ECE5180/6180 Coupled Line Filters

Portfolio Question:
(1) How do you design a coupled line bandpass filter?\
(2) Design filters for your lab.
    (a) One filter should pass 2.4 GHz and reject 2.6 GHz. The other should pass 2.6 and reject 2.4 GHz.
    (b) Simulate the filters on ADS using MCLIN (microstrip coupled line).
    (c) Examine (and tune) the filter response for your lab.
    (d) Also find the extra passbands (at about 5 GHz).
    (e) Prepare your lab for milling.
(3) Grad Students: Understand the derivation and design method. Undergrads: Understand the design method.

Text Section 8.7

Coupled Line Filter
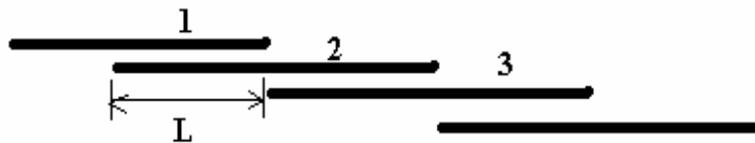
$L = \lambda/4$
Generally Zo = 50 ohms (all lines)
What changes? Separation between the lines (coupling factor).

Design Steps:
1) Choose type of filter (Maximally flat, equal ripple, etc.)
2) Find "fractional bandwidth" Δ
    $\Delta = \omega_{BW} / \omega$ fractional bandwidth
    $\omega_{BW} = \omega_2 - \omega_1$ -3dB bandwidth ω_{BW}
    ω_o center frequency ω_o
3) Convert frequency where attenuation is specified (ω) to normalized low pass form (using 8.71 on page 457) Now $\omega_c = 1$

$$\omega_{LP} = \frac{1}{\Delta}\left(\frac{\omega}{\omega_o} - \frac{\omega_o}{\omega}\right)$$

4) Look on the graphs (8.27 for Chebyshev, 8.26 for binomial) using horizontal axis:

$$\left|\frac{\omega_{LP}}{\omega_c}\right| - 1$$

Find the filter order N that is higher than the required attenuation at the frequency.
5) Use the tables to find the "g" values of the filter (Chebyshev or binomial)
6) Use equations 8.121 to find ZoJn for n=1,2,…N+1

$$Z_o J_1 = \sqrt{\frac{\pi\Delta}{2g_1}}$$

$$Z_o J_n = \frac{\pi\Delta}{2\sqrt{g_{n-1}g_n}} \quad for\, n = 2,3,...,N$$

$$Z_o J_{N+1} = \sqrt{\frac{\pi\Delta}{2g_N g_{N+1}}}$$

7) Find the even and odd mode impedances from (8.108 p.480)

$$Z_{oe} = Z_o\left[1 + JZ_o + (JZ_o)^2\right]$$

$$Z_{oo} = Z_o\left[1 - JZ_o + (JZ_o)^2\right]$$

8) To build this, use ADS microstrip coupled line (MCLIN). Highlight this element and send it to Linecalc. You can then input Zoe, Zoo, and Zo, and it will tell you the width and separation. Note that the smallest bit we have is 10 mils, so this is the minimum spacing between lines. Also use Linecalc to tell you the length for the λ/4 lines. Remember to add half the length of the THRU to both ends and to "orient" your filter properly so that it can be attached to the coupler (one filter goes "up", and the other goes "down").