University of Portland
School of Engineering

Best of luck!


Ampere (1775-1855)


Gauss (1777-1855)


Faraday (1791-1867)


Maxwell (1831-1879)


Hertz (1857-1894)

EE 301-Electromagnetic Fields-3 cr. hrs.
Spring 2014

Final Examination

(Prepared by Professor A. S. Inan)

(Thursday, May 1, 2014, 10:30-12:30 noon)
(Closed Book Exam; Formula Sheets Allowed)

Name:_____ ☺

*Signature:*_____ ☺

Hi Inan's Students: FYI, this week, on April 29, 2014, I turned 109 years old. Also, this year marks the 75th anniversary of the first publication of the Smith chart (I published it in the *Electronics* magazine in 1939). I wish you the best luck in Inan's final exam and in case he doesn't let you use my chart during his final, please let me know right away! PHS!

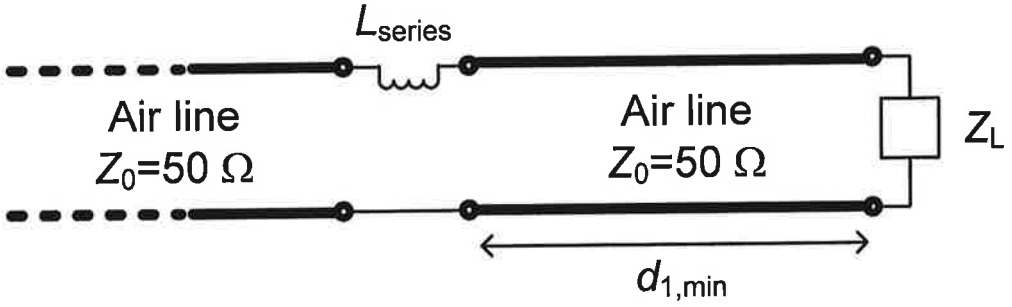
Points gained on each problem:

#1	
#2	
#3	
#4	
Total	

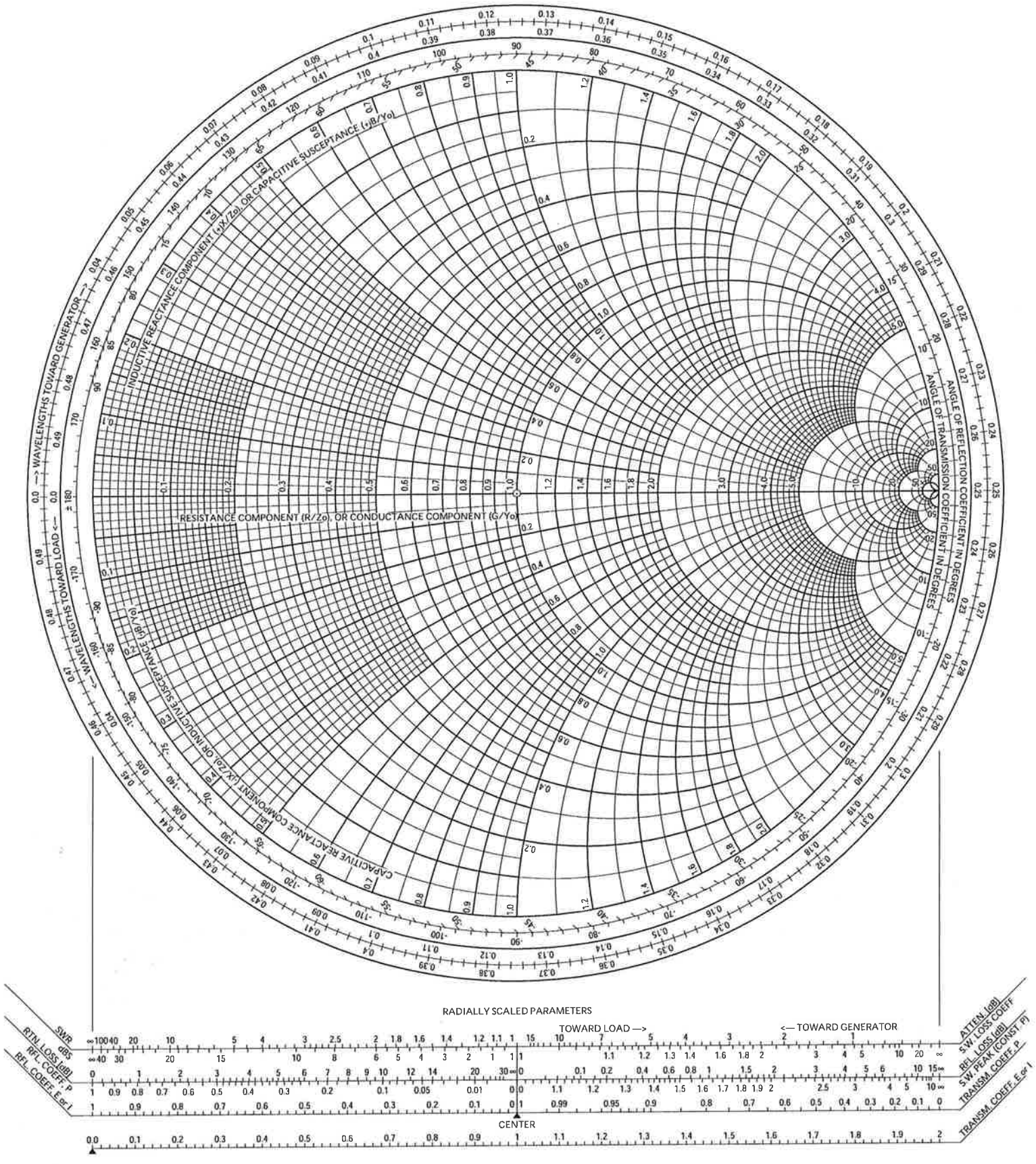
Note: The above table belongs to Inan, so, don't dare to touch it!! ☺

(1) (*Total:* 25 points) **A single, series inductor matching network.**

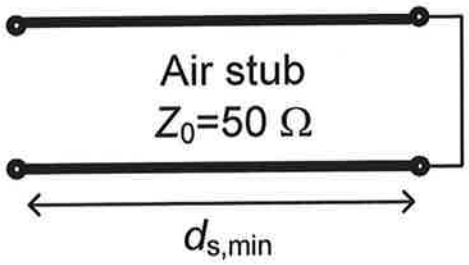
(a) (17 points) Use the Smith chart to design a single, series inductor matching network as shown to match a load impedance of $Z_L = 25 - j25\ \Omega$ to a 50 Ω air transmission line at a frequency of 900 MHz. Introduce the series inductor as close as possible to the load position. Provide your design values $d_{1,\min}$ (in actual lengths) and L_{series}.



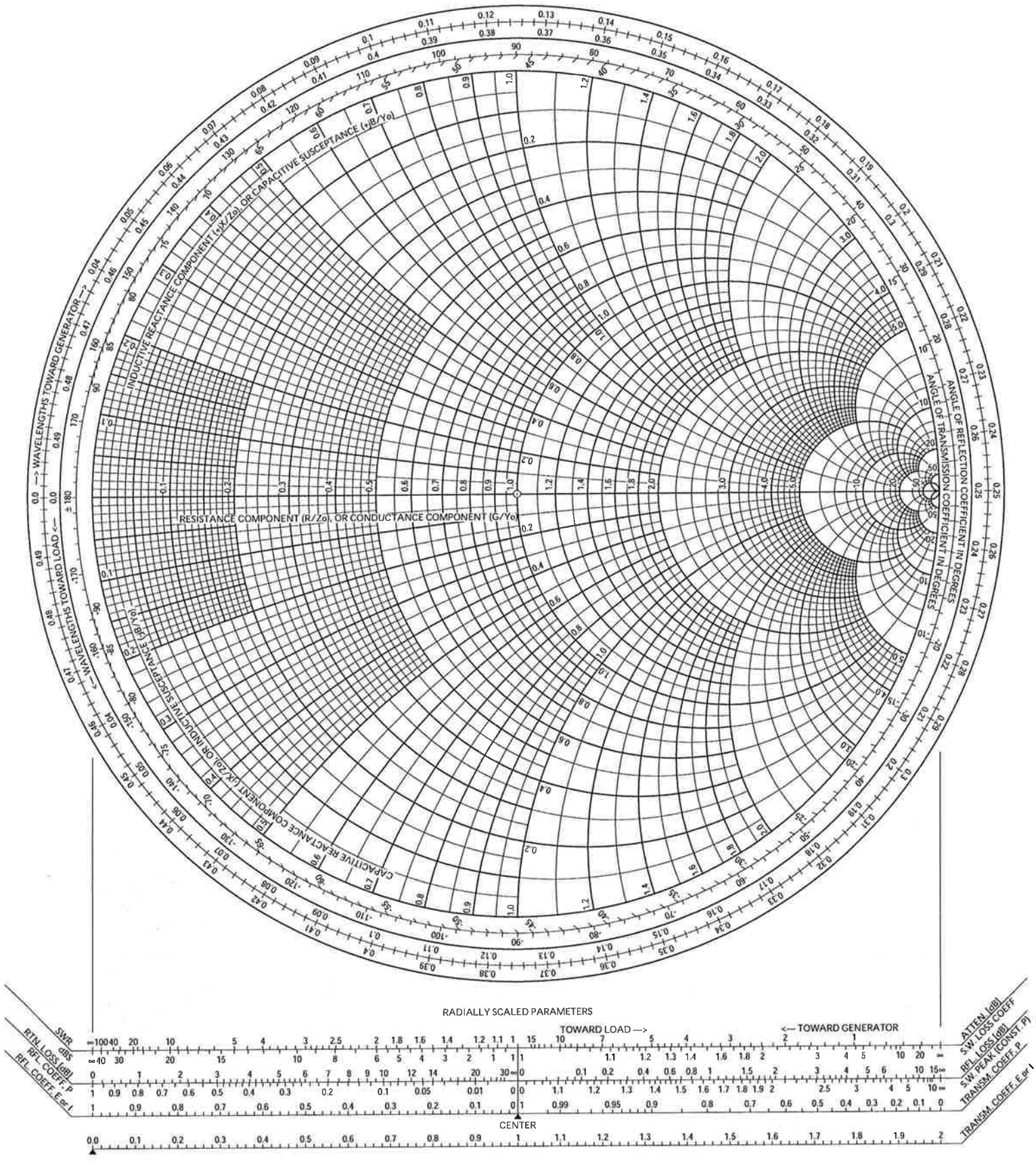
Smith Chart



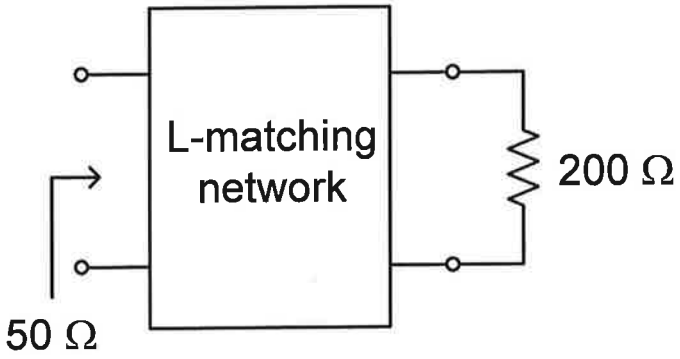
(b)(8 points) Design a short-circuited 50 Ω air stub with a minimum length $d_{s,min}$ so that it provides the same impedance provided by the series inductor L_{series} found in part (a) at 900 MHz.



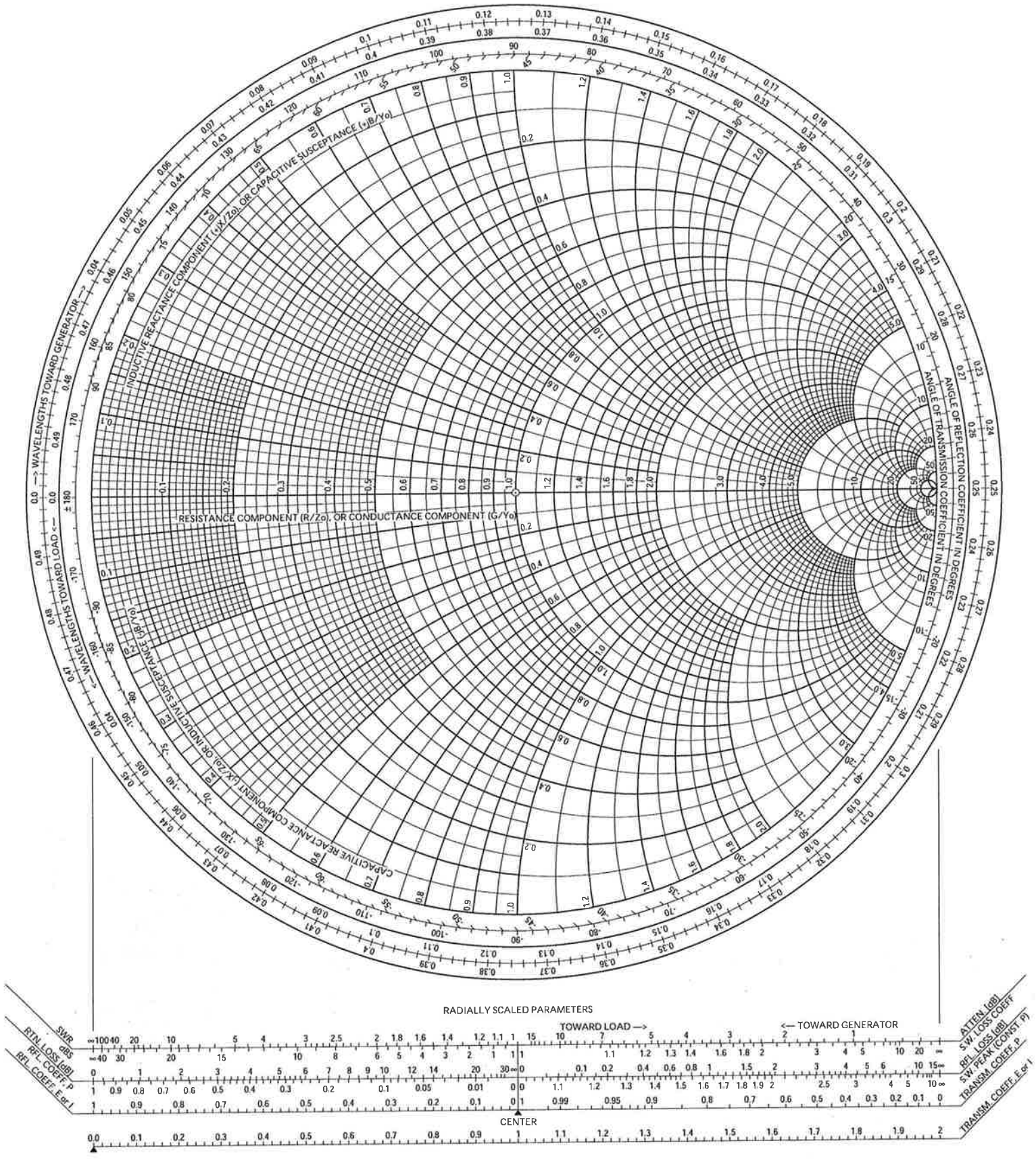
Smith Chart



(2) (25 points) **L-matching network design.** Design an L-matching network to match a load impedance of Z_L = 200 Ω to Z_0 = 50 Ω at 500 MHz. Draw your complete circuit designed including the load impedance and the terminals where the 50 Ω appears and provide all the element values (including their units) on your drawing.

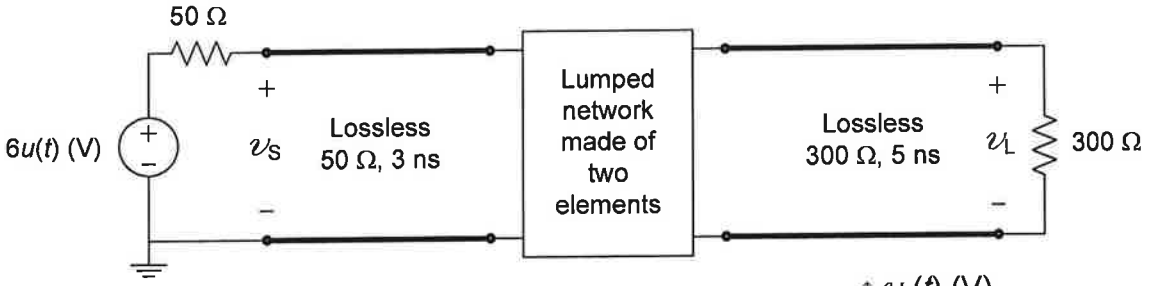


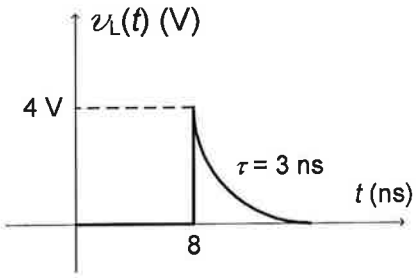
Smith Chart



(3)(*Total:* 25 points) **Unknown lumped circuit box.** The load-end voltage waveform $v_L(t)$ observed at the end of the two transmission-line electric circuit due to a step excitation is as shown.

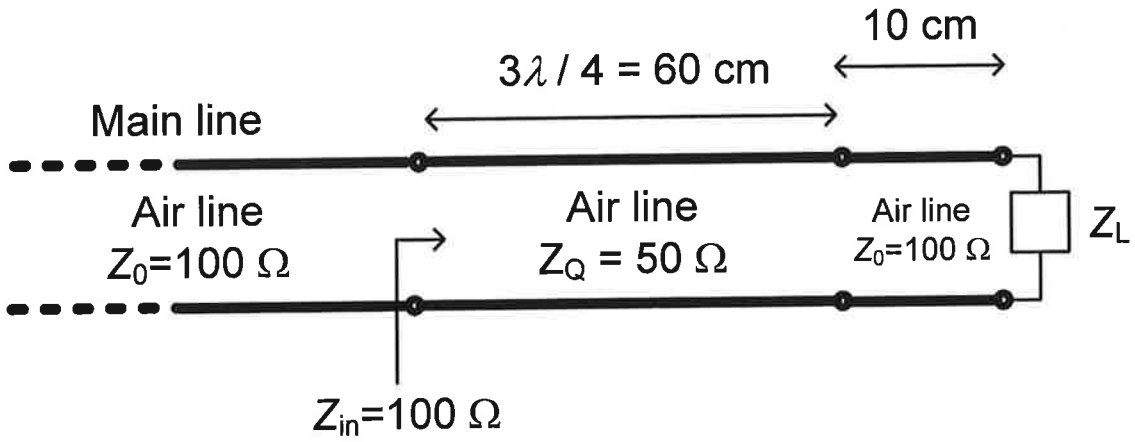
(a) (15 points) If the lumped circuit box between the two lines consists of two lumped elements, one resistive and the other reactive, based on the $v_L(t)$ waveform, determine the type of the reactive element (i.e., capacitor or inductor), how the two elements are connected inside the box, and their values. (Hint: The two elements form a rotated L shape.)





(b) (10 points) Find the complete mathematical expression for the source-end voltage $v_S(t)$ and sketch it. Include all the pertinent values on your sketch.

(4)(25 points) **Impedance matching network.** An impedance matching network is designed to match a load impedance Z_L to a 100 Ω air transmission line, as shown. Determine the value of the load impedance Z_L.



Smith Chart