# ECE ECE145A (undergrad) and ECE218A (graduate)

## Mid-Term Exam. November 6, 2013

Do not open exam until instructed to.

Open notes, open books, etc

You have 1 hr and 15 minutes.

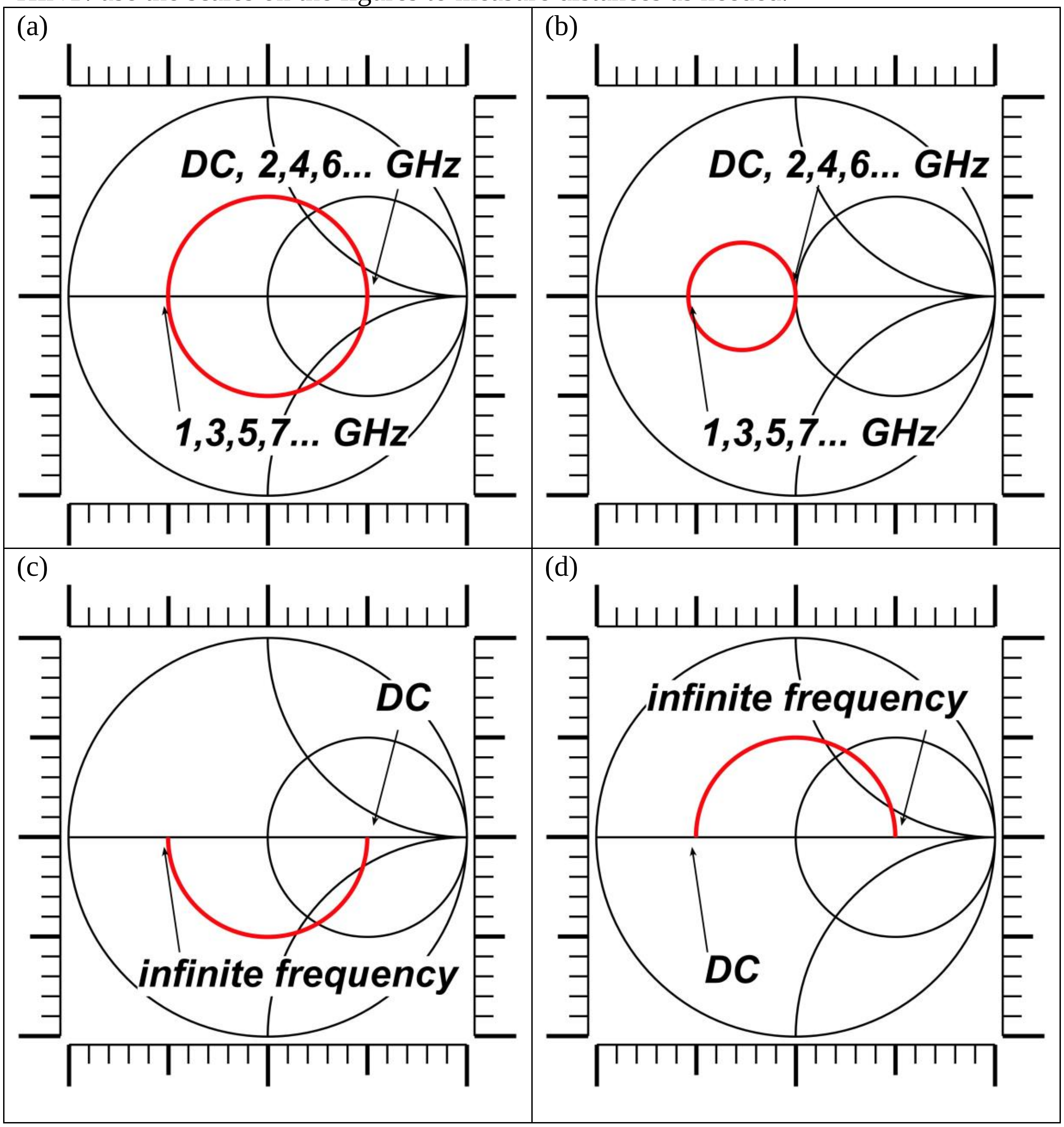
Use any and all reasonable approximations (5% accuracy is fine. ) , ***AFTER STATING THEM.***

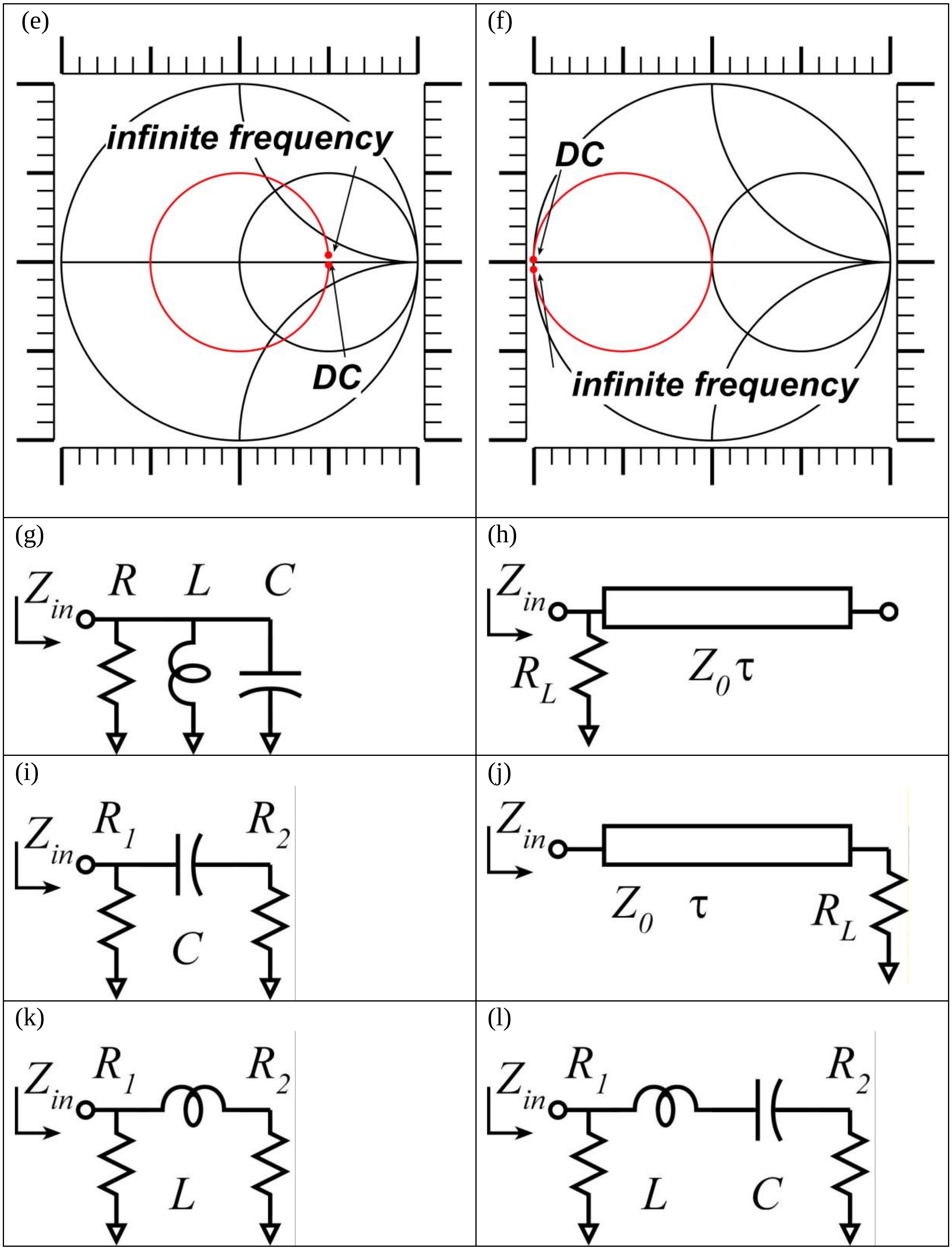
| Problem | Points Received | Points Possible |
|---|---|---|
| 1 | | 15 |
| 2a | | 10 |
| 2b | | 15 |
| 2c | | 10 |
| 3a | | 10 |
| 3b | | 10 |
| 3c | | 15 |
| 4 | | 15 |
| total | | 100 |

**Name: ________________________**

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

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




(e)
infinite frequency
DC
(f)
DC
infinite frequency
(g)
Z in
R
L
C
(h)
Z in
R L
Z 0 τ
(i)
Z in
R 1
R 2
C
(j)
Z in
Z 0
τ
R L
(k)
Z in
R 1
R 2
L
(l)
Z in
R 1
R 2
L
C

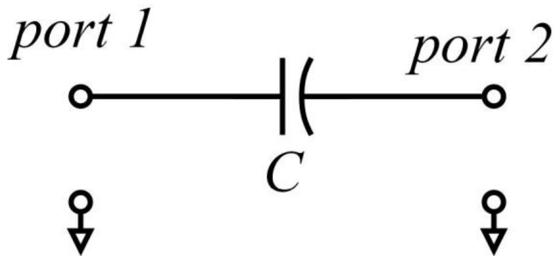
.

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, 35 points**
*2-port parameters and Transistor models*

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

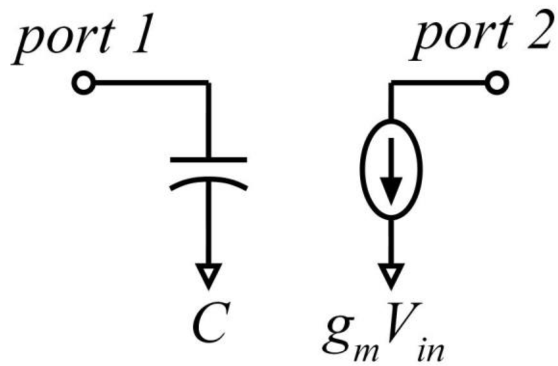



This might be a DC blocking capacitor. What value would you need for C if you wanted S21 = -3 dB at 100MHz in a 50 Ohm system ?

Part b, 15 points

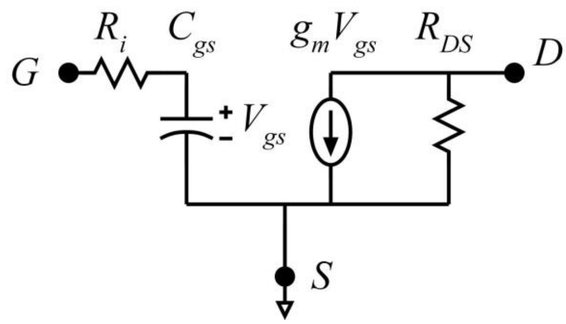
First, compute H21 and S21, both as a function of frequency, for this network.

Second, after assuming that gmZo>>1, find the frequency at which S21 has a magnitude of 1 and compare this to the current-gain cutoff frequency. Please then comment.



Part c, 10 points
Ri=10 Ohms, Cgs=1pF, gm=100 mS, Rds=100Ohms.

Calculate Y11 and Y21 at 1 GHz.

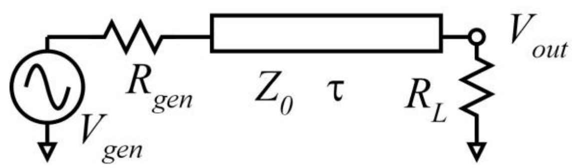


**Problem 3, 35 points**
*Transmission-line theory*

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

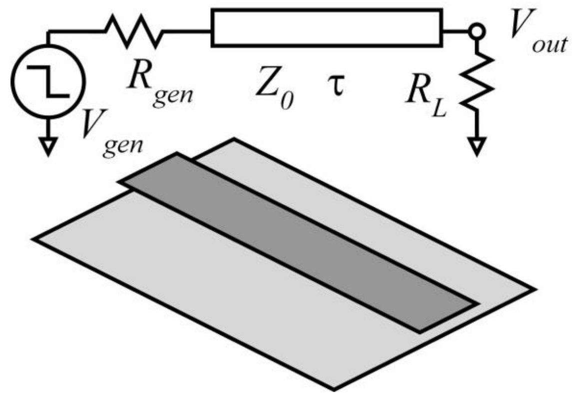
You are probing a circuit using a 9MOhm oscilloscope probe (Rgen) connected to a 1MOhm oscilloscope through 1 meter of coaxial cable. The cable has 50Ohms characteristic impedance and uses Polyethylene, with a dielectric constant of 2.25, to separate the conductors.




What is the -3dB frequency of this test setup ?

Part b, 10 points

You are connecting a high-current driver to pulse a solid-state laser. The generator is a 1V step-function with 0.1 Ohm output impedance. The load is 0.9 Ohm. Generator and load are connected with a signal conductor (dark grey) of 1cm width and 10 cm length, separated by 1 mm from a ground-plane/ground-return conductor. Find the pulse-response 10%-90% rise time.



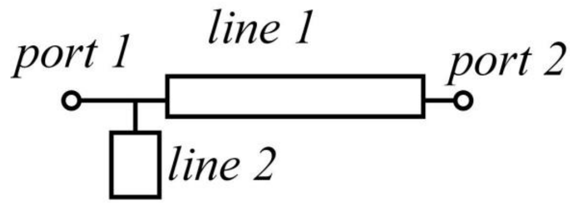

Approximate the effect of fringing fields at the edges of the conductors by assuming that the effective microstrip line width is the physical width plus twice the conductor-ground spacing.

Part c, 15 points

You are working with a Duriod board (dielectric constant of 2.4), 0.5 mm thick. Line 1 is 2 mm wide and 2 cm long. LIne 2 is 2 mm wide and 5 mm long.

First: find the characteristic impedance and propagation delay of both lines.

Second: assuming that the lines are both short in comparison with a quarter-wavelenght, draw a lumped-element equivalent circuit, calculating all element values.




Approximate the effect of fringing fields at the edges of the conductors by assuming that the effective microstrip line width is the physical width plus twice the conductor-ground spacing.

**Problem 3, 15 points**
*Impedance-matching exercise.*

The (50 OHm normalization) Smith chart gives the input impedance of a circuit at 10 GHz signal frequency. Design a lumped-element matching network which converts this impedance to **25Ohms** at 10 GHz. Give all elment values.