MCC120

Microwave Electronics, Chalmers University of Technology, MC2, building B, 6th floor.

Exam in **FOUNDATIONS FOR MICROWAVE ENGINEERING** for MPMPE and E4/F4

Tuesday, December 14, 2010, 8:30-12:30, M building

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Questions: Docent Piotr Starski tel.: 031-772 17 34

Solutions are in my office.
The inspection of the results can be done in my office on Tuesday, January 4, 2011, 10:30-11:30.
The final results will be sent to registrar office on Monday, January 10, 2011.
The limits for the grades are as follows:

- ***7.5** credits* ➔ *grade **3***
- ***11** credits* ➔ *grade **4***
- ***14.5** credits* ➔ *grade **5***

The following items are allowed on the examination:

- ***Any type of calculator***
- ***Copies of the lectures viewgraphs***
- ***"Foundations for microwave engineering" by Collin***
- ***A conversion table distributed in the tutorials***
- ***Mathematical tables***

It is imperative to clearly explain how the results have been obtained

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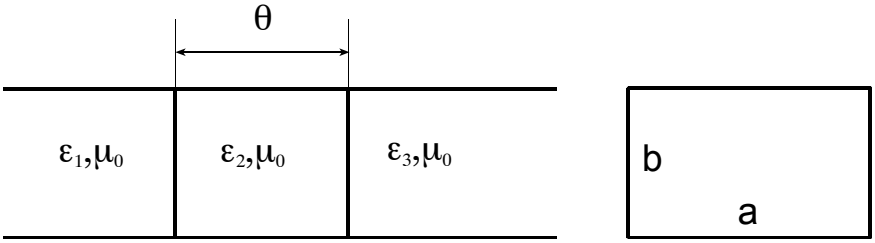
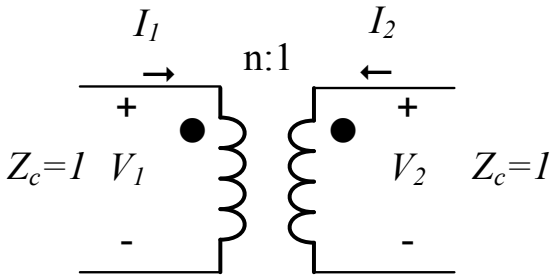
1. A rectangular waveguide is filled with three different dielectrics: ε_1, μ_0, ε_2, μ_0 and ε_3, μ_0



We know also, that $\varepsilon_1 < \varepsilon_2 < \varepsilon_3$. Calculate the length of the section in the middle, θ, and ε_2, to obtain maximal power transfer at center frequency from the left to the right. Assume that the waveguide is working in the dominant mode and a=2b.

2. We have an air filled circular waveguide. The waveguide is excited in *TM* modes. Calculate the frequency *f* as a function of cut-off frequency f_c to obtain the lowest possible attenuation (consider only metallic losses).

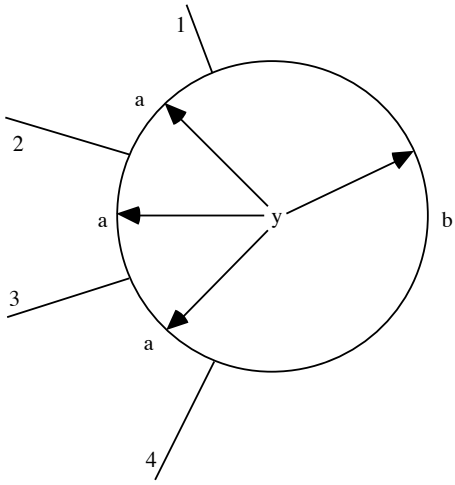
3. For an ideal transformer



derive the s matrix starting from the given currents and voltages.

4. Consider a 3 port network which is lossless and reciprocal. We know that $s_{13}=s_{23}$ and $s_{11}=s_{22}$. Port 2 of the network is loaded with a matched load. Show that by loading port 3 with an appropriate reactance port 1 can be matched.

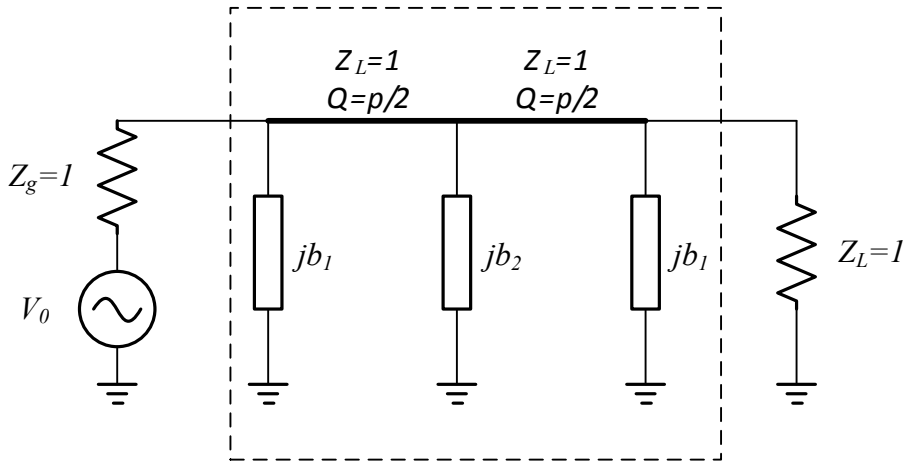
5. Analyze the circuit below:



$a = \lambda/8_{f=f_0}$, $b = 5\lambda/8_{f=f_0}$

The ring has normalized admittance y. Calculate s parameters if the ring is fed in port 1. Calculate y to obtain around 3 dB power split (exact equal power split is not possible).

6. Consider the circuit below:



Calculate b_2 as the function of b_1 if the circuit in the dashed lines is matched. What is the transmission phase of this circuit expressed in b_1? Is it possible to have different components at match, i.e. inductor or capacitor at the same time as b_1 and b_2?