ECE ECE145A (undergrad) and ECE218A (graduate)

Mid-Term Exam. November 12, 2014

Do not open exam until instructed to.

Open notes, open books, etc

You have 1 hr and 15 minutes.

Use any and all reasonable approximations (5% accuracy is fine.) , ***AFTER STATING THEM.***

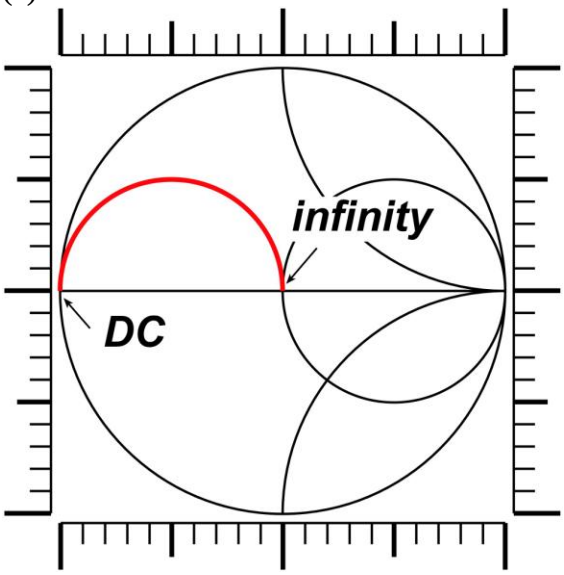
Problem	Points Received	Points Possible
1		15
2a		10
2b		15
3a		10
3b		10
3c		10
4		15
5		15
total		100

Name: _____

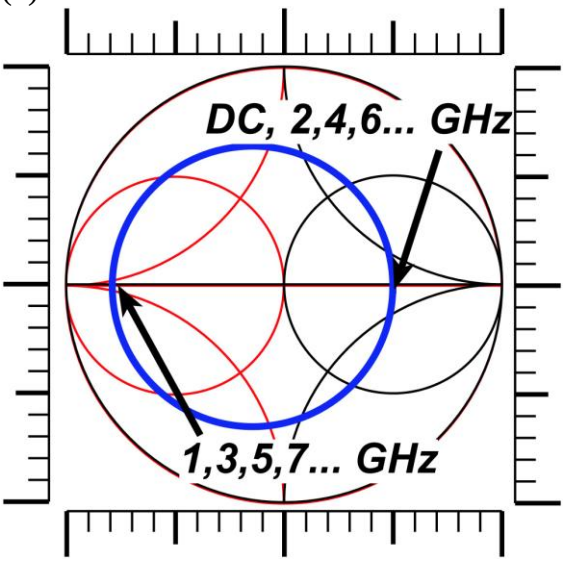
Problem 1, 15 points
The Smith Chart and Frequency-Dependent Impedances.

HINT: use the scales on the figures to measure distances as needed.

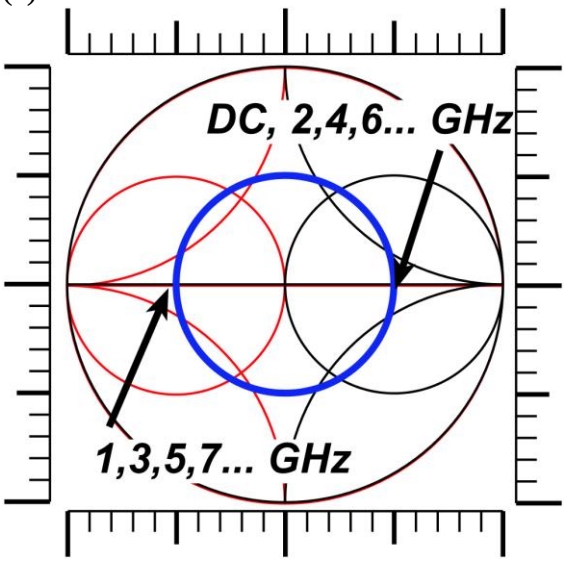
(a)



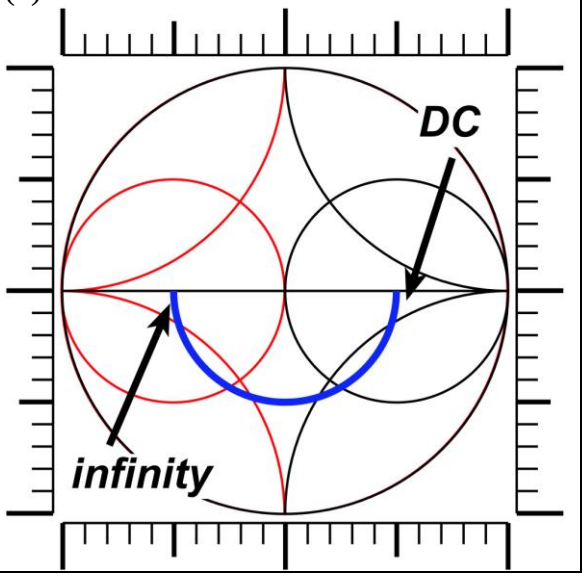
(b)



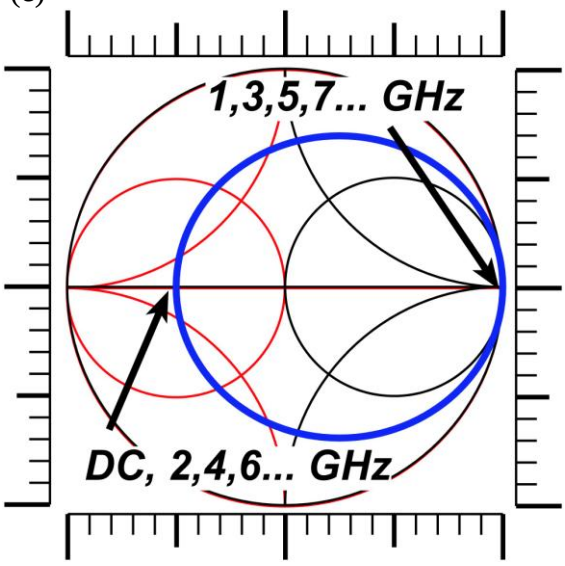
(c)



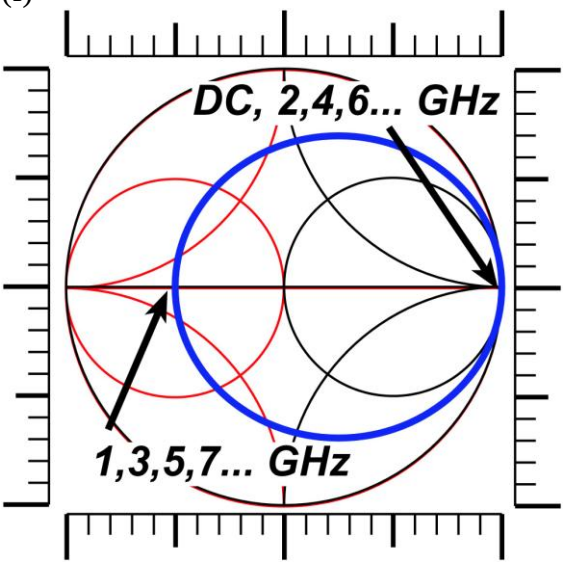
(d)



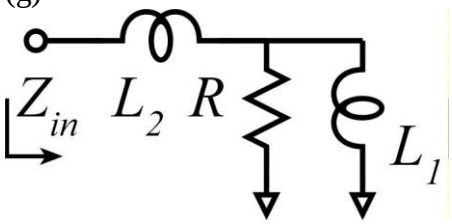
(e)


1,3,5,7... GHz
DC, 2,4,6... GHz

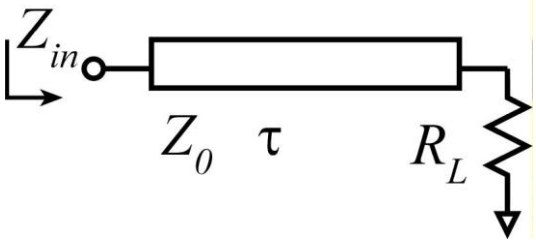
(f)


DC, 2,4,6... GHz
1,3,5,7... GHz

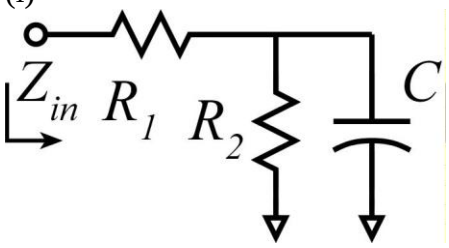
(g)


Z_{in}
L_2
R
L_1

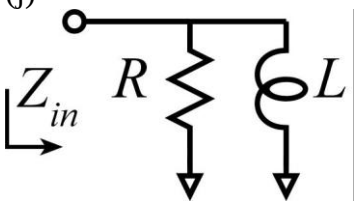
(h)

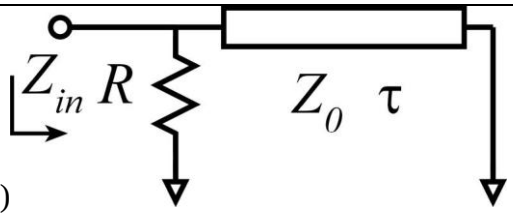

Z_{in}
Z_0
τ
R_L

(i)

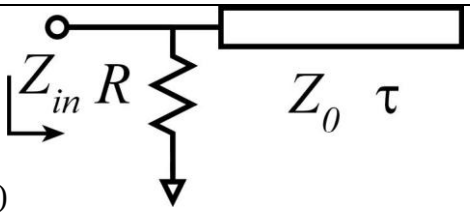

Z_{in}
R_1
R_2
C

(j)


Z_{in}
R
L


Z_{in}
R
Z_0
τ

(k)


Z_{in}
R
Z_0
τ

(l)

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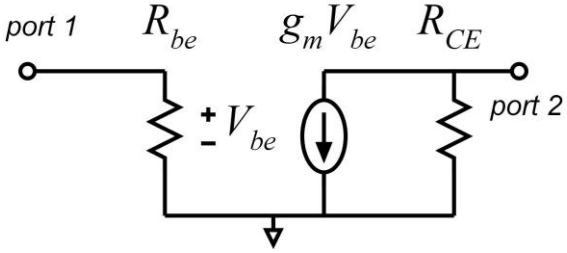
First match each Smith Chart with each circuit. ***Then determine as many component values as is possible*** (RLC values, transmission line delays and characteristic impedances)...note that some values cannot be determined with the information given. The charts all use 50 Ohm normalization:

Smith chart (a). Circuit=_____. Component values=_____
Smith chart (b). Circuit=_____. Component values=_____
Smith chart (c). Circuit=_____. Component values=_____
Smith chart (d). Circuit=_____. Component values=_____
Smith chart (e). Circuit=_____. Component values=_____
Smith chart (f). Circuit=_____. Component values=_____

Problem 2, 25 points
2-port parameters and Transistor models

Part a, 10 points
For the network at the right, give algebraic expressions for the four Y-parameters and for the four S-parameters.

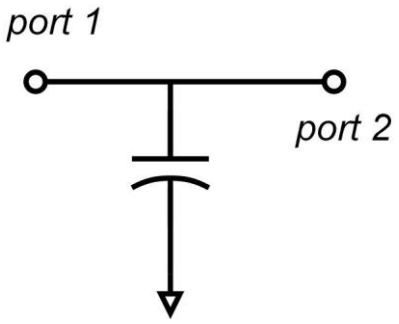
Assume a normalization to impedance Zo for the S parameters.



Part b, 15 points

First, compute S11 and S21, both as a function of frequency, for this network.

Second, a find the frequency at which S21 has a magnitude of 0.7071, i.e. is down 3dB from the DC value.

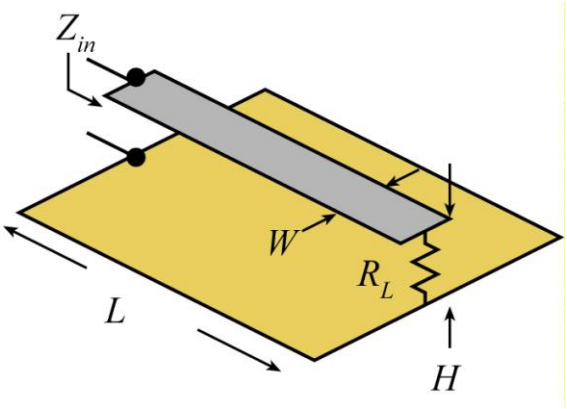


Problem 3, 30 points
Transmission-line theory

Hint: we are testing here your understanding of transmission-lines and their relationships to lumped elements. If the calculation appears to be extremely difficult, you may possibly be missing some key insight.

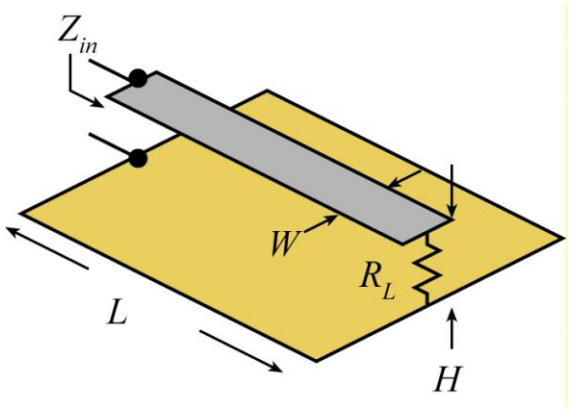
Part a, 10 points
Ignoring fringing fields, you have a microstrip line of 3cm length, 5mm width and 1 mm height above a ground plane. The dielectric constant is 1.0.

Find the characteristic impedance of the line, the velocity, the total line inductance, and the total line capacitance.



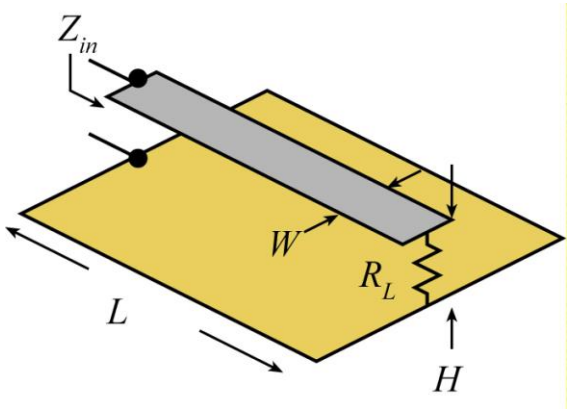
Part b, 10 points

If the line is loaded by RL=1 Ohms, find an approximate value for Zin at 100MHz signal frequency. Hint: wise use of approximations will make this calcualtion easy.



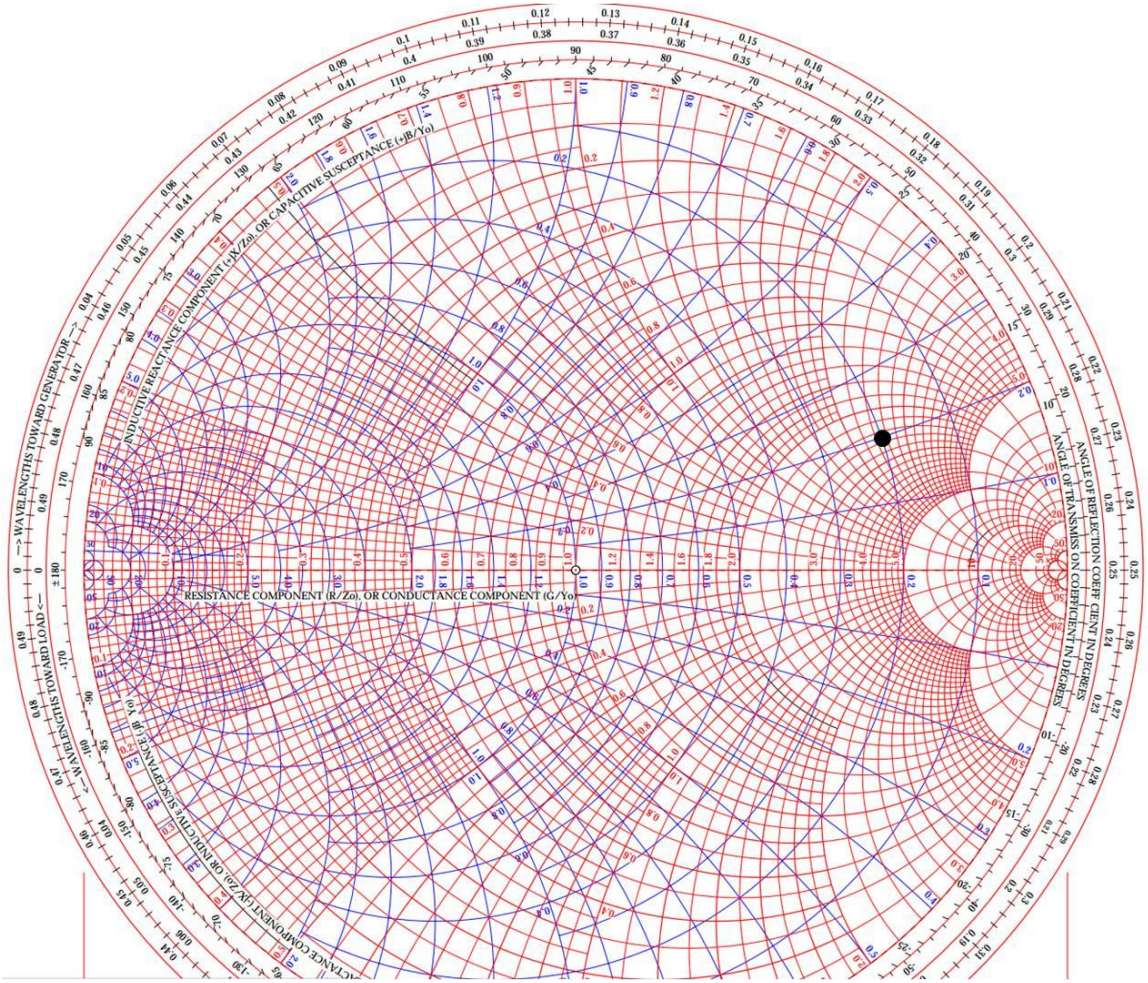
Part c, 10 points

If the line is loaded by RL=1 Ohms, find the value for Zin at 2.5GHz signal frequency.



Problem 4, 15 points
Impedance-matching exercise.

The (50 Ohm normalization) Smith chart gives the input impedance of a circuit at 1 GHz signal frequency. Design a lumped-element matching network which converts this impedance to **50Ohms** at 1 GHz. Give all elment values.



Problem 5, 15 points
Signal flow graphs

We have a cascade of two amplifiers, "x" and "y". The signal flow graph is also shown.

Find S11 and S21 of the resulting combination.