Name_____

ELC 4383 – RF/Microwave Circuits I

Fall 2017

Midterm Exam – October 12, 2017

Open Book/Open Notes

1 hour and 15 minutes

1. The exam is open-book/open-notes.

2. A calculator may be used to assist with the test. No laptops or tablets are allowed. No cellular phones may be used in any way during the test. Unauthorized electronic device use will result in disqualification.

3. You must circle or box your answers to get full credit.

4. All work and steps toward a solution must be clearly shown to obtain credit.

5. Partial credit may be given provided that the grader can clearly follow your work to the extent that an understanding of the problem is demonstrated.

6. No collaboration is allowed on this examination. Only Dr. Baylis or a teaching assistant may be consulted for clarification.

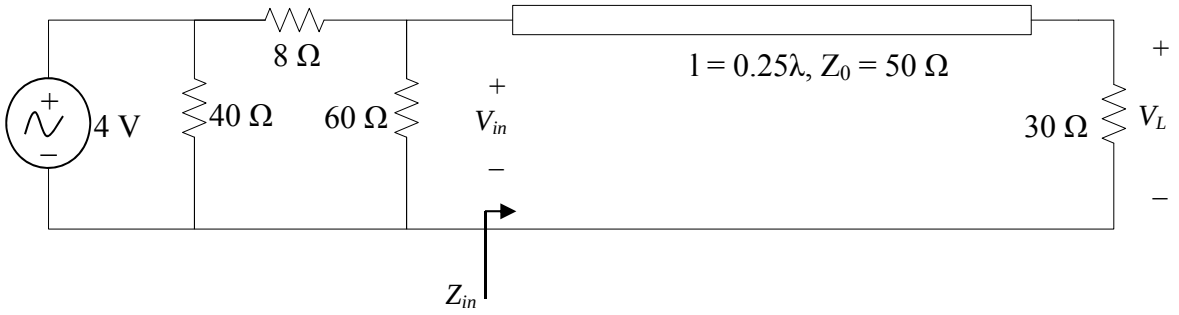
7. You may attach extra sheets to the exam if necessary. Each page should contain your name, the problem number, and the page number for that problem.

Please sign the statement below. YOU MUST SIGN THE STATEMENT OR YOU WILL GET A ZERO FOR THIS EXAMINATION!!!

I hereby testify that I have neither provided or received information from unauthorized sources during the test and that this test is the sole product of my effort.

Signed _____ Date_____

PROBLEM 1 (20 points): Consider the circuit given below containing a lossless transmission line terminated in a 30 Ω load. An AC voltage source of 4 V (peak) is used (the phasor representation is $4e^{j0^\circ}$ V). Do not use the Smith Chart to solve this problem; use the necessary formulas.



(a) Find Z_{in}, the input impedance to the transmission line (5 points).

(b) Find the phasor voltage V_{in} at the input to the transmission line segment (5 points).

(Problem 1 continued on next page.)

(c) What is the total power delivered to the load (in W) (5 points)?

(d) What is the phasor expression for V_L, the total voltage across the load (5 points)?

PROBLEM 2 (20 points): Find all four S-parameters, referenced to $Z_0 = 50\ \Omega$, for the following network:

$l = 0.25\lambda$, $Z_0 = 110\ \Omega$

Port 1 Port 2

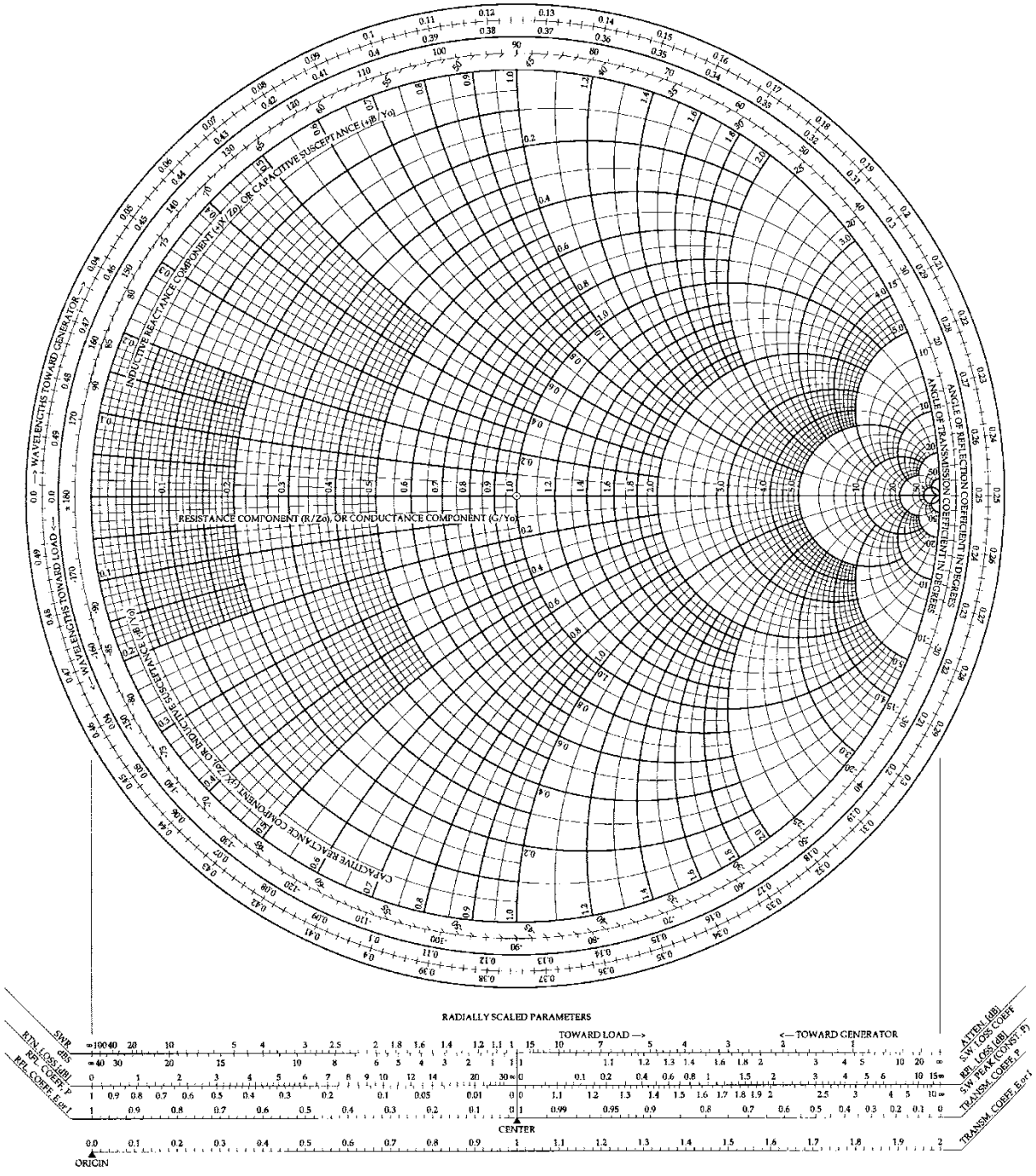
Note that the network is physically symmetric; therefore, $S_{22} = S_{11}$ and $S_{12} = S_{21}$.

(Extra Workspace for Problem 2):

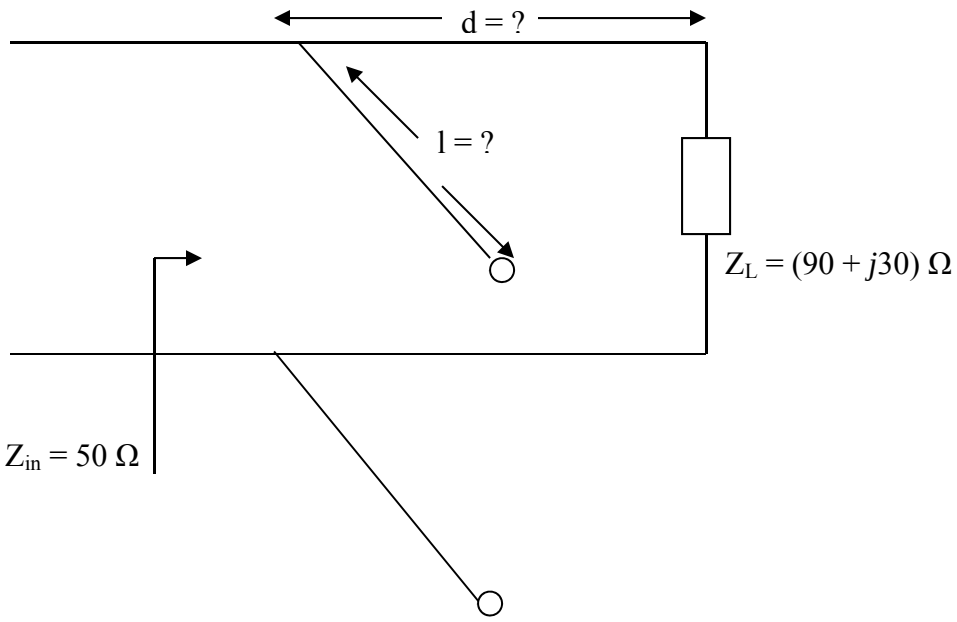
PROBLEM 3 (20 points): Use the Smith Chart on the next page to design a lumped element, lossless, L-section matching network to match a load impedance of $Z_L = (30 + j5)\ \Omega$ to a line with a characteristic impedance of $Z_0 = 50\ \Omega$ at a frequency of 1.6 GHz. Draw this matching network with the elements and their values clearly indicated.

The Complete Smith Chart

Black Magic Design

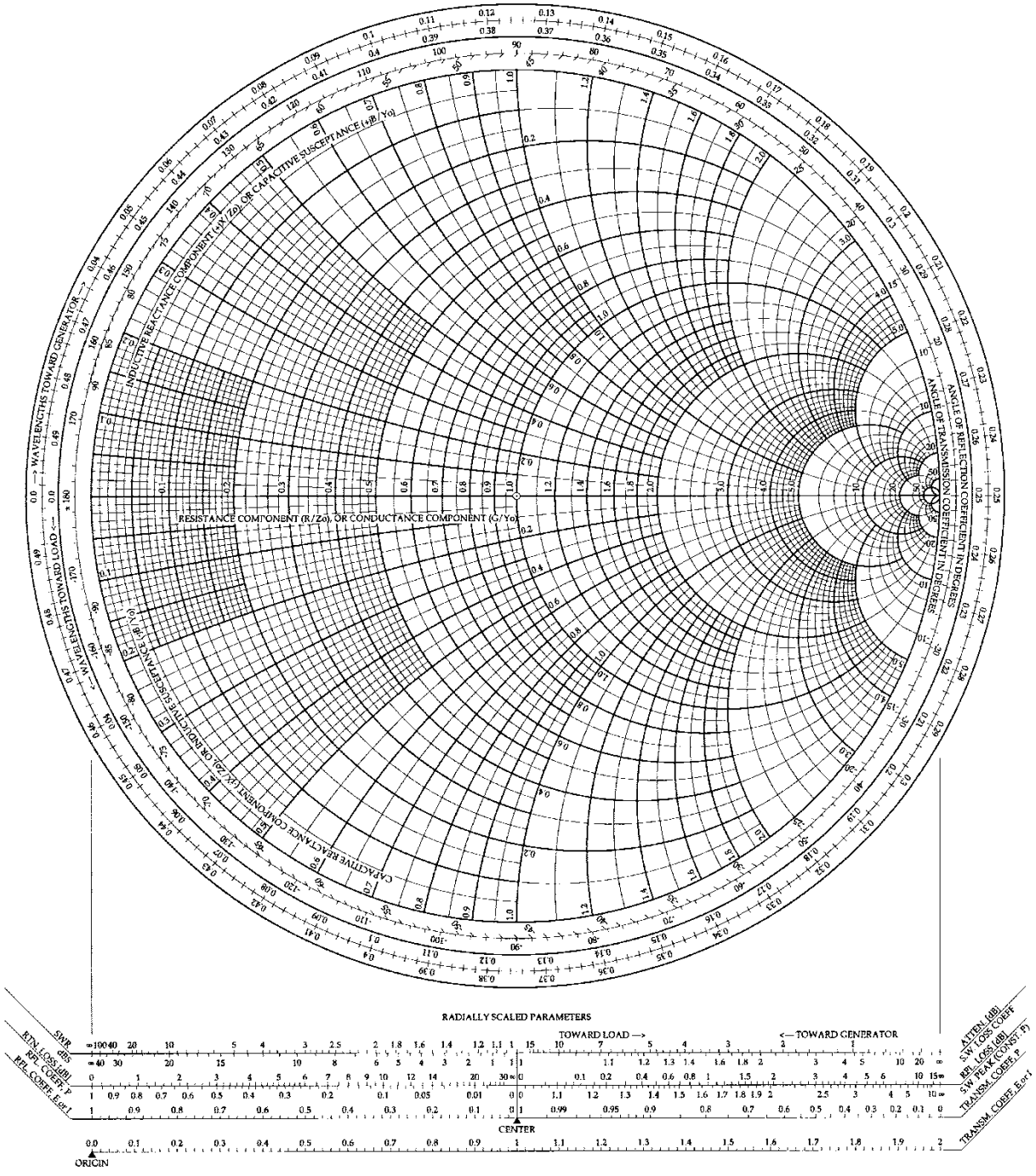


PROBLEM 4 (20 points): Use single-stub impedance matching techniques with the Smith Chart on the following page to provide $Z_{in} = 50\ \Omega$. Use an open-circuit stub and find d and l in terms of λ. Use $Z_0 = 50\ \Omega$ for all transmission lines.



The Complete Smith Chart

Black Magic Design



PROBLEM 5 (20 points): A 28 Ω load must be matched to a 50 Ω line.

(a) What is the characteristic impedance of a single-section quarter-wave transformer to perform this matching (5 points)?

(b) What is the percent bandwidth of the quarter-wave transformer for which the magnitude of the input reflection coefficient to the matching section $|\Gamma_{in}| \leq 0.2$ (5 points)?

(c) Design a binomial matching network with N = 3 sections. Draw a diagram of the network, with line lengths (in wavelengths) and characteristic impedances clearly given (10 points).

(continued on next page)

(Extra Workspace for Problem 5):