ECE ECE145A (undergrad) and ECE218A (graduate)

Mid-Term Exam. November 8, 2022

Do not open exam until instructed to.

Open notes, open books, etc.

You have 1 hour and 15 minutes.

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

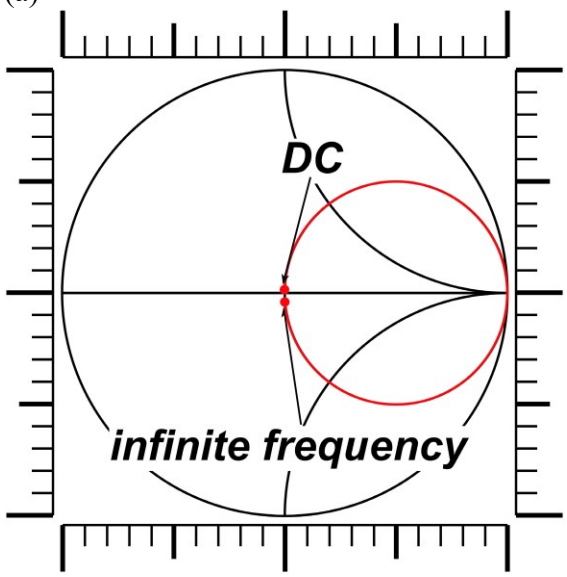
Problem	Points Received	Points Possible
1		15
2a		10
2b		7
2c		8
2d (218 only)		10 (218A only)
3a		5
3b		5
3c		7.5
3d		7.5
4		15
5a		10
5b (218 only)		15 (218A only)
6		10
total		100 (145), 125 (218A)

Name: _____

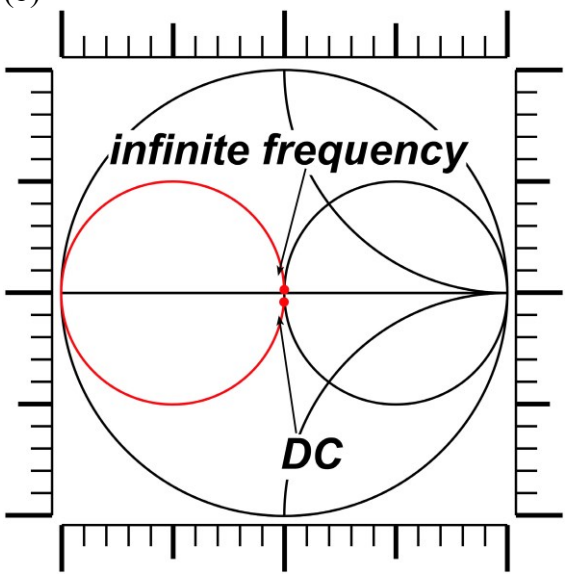
Problem 1, 15 points
The Smith Chart and Frequency-Dependent Impedances.

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

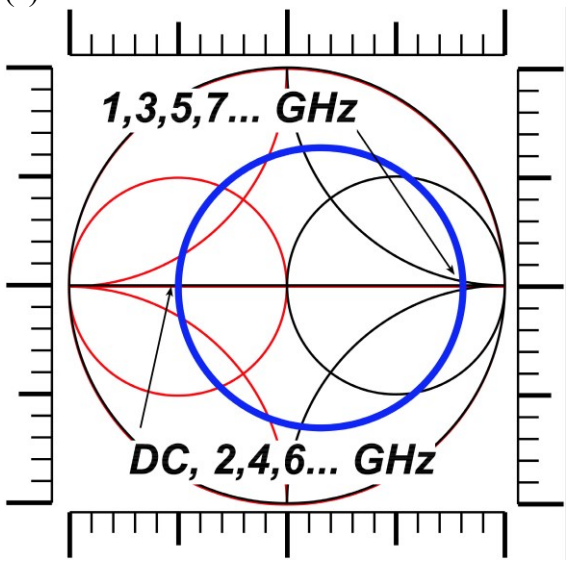
(a)



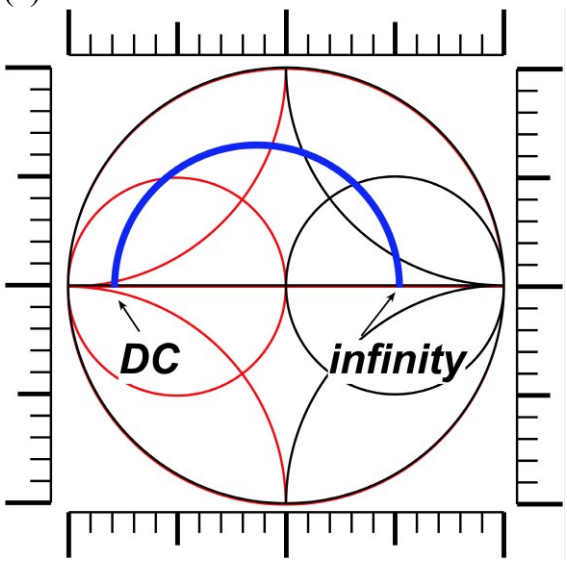
(b)

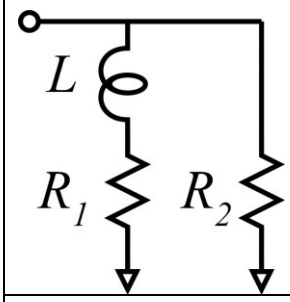
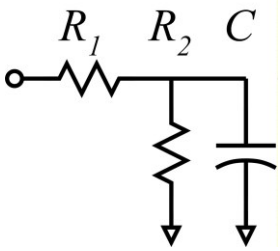
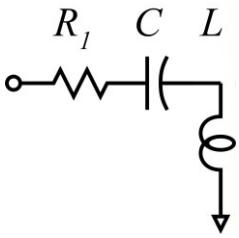
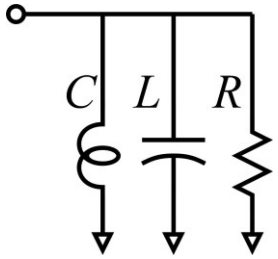
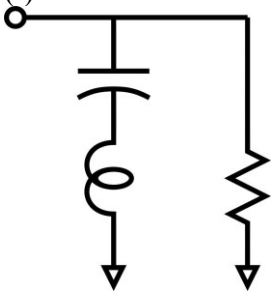
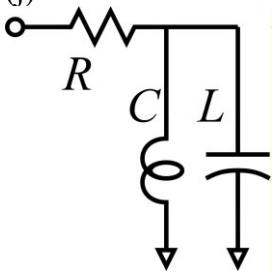
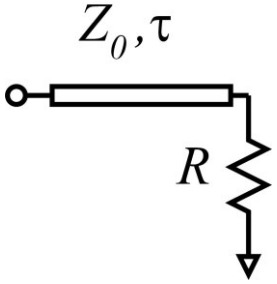
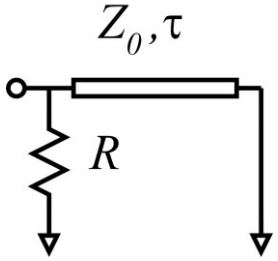
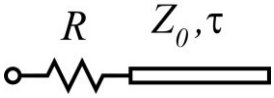
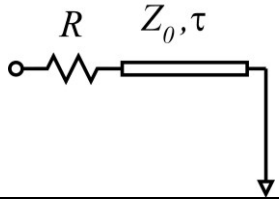


(c)



(d)



(e) 	(f) 	(g) 	(h) 
(i) 	(j) 	(k) 	(l) 
(m) 	(n) 		

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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: _____ , _____ , _____ ,

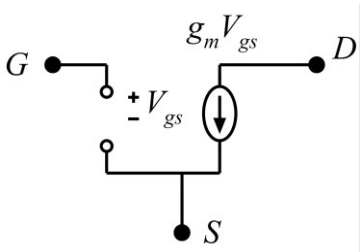
Smith chart (c). Circuit=_____.
Component values: _____ , _____ , _____ ,

Smith chart (d). Circuit=_____.
Component values: _____ , _____ , _____ ,

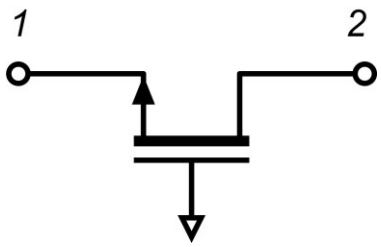
Problem 2, 25 points (ece145A), 35 points (ece218A)
2-port parameters and Transistor models

Part a, 10 points

At the right is the equivalent circuit for a FET. The transconductance gm is 1 mS.

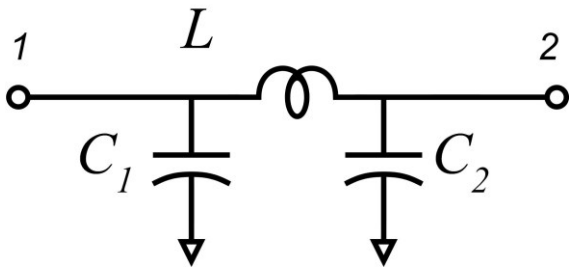


Now, given this model, for the network at the right, give the numerical values of S21 and S11. The reference Zo is 50 Ohms. .



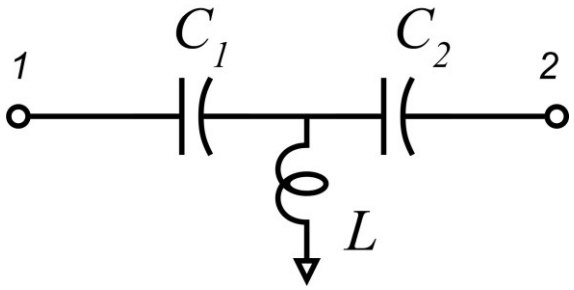
Part b, 7 points

Derive algebaic expressions for the four Y parameters for this network



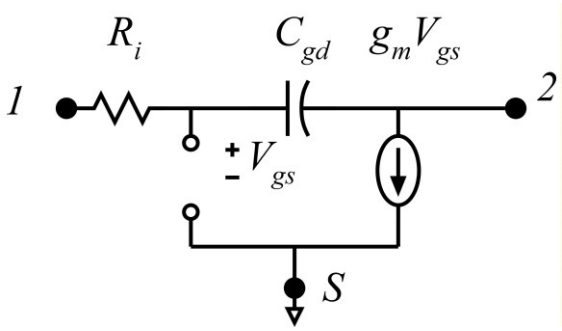
Part c, 8 points

Derive algebaic expressions for the four Z parameters for this network



Part d, ***ECE218A students only*** 10 points

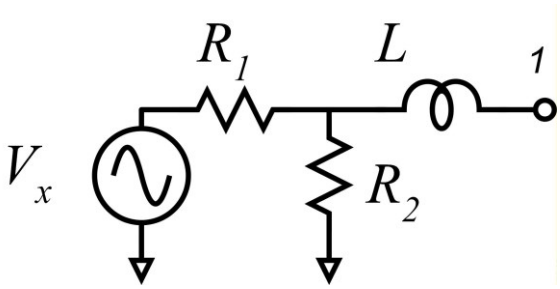
Compute the Y parameters for network, to second order in $j\omega C_{gd} R_i$. The Taylor series expansion $(1+\varepsilon)^{-1} = 1 - \varepsilon + \varepsilon^2 + O(\varepsilon^3)$ may be useful



Problem 3, 25 points (ECE145A), 25 points (ECE 218A)
Available source power relationships, lumped/distributed relationships.

Part a, 5 points
Vs is 2V RMS at 10GHz. R1 and R2 are both 50 Ohms, L is 0.795 nH.

At 10GHz, what is the available signal power ? Draw the circuit diagram of a load network, with element values specified, that would, when connected to the source, absorb this amount of power from the generator.



Part b, 5 points

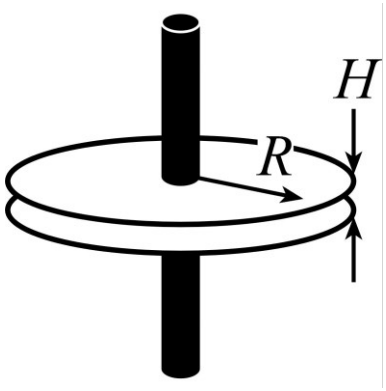
A coaxial cable has 50 Ohms characteristic impedance, is 10 meters long, and the insulating dielectric has a dielectric constant of 2.0.

a) What is the total capacitance of the cable ?

b) What is the total inductance of the cable ?

Part c, 7.5 points

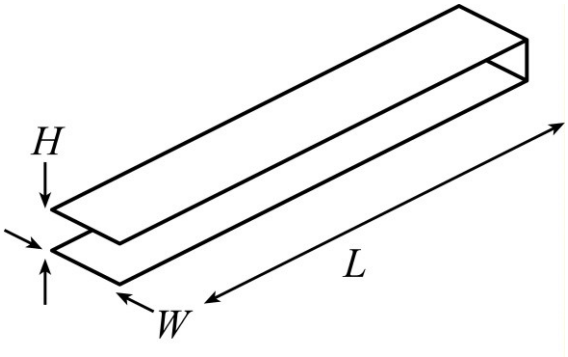
A capacitor has round plates of radius R=1 cm, and separation H = 0.1 mm. Between the plates is an insulator whose dielectric constant is 100.



a) What is the capacitor's impedance at 1 kHz ?
b) At what frequencies is the impedance infinity Ohms ?
c) At what frequencies is the impedance zero Ohms ?

Part d, 7.5 points

Using the approximate formula for transmission-line characteristic impedance, $Z_0 \simeq \frac{377\Omega}{\sqrt{\epsilon_r}} \frac{H}{H+W}$, if H=1 mm, W=5 mm, and L=10 cm, we have two metal plates that are short-circuited at a distance L from the drive point.



a) what is the approximate inductance between the two ends of the wire ?

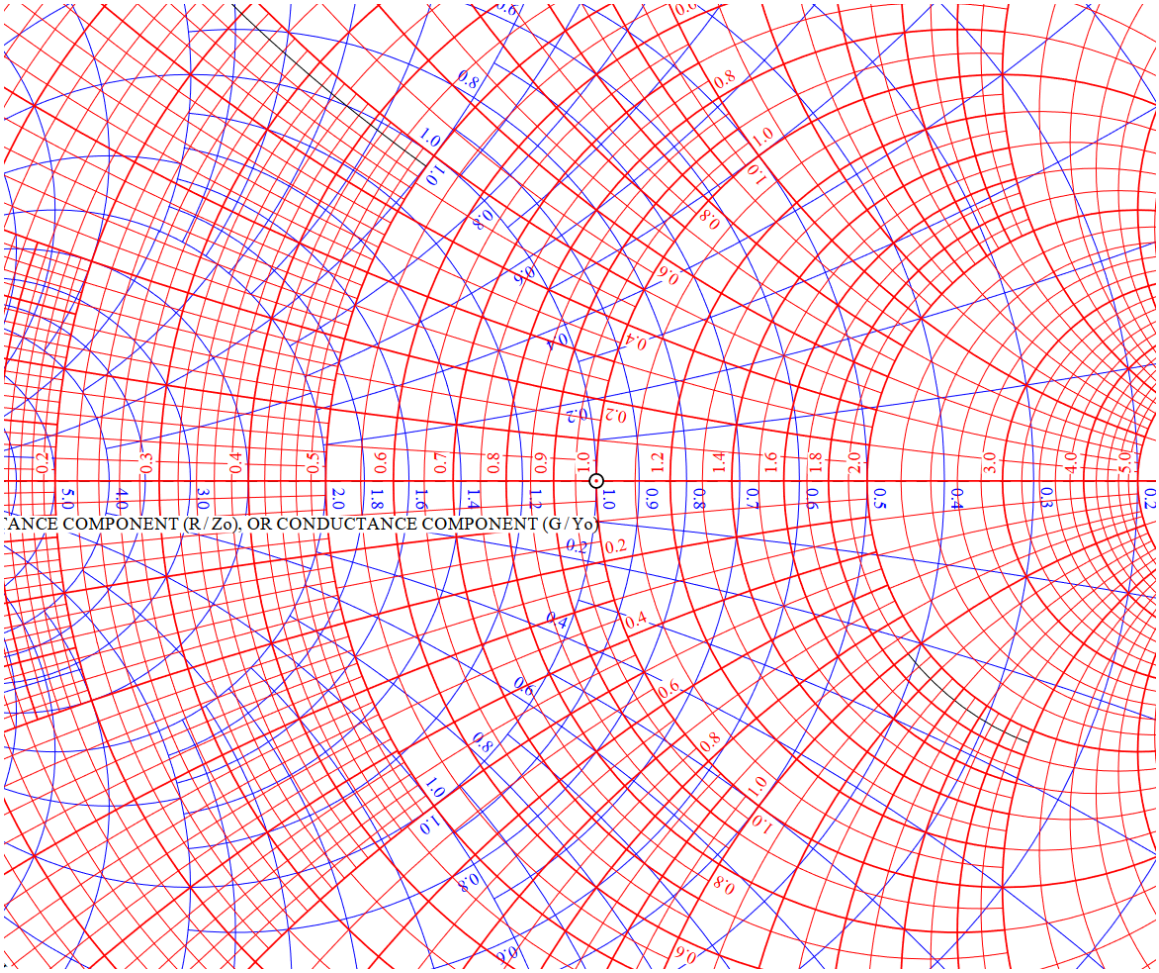
b) At what frequencies is the impedance infinity Ohms ?

c) At what frequencies is the impedance zero Ohms ?

Problem 4, 15 points
Impedance-matching exercise.

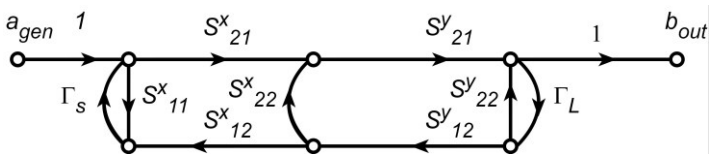
At 10GHz signal frequency, an antenna has an input impedance of 100+j0 Ohms. Design a matching network, using a series inductor and a shunt capacitor, which matches this impedance to 25 Ohms. Use a Smith chart with 50 Ohms impedance normalization

Give all element values. Either use a separate impedance-admittance chart , or use the attached one below..


ANCE COMPONENT (R / Zo), OR CONDUCTANCE COMPONENT (G / Yo)

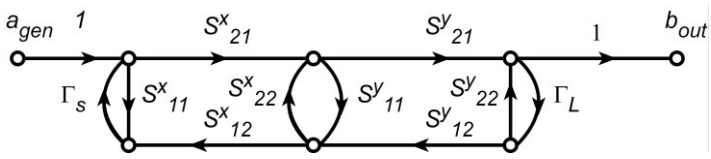
Problem 5, 10 points (ece145A), 25 points (218A)
Signal flow graphs

Part a, 10 points
Find b_{out}/a_{gen} for this network.



Part b, (218A only) 15 points

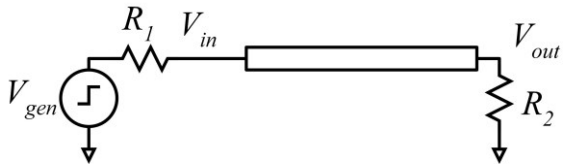
Find b_{out}/a_{gen} for this network.



Problem 6, 10 points

Transmission lines in the time domain.

Vgen is a 1V step-function occurring at t=0 seconds. Zline is 50 Ohms. The line is 2 meters long and has a diectric constant of 4.0.



R2 is zero Ohms
R1 is 50 Ohms.

Plot Vin (t) on the graph below.