8.8 Design a high-pass lumped-element filter with a 3 dB equal-ripple response, a cutoff frequency of 3 GHz, and at least 30 dB insertion loss at 2.0 GHz. The characteristic impedance is 75 Ω. Use CAD to plot the insertion loss versus frequency.

- Also, draw labeled sketch of design. CAD part is not required.

➢ Calculate $|\omega/\omega_c| - 1 = |3/2| - 1 = 0.5$. From Figure 8.27, we see that a LP prototype filter of order ***N* = 5** is needed to meet the 30 dB attenuation specification.

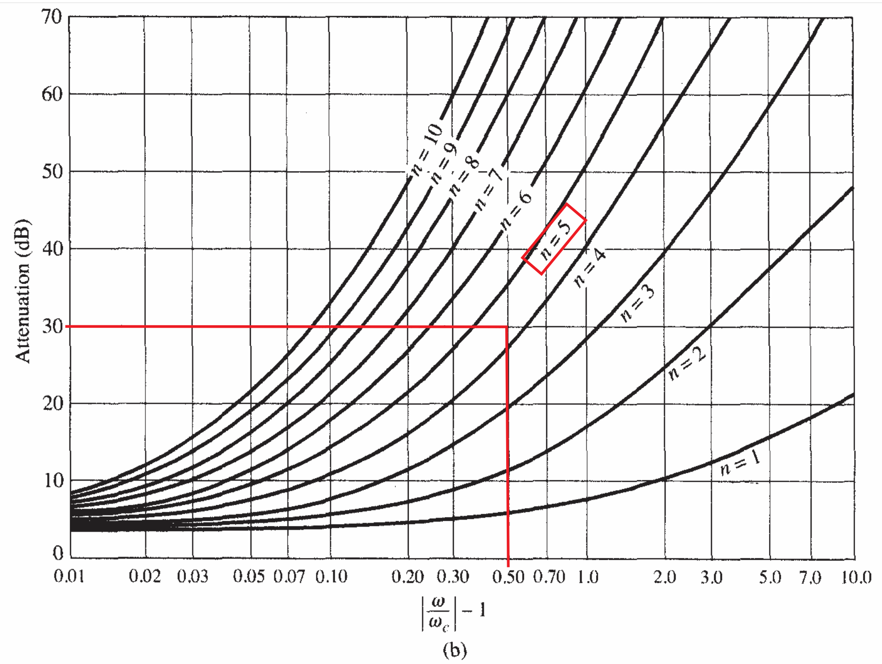

FIGURE 8.27 Attenuation versus normalized frequency for equal-ripple filter prototypes. (b) 3.0 dB ripple level.

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.

➢ From Table 8.4, we get the immittances: **$g_1 = g_5 = 3.4817$**, **$g_2 = g_4 = 0.7618$**, **$g_3 = 4.5381$**, and **$g_6 = 1$** (matched).

TABLE 8.4 **Element Values for Equal-Ripple Low-Pass Filter Prototypes ($g_0 = 1, \omega_c = 1$, $N = 1$ to 10, 3.0 dB ripple)**

	3.0 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	1.9953	1.0000									
2	3.1013	0.5339	5.8095								
3	3.3487	0.7117	3.3487	1.0000							
4	3.4389	0.7483	4.3471	0.5920	5.8095						
5	3.4817	0.7618	4.5381	0.7618	3.4817	1.0000					
6	3.5045	0.7685	4.6061	0.7929	4.4641	0.6033	5.8095				
7	3.5182	0.7723	4.6386	0.8039	4.6386	0.7723	3.5182	1.0000			
8	3.5277	0.7745	4.6575	0.8089	4.6990	0.8018	4.4990	0.6073	5.8095		
9	3.5340	0.7760	4.6692	0.8118	4.7272	0.8118	4.6692	0.7760	3.5340	1.0000	
10	3.5384	0.7771	4.6768	0.8136	4.7425	0.8164	4.7260	0.8051	4.5142	0.6091	5.8095

Source: Reprinted 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.

- For the filter architecture of Fig 8.25a, we get the necessary scaled & transformed shunt inductances and series capacitances using the immittances and equations (8.64d), (8.70a), and (8.70b):

$$g_1 = g_5 = 3.4817 \Rightarrow L_1' = L_5' = \frac{R_0}{\omega_c C_k} = \frac{R_0}{\omega_c g_1} = \frac{75}{(2\pi)3\times 10^9 (3.4817)} \Rightarrow \underline{L_1' = L_5' = 1.1428 \text{ nH}}$$

$$g_2 = g_4 = 0.7618 \Rightarrow C_2' = C_4' = \frac{1}{R_0 \omega_c L_k} = \frac{1}{R_0 \omega_c g_2} = \frac{1}{75(2\pi)3\times 10^9 (0.7618)} \Rightarrow \underline{C_2' = C_4' = 0.9285 \text{pF}}$$

$$g_3 = 4.5381 \Rightarrow L_3' = \frac{R_0}{\omega_c C_k} = \frac{R_0}{\omega_c g_3} = \frac{75}{(2\pi)3\times 10^9 (4.5381)} \Rightarrow \underline{L_3' = 0.8768 \text{ nH}},$$

and, per (8.64d), $g_6 = 1 \Rightarrow R_L' = R_0 R_L = R_0 g_6 = 50(1) \Rightarrow \underline{R_L' = 50\ \Omega}$.

- Further, the source resistance per (8.64c) is: $R_S' = R_0 \Rightarrow \underline{R_S' = 50\ \Omega}$.

- The resulting **highpass** filter circuit is: