Exam in Microwave Engineering (MCC121)

Friday, December 21, 2012

MCC121

Exam in **Microwave Engineering**

Friday, December 21, 2012, 1400 - 18:00, "V-salar"

Teachers: Jan Stake phone: 031 -772 1836
Vincent Desmaris phone: 031 -772 1846
During the exam, teacher will visit around 1430 and 1600.

Examiner: Prof. Jan Stake. Terahertz and millimetre wave lab., Department of microtechnology and nanoscience (MC2), Chalmers University of Technology.

The inspection of the results can be done in my office (D615), MC2-building, Monday, January 7th, 13:00-14:30. The final results will be sent to registrar office on January 11th, 2013.

This is an open book exam. The following is allowed:

- *Calculator (approved by Chalmers)*
- *"Microwave Engineering" by Pozar*
- *Mathematics handbook (Beta)*
- *Smith charts*

To pass this written examination, you need at least 24p out of 60p. Final grade of the course will also include results from assignment 1. That is: 3 (≥28p), 4 (≥42p) and 5 (≥56p).

Teamwork is not permitted on this examination. The university academic integrity policy will be strictly enforced. Failure to comply with the academic integrity policy will result in a zero for this examination.

Make sure you have understood the question before you go ahead. Write shortly but make sure your way of thinking is clearly described. It is imperative to clearly explain how the results have been obtained. Solve the problem as far as you can – constructive, creative and valuable approaches are also rewarded. Assume realistic numbers/parameters when needed if data is missing in order to solve the problem.

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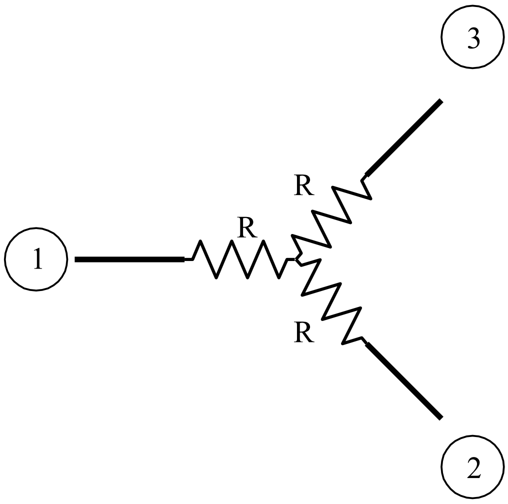
Problem 1

Prove that a short ($l < \lambda/12$) low impedance transmission line ($Z_0 < Z_L/3$) can be approximated as a shunt capacitor. Determine the value of this capacitor in terms of the line parameters.

(10p)

Problem 2

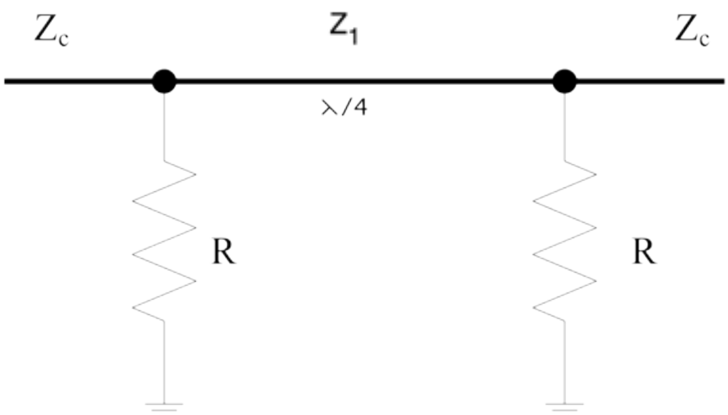
a. Design a three-port resistive power divider for an equal power split. The impedance level is 75Ω.
b. Calculate also the signal in port 3 if port 2 is mismatched and connected to 100Ω load. Assume other ports matched.
c. Has this leakage signal a significant influence on the performance of the power divider?



(10p)

Problem 3

The circuit below can be used as a simple attenuator. Just by soldering two shunt resistors, separated by a quarter wavelength, it is possible to make a quick-fix-attenuator without major modifications in a planar microstrip circuit.

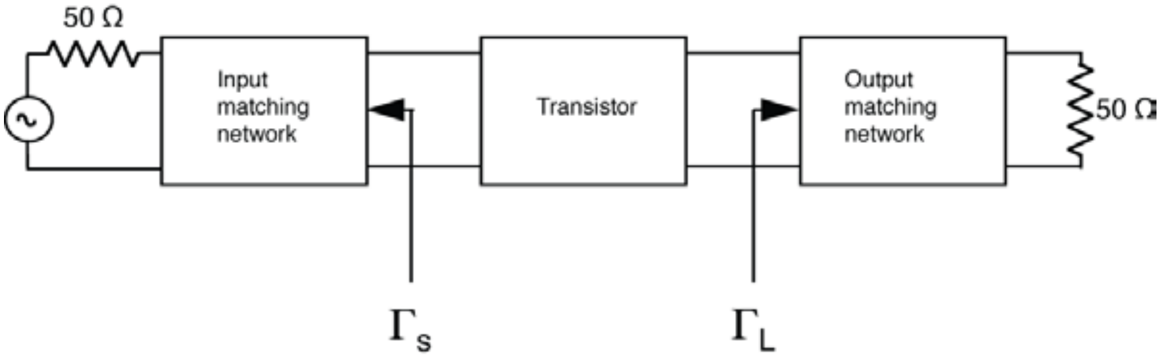


Determine a condition for Z_1 and R so the attenuator is matched. Calculate R and Z_1 to obtain 2dB attenuation. What's the return loss if you choose $Z_1=Z_c$?   ($Z_c=50\Omega$)

(10p)

Problem 4

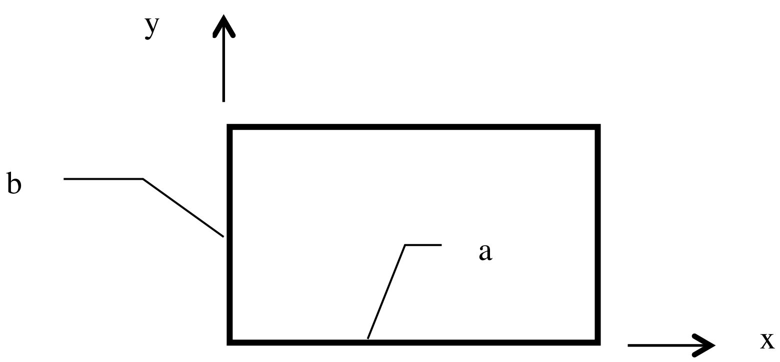
A transistor requires a source reflection coefficient of $\Gamma_S=0.5/\underline{166}°$for proving minimum noise figure in an amplifier circuit. Design the input matching circuit using distributed transmission lines, so embedding impedance corresponding to Γ_S is presented to the transistor as shown below. The amplifier will be used in a Z_c = 50 ohm system impedance environment.



(10p)

Problem 5

Consider a rectangular waveguide:



Select the ratio a/b to obtain the largest possible frequency range at the lowest possible attenuation for the dominant mode.

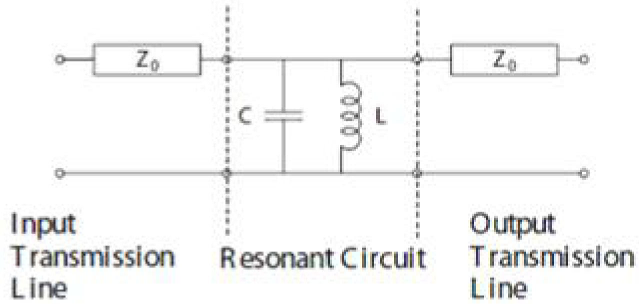
(10p)

Problem 6

Show that near resonance for the circuit below, the following approximations can be made:

$$|S_{21}|^2 = \frac{1}{1+Q^2\left(1-\left(\frac{w}{w_0}\right)^2\right)^2} \quad \text{or} \quad |S_{21}|^2 = \frac{1}{1+Q^2\left(1-\left(\frac{w_0}{w}\right)^2\right)^2}$$

Where Q is the loaded Q-factor and w_0 is the angular frequency of resonance.



What is S_{21} at resonance?

(10p)

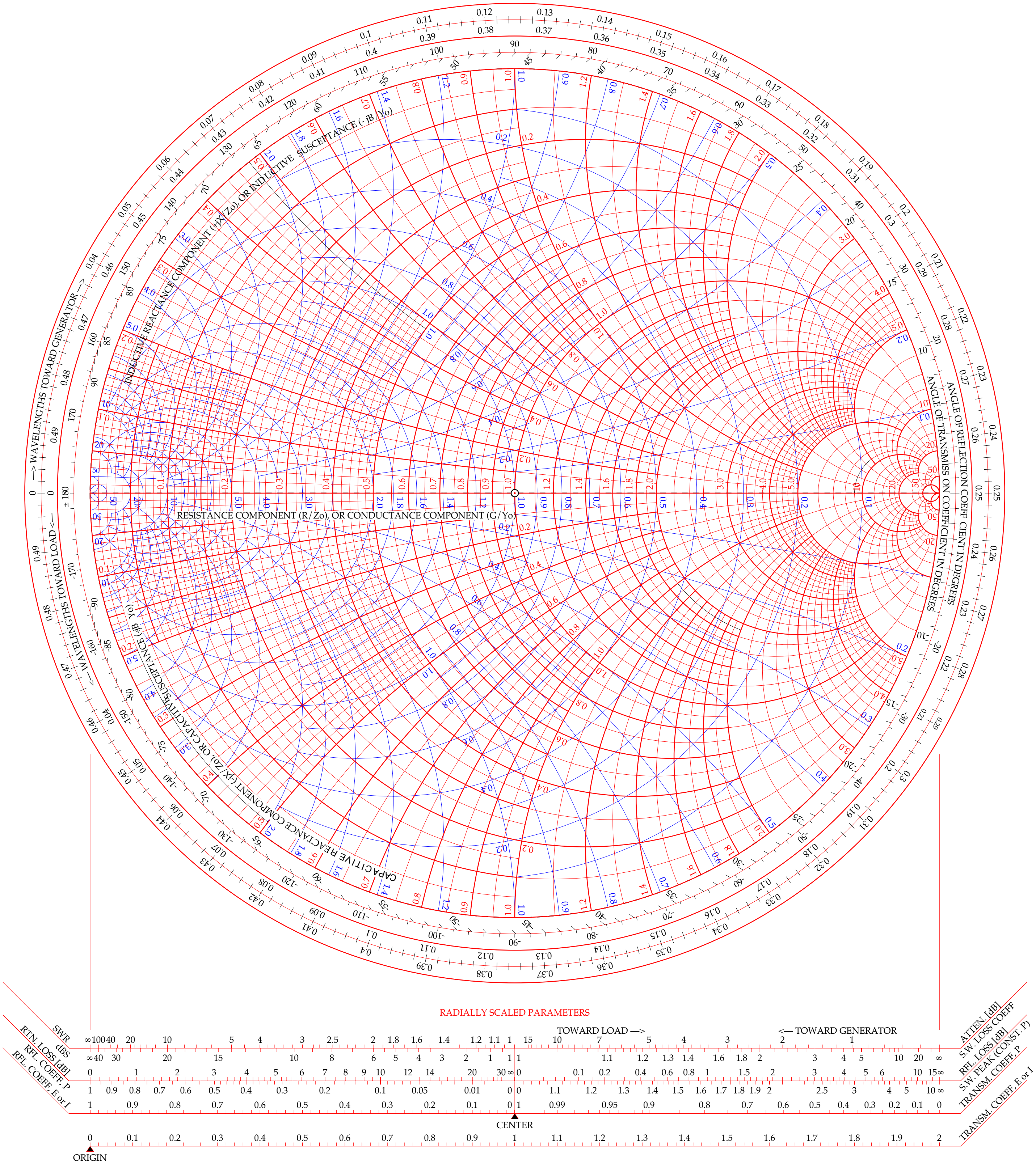
Good Luck! / JS

Enclosures:

1) Smith Charts

NAME	TITLE	DWG. NO.
		DATE
SMITH CHART FORM ZY-01-N	COLOR BY J. COLVIN, UNIVERSITY OF FLORIDA, 1997	

NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES



The Complete Smith Chart

Black Magic Design