HOMEWORK ASSIGNMENT #9

Due Thursday, April 20
(at the beginning of class)

Problems identified by numbers such as “1.8” are from Pozar’s *Microwave Engineering*, 4th Edition, © 2012. Those followed by a “(M)”, such as “1.8 (M)”, have been modified from the original problems in the text, as explained in the assignment below. Make sure to follow the changes as given.

1. 6.8 (M) After solving the problem in the book, assume that \( Z_0 = 50 \, \Omega \), \( R = 100 \, \Omega \) and \( C = 20 \, \text{pF} \). Find the value of L for resonance at \( f_0 = 4.0 \, \text{GHz} \). Assume the line length is \( \lambda/4 \) at 4.0 GHz. Plot the resistance and reactance of the load (series RLC circuit) versus normalized frequency \( (f/f_0) \). Then plot the input resistance and reactance versus normalized frequency \( (f/f_0) \). For both plots, let the normalized frequency vary from 1.0 to 2.0.

2. 6.10 (M) For the cavity described in this problem, find the fields \( H_x \) and \( H_y \) inside the cavity and show that the \( Q \) of the cavity is given by

\[
Q = \frac{k_0 \eta_0}{4 R_s} \frac{a b d (a^2 + b^2)}{(a^3 d + b^3 d + a^3 b + ab^3)}.
\]

3. 6.11 (M) Show that this transcendental equation is given by

\[
\beta_d \tan \beta_a (d - t) = \beta_a \tan \beta_d t
\]

where \( \beta_a = \sqrt{k_0^2 - (\pi/a)^2} \) and \( \beta_d = \sqrt{\varepsilon_r k_0^2 - (\pi/a)^2} \).

Now consider the specific case in which \( a = 1.58 \, \text{cm} \), \( b = 0.78 \, \text{cm} \), \( d = 3.16 \, \text{cm} \), \( \varepsilon_r = 2.2 \), and \( t \) varies from 0 to 3 mm. Solve the above transcendental equation numerically for \( k_0 \), and then find the corresponding resonant frequency (in GHz), for \( t = 0, 1, 2, \) and 3 mm. Finally, plot the resonant frequency as a function of the dielectric thickness, \( t \).

4. 6.18 (M) Change values so that \( \varepsilon_r = 36.0, \ 2a = 1.0 \, \text{mm}, \) and \( L = 0.8 \, \text{mm} \).