ECE ECE145A (undergrad) and ECE218A (graduate)

Mid-Term Exam. November 8, 2011

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		20
2a		10
2b		10
2c		10
3a		15
3b		10
4		25
total		100

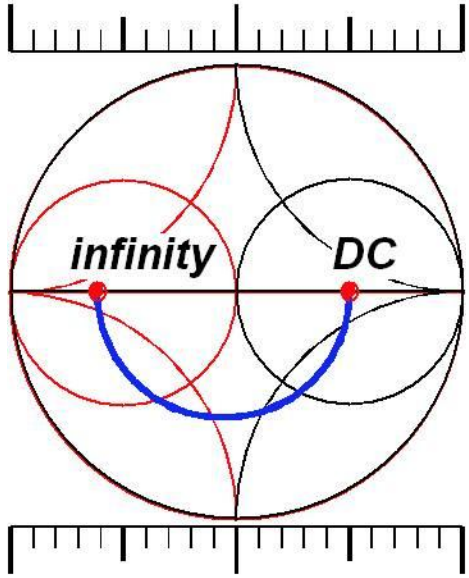
Name: ________________________

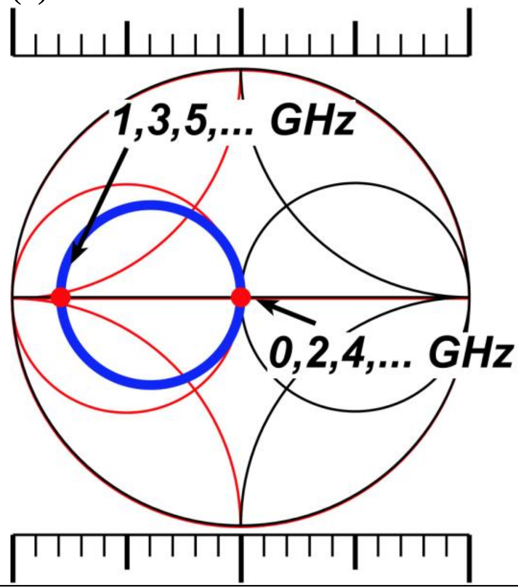
Problem 1, 20 points

The Smith Chart and Frequency-Dependent Impedances.

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

<table>
<tr><td>(a)


</td><td>(b)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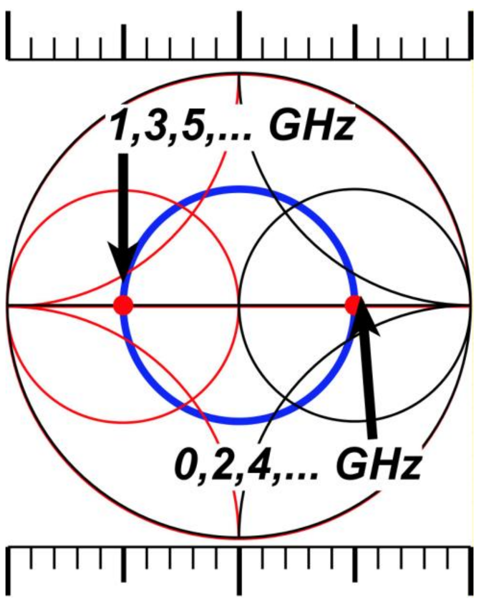
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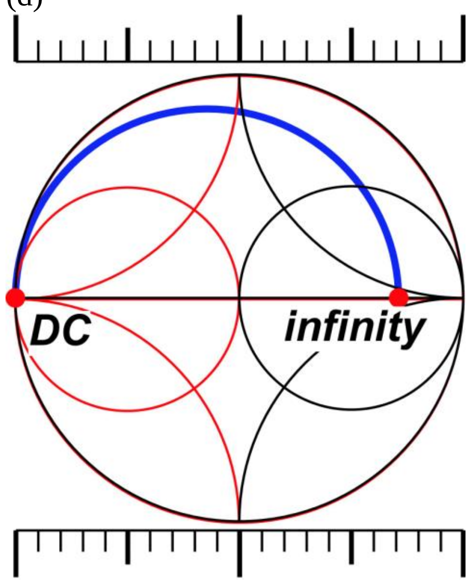
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<tr><td>(e)</td><td>(f)</td></tr>
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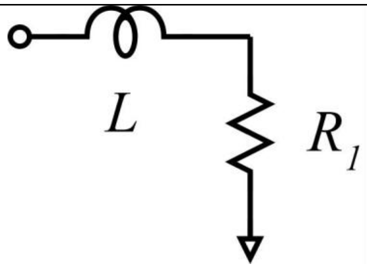
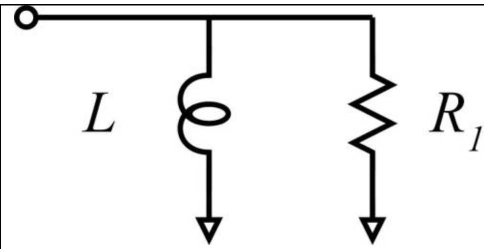
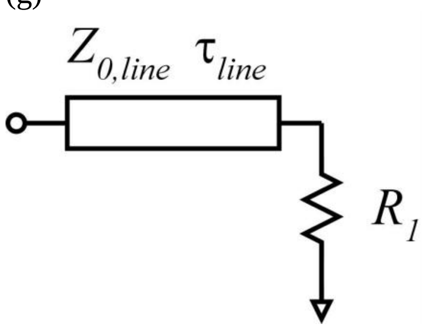
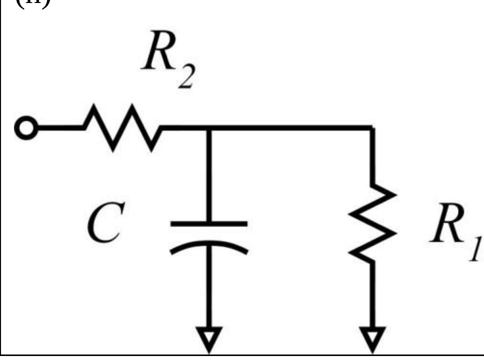
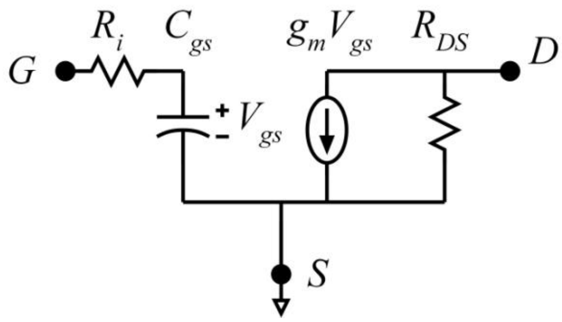
	
(g) 	(h) 

Match each Smith Chart with each circuit, and give all resistor values, and all transmission line delays and characteristic impedances. 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=_____________________

Problem 2, 40 points
Elementary impedance matching network design.



To the left is the equivalent circuit of a FET. The Transconductance is 100 mS, Ri=10 Ohms, C_{gs} =100 fF, R_{DS} =100 Ohms

Part (a), 15 points.

Using the impedance-admittance charts that have been passed out, design a lumped-element matching network to match the input impedance to 50 Ohms at 10 GHz. Use a series inductor and a shunt capacitor. Give the circuit diagram and the element values.

Part (b), 15 points.

Using the impedance-admittance charts that have been passed out, design a lumped-element matching network to match the output impedance to 50 Ohms at 10 GHz. Use a shunt inductor and a series capacitor. Give the circuit diagram and the element values.

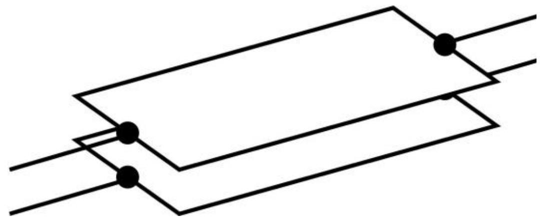
Part (c), 10 points

Now instead design a quarter-wave line to match the load to 50 Ohms. Find the required line impedance and the physical length.

Problem 3, 25 points
Transmission-lines and lumped elements

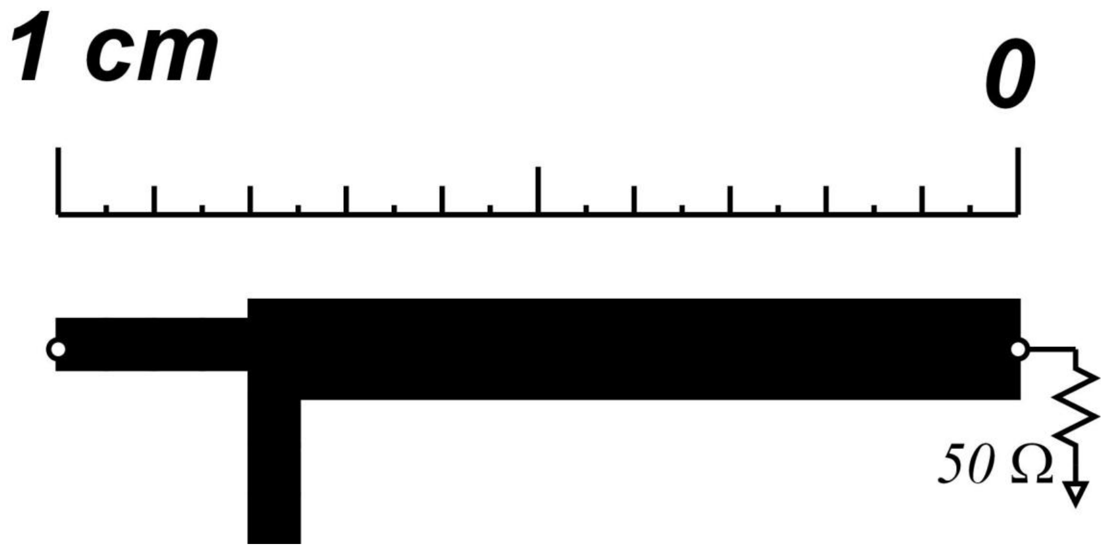
Part a: 5 points

A transmission line has plates of 300 μm width and 100 μm separation. The line is 1 cm long. The region between the plates has a dielectric constant of 2.0. Neglect the fringing fields at the edges of the plates.



Find the following:
characteristic impedance:____________
propagation velocity: ________________
propagation delay: ________________
total inductance: __________________
total capacitance: _________________

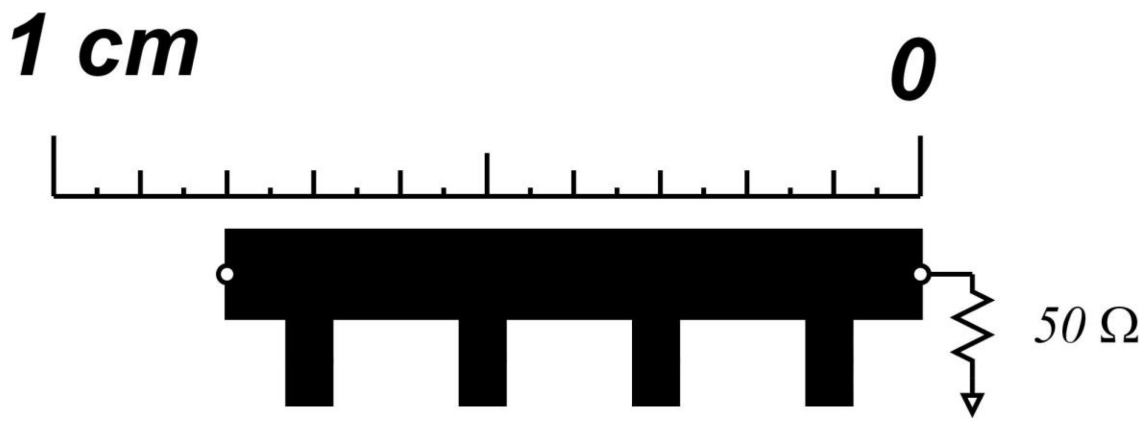
part b, 10 points



Above is an accurate scale drawing of a microstrip circuit. The dots represent the connection points. The circuit board is 0.25 mm thick and has a dielectric constant of 2.0. To approximately model fringing fields, the effective conductor width is taken as the physical conductor width plus the board thickness.

First, draw a transmission-line equivalent circuit for the circuit, giving all characteristic impedances and line propagation delays. ***Second***, assuming a signal frequency of 5 GHz, draw a second circuit diagram in which you replace line sections shorter than an eight-wavelength with T or Pi-section models, giving the computed values of all LC elements of these sections.

part c, 10 points



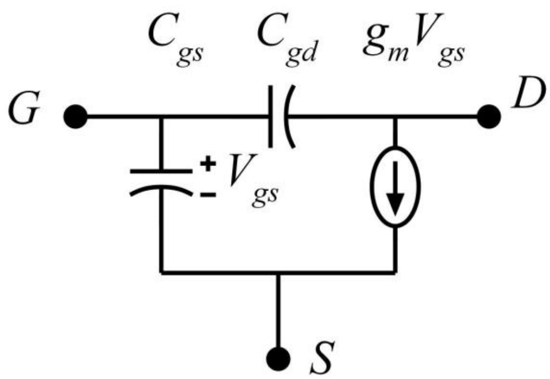
We now repeat the problem for the structure above.

First draw an equivalent circuit using transmission-line sections for all elements, giving all line impedances and delays.

Second draw a transmission line circuit where all elements are replaced by LC ***PI-sections***., giving the values of all L's and C's.

Third, neglecting the ***inductances*** of the ***shunt line elements***, please comment on the approximate behavior of the structure.

Problem 4, 15 points
resistive feedback amplifiers



A FET has a transconductance of 0.3 mS per micron of gate width.
$f_t = g_m /(2\pi(C_{gs} + C_{gd})$ is 100 GHz, and C_{gd} is 20% of C_{gs}.

Design a resistive feedback amplifier with 12 dB gain S21 for a 50 Ohm system using this FET. Draw the circuit diagram with all element values and determine the following:

FET width=_____________
transconductance=_______________
C_{gs} =______________________
C_{dg} =______________________
amplifier 3-dB bandwidth (from nodal analysis or the time constant method).