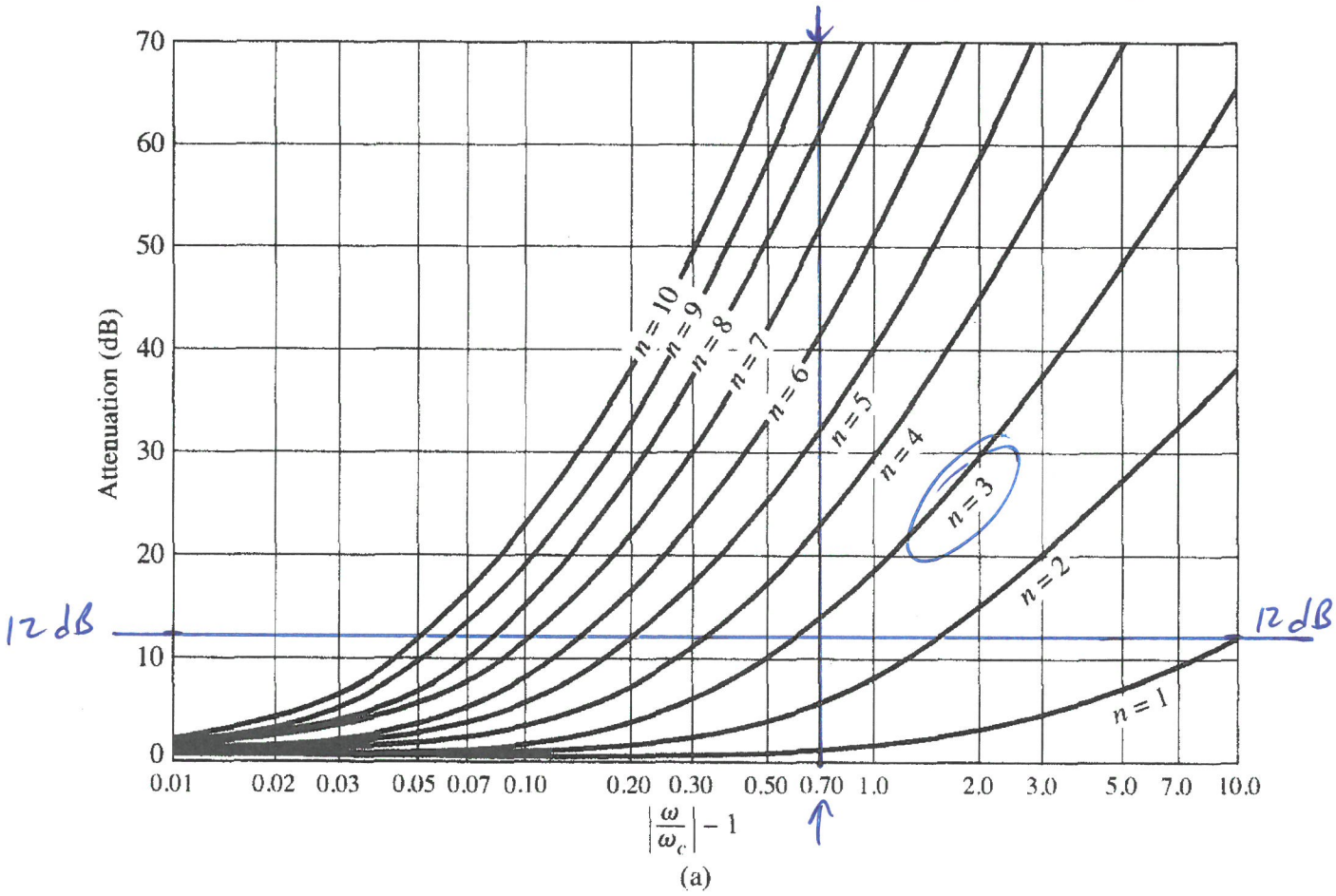


TABLE 8.4 Element Values for Equal-Ripple Low-Pass Filter Prototypes ($g_0 = 1$, $\omega_c = 1$, $N = 1$ to 10, 0.5 dB ripple)

	0.5 dB Ripple										
N	g_1	g_2	g_3	g_4	g_5	g_6	g_7	g_8	g_9	g_{10}	g_{11}
1	0.6986	1.0000									
2	1.4029	0.7071	1.9841								
3	1.5963	1.0967	1.5963	1.0000							
4	1.6703	1.1926	2.3661	0.8419	1.9841						
5	1.7058	1.2296	2.5408	1.2296	1.7058	1.0000					
6	1.7254	1.2479	2.6064	1.3137	2.4758	0.8696	1.9841				
7	1.7372	1.2583	2.6381	1.3444	2.6381	1.2583	1.7372	1.0000			
8	1.7451	1.2647	2.6564	1.3590	2.6964	1.3389	2.5093	0.8796	1.9841		
9	1.7504	1.2690	2.6678	1.3673	2.7239	1.3673	2.6678	1.2690	1.7504	1.0000	
10	1.7543	1.2721	2.6754	1.3725	2.7392	1.3806	2.7231	1.3485	2.5239	0.8842	1.9841



(a)

FIGURE 8.27 Attenuation versus normalized frequency for equal-ripple filter prototypes. (a) 0.5 dB ripple level.

Adapted from G. L. Matthaei, L. Young, and E. M. T. Jones, *Microwave Filters, Impedance-Matching Networks, and Coupling Structures*, Artech House, Dedham, Mass., 1980, with permission.

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Name Key B

Instructions: Open notes/text. Place answers in indicated spaces. **Show** & **clearly label** *all* work for partial credit.

Design an equal-ripple low-pass filter prototype with a ripple of 0.5 dB in the passband and an attenuation of at least 16 dB at 200% of the cutoff frequency that is matched to the same impedance at the load and source. I.e., give the minimum order N and the immittance values g_0 to g_{N+1}. Then, draw the actual filter with all components labeled when the cut-off frequency is 600 MHz in a system with an 85 Ω load and source for a design with the use of inductors minimized.

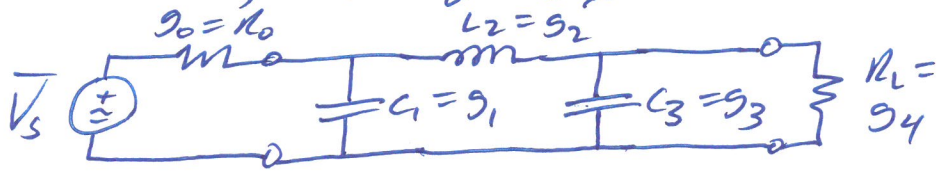
Find normalized frequency $\left|\frac{\omega}{\omega_c}\right| - 1 = \left|\frac{2\omega_c}{\omega_c}\right| - 1 = 1$

and plot on Fig 8.27. Draw horizontal line at 16dB.

Based on Fig 8.27, $N=3$ is the lowest order filter to meet spec.

From Table 8.4, $g_0 = g_4 = 1$, $g_1 = g_3 = 1.5963$, & $g_2 = 1.0967$.

To minimize inductors, use topology of Fig 8.25a for prototype $N=3$

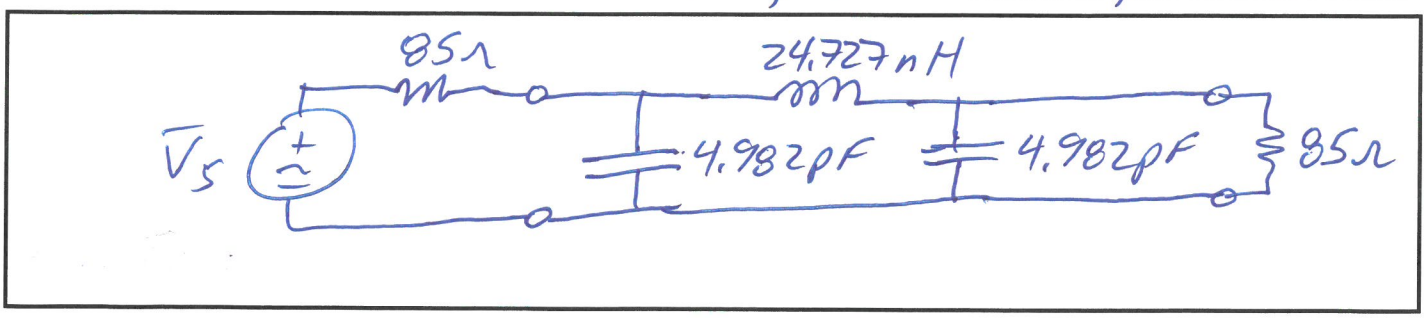


Per (8.64a) & (8.64d), $R_s' = R_0 = 85\,\Omega$ and $R_L' = R_0 g_4 = 85(1) = 85\,\Omega$

Per (8.67a), $C_1' = C_3' = \frac{C_1}{R_0 \omega_c} = \frac{1.5963}{85(2\pi)600\times10^6} = 4.98155\,pF$

Per (8.67b), $L_2' = \frac{R_0 L_2}{\omega_c} = \frac{85(1.0967)}{2\pi(600\times10^6)} = 24.72724\,nH$

Prototype: $N =$ 3 immittances: $g_0 = g_4 = 1$, $g_1 = g_3 = 1.5963$, & $g_2 = 1.0967$



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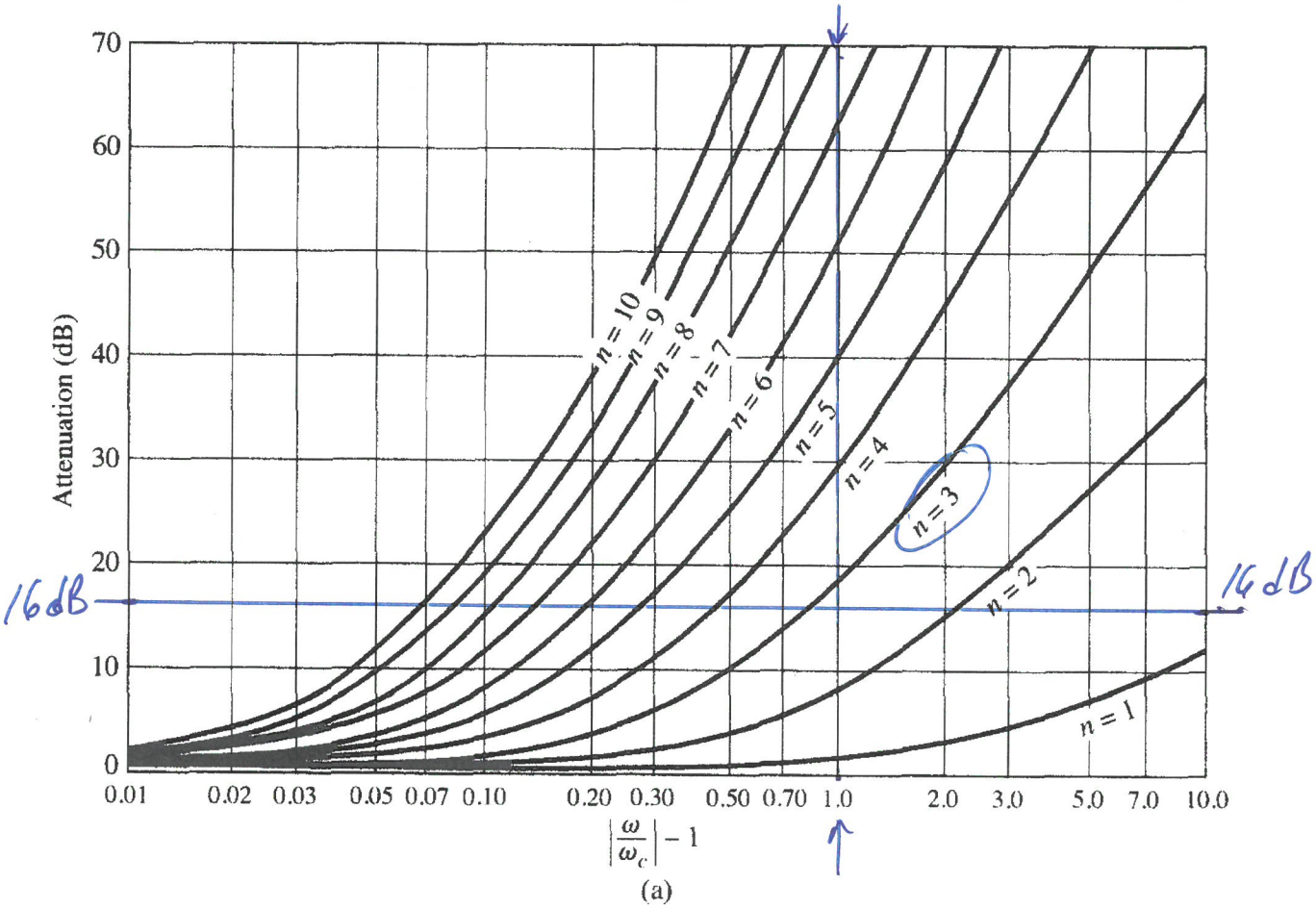

FIGURE 8.27 Attenuation versus normalized frequency for equal-ripple filter prototypes. (a) 0.5 dB ripple level.

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