EE 481/581 Microwave Engineering (Fall 2025)
Homework 10
Wednesday, November 19, 2025

1) For a 50 Ω system, design a lumped-element, 0.5 dB ripple, Chebyshev low-pass filter with a cut-off frequency of 2.4 GHz with an attenuation of at least 15 dB at 4.8 GHz using the architecture of Fig. 8.25a. a) Determine the filter order N and the low-pass filter prototype element values. b) Draw a labeled sketch of the scaled filter with component values. c) Draw a labeled sketch of the filter in phasor form with $V_s = 1\angle 0°$ V. d) Plot the amplitude response $|V_L|$ in decibels with horizontal dashed lines at 20log(0.5) & 20log(0.5) - 0.5 and a vertical dashed line at 2.4 GHz for $0 \le f \le 5$ GHz and -25 dB $\le |V_L| \le 0$.

2) For a 50 Ω system, design a lumped-element, Butterworth high-pass filter with a cut-off frequency of 2.4 GHz with an attenuation of at least 15 dB at 1.2 GHz using the architecture of Fig. 8.25a. a) Determine the filter order N and the low-pass filter prototype element values. b) Draw a labeled sketch of the scaled and transformed filter with component values. c) Draw a labeled sketch of the filter in phasor form with $V_s = 1\angle 0°$ V. d) Plot the amplitude response $|V_L|$ in decibels with horizontal dashed lines at 20log(0.5) & 20log(0.25) and a vertical dashed line at 2.4 GHz for $0 \le f \le 5$ GHz and -25 dB $\le |V_L| \le 0$.

3) For a 50 Ω system, design a 4th-order, lumped-element, linear phase bandpass filter with a center frequency of 2.4 GHz and a bandwidth of 20% using the architecture of Fig. 8.25a. a) Determine the low-pass filter prototype element values. b) Draw a labeled sketch of the scaled and transformed filter with component values. c) Draw a labeled sketch of the filter in phasor form with $V_s = 1\angle 0°$ V. d) Plot the amplitude response $|V_L|$ in decibels with horizontal dashed lines at 20log(0.5) & 20log(0.25) and vertical dashed lines at 2.4 ± 10% GHz for $0 \le f \le 5$ GHz and -20 dB $\le |V_L| \le 0$.

4) **EE 581 only:** 8.6 with ripple specification changed to 1.5 dB. a) Find the parameter k^2 as well as values k_{neg} & k_{pos}. b) Find the equations for the P_{LR} in terms of ω and the circuit component values. c) Find the two possible values for R, i.e., R_{small} & R_{big}. d) Find equations for realizable values of the inductance L_{kneg} and L_{kpos} in terms of R, C, and k_{neg} or k_{pos}. e) Equate ω^2 coefficients and then use the L_{kneg} & L_{kpos} equations to generate two polynomials in terms of C. f) Find R_s, L, C, & R and draw prototype low-pass filter circuit with component values. [Hints: Try all four permutations of k_{neg}, k_{pos}, R_{small}, and R_{big} in the polynomials to find the solution with realizable components. Consider using quadratic formula or numerical polynomial root solver.]

Due Monday, November 24, 2025 at my office or EECS dept. mail box by 4PM.

Note: For plots, you can use MathCAD or Matlab. Include either worksheet (MathCAD) or m-file & plots (Matlab) with each solution.