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7/07/17

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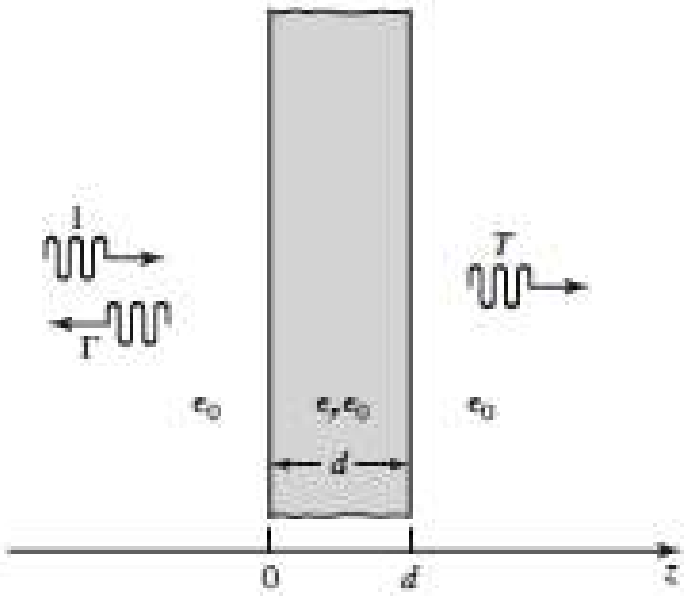
Exercise 1

A plane wave is normally incident on a dielectric slab of permittivity ε_r and thickness d, where $d=\lambda_0/(4(\varepsilon_r)^{1/2})$, and λ_0 is the free-space wavelength of the incident wave, as shown in the figure. If free-space exists on both sides of the slab, find the reflection coefficient of the wave reflected from the front of the slab.



Microwave Engineering

7/07/17

Last name:	First name:

Exercise 2

An attenuator can be made using a section of waveguide operating below cut-off. If a=2.286 cm and the operating frequency is 12 GHz, determine the required length of the below cut-off waveguide to achieve an attenuation of 100 dB. Ignore the effects of reflection at input and at output.

Microwave Engineering

7/07/17

Last name:	First name:

Exercise 3

A four port network has the scattering matrix shown below:

- Is the network lossless?
- Is the network reciprocal?
- Compute the reflection coefficient at port 1 when all other ports are matched.
- Compute the reflection coefficient at port 1 with port 3 short circuited and port 2 and 4 matched.

$$S = \begin{bmatrix} 0.1\, e^{j\pi/2} & 0.6\, e^{-j\pi/4} & 0.6\, e^{j\pi/4} & 0 \\ 0.6\, e^{-j\pi/4} & 0 & 0 & 0.6\, e^{j\pi/4} \\ 0.6\, e^{-j\pi/4} & 0 & 0 & 0.6\, e^{-j\pi/4} \\ 0 & 0.6\, e^{j\pi/4} & 0.6\, e^{-j\pi/4} & 0 \end{bmatrix}$$

Microwave Engineering

7/07/17

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Exercise 4

Derive an expression for the Q of a transmission line resonator consisting of a short-circuited transmission line 1λ long.