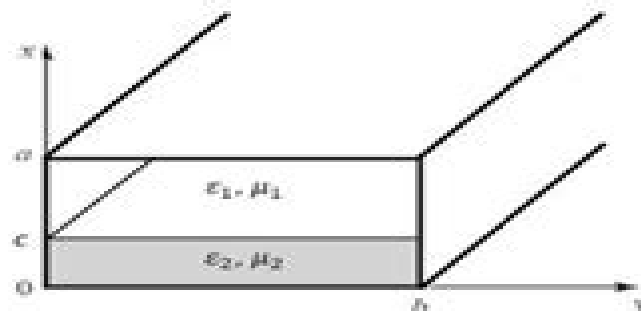


Question 5

Consider that the rectangular waveguide is partially filled with dielectric medium 2 from $x = 0$ to $x = c$ and partially filled with medium 1 from $x = c$ to $x = a$ ($a < b$ and $0 < c < a$).



(a) Show that any mode TE_x or TM_x will fail to satisfy the boundary conditions, except for the $TE_{x_{m0}}$ case. Solve for the $TE_{x_{m0}}$ mode and find the transcendental equation that governs the propagation constant given by:

$$\frac{\mu_2}{k_{2x}} \tan(k_{2x}c) + \frac{\mu_1}{k_{1x}} \tan(k_{1x}(a-c)) = 0,$$

where $k_{1x} = \sqrt{k_1^2 - \beta^2}$, and $k_{2x} = \sqrt{k_2^2 - \beta^2}$

(b) For the $TE_{x_{m0}}$ mode, what are the wave impedances in the two regions?

(c) Find the hybrid modes (having both E_z and H_z) by solving $TM_{x_{mn}}$ modes, which have electric Hertz potential in x -direction: $\Pi = \mathcal{E} \psi(x, y) e^{i\beta z}$

(d) Letting $\epsilon_1 = \epsilon_2$ and $\mu_1 = \mu_2 = \mu$, show the cutoff frequency for the dominant $TM_{x_{mn}}$ mode is obtained by:

$$\omega_c = \frac{\pi}{b} \sqrt{\frac{\epsilon_2(a-c) + \epsilon_1 c}{\mu \epsilon_1 \epsilon_2 a}}.$$

Partially Filled Rectangular Waveguide

Edward J. Rothwell, Michael J. Cloud



Partially Filled Rectangular Waveguide:

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