Computational Electromagnetics

Assignment on Dyadic Green's Functions

Slot in Wall of Infinitely-Long Rectangular Waveguide

May 2025

Consider the infinitely-long rectangular waveguide as shown in Fig. 1, created by "digging out" an infinitely-long rectangular region from an infinite perfect electric conducting (PEC) lower half-space. A rectangular slot is cut through the upper wall, as shown in the drawing of Fig. 1. Assume that the waveguide is excited by the dominant TE_{10} mode propagating along the +*z* direction, incident from $z = -\infty$.

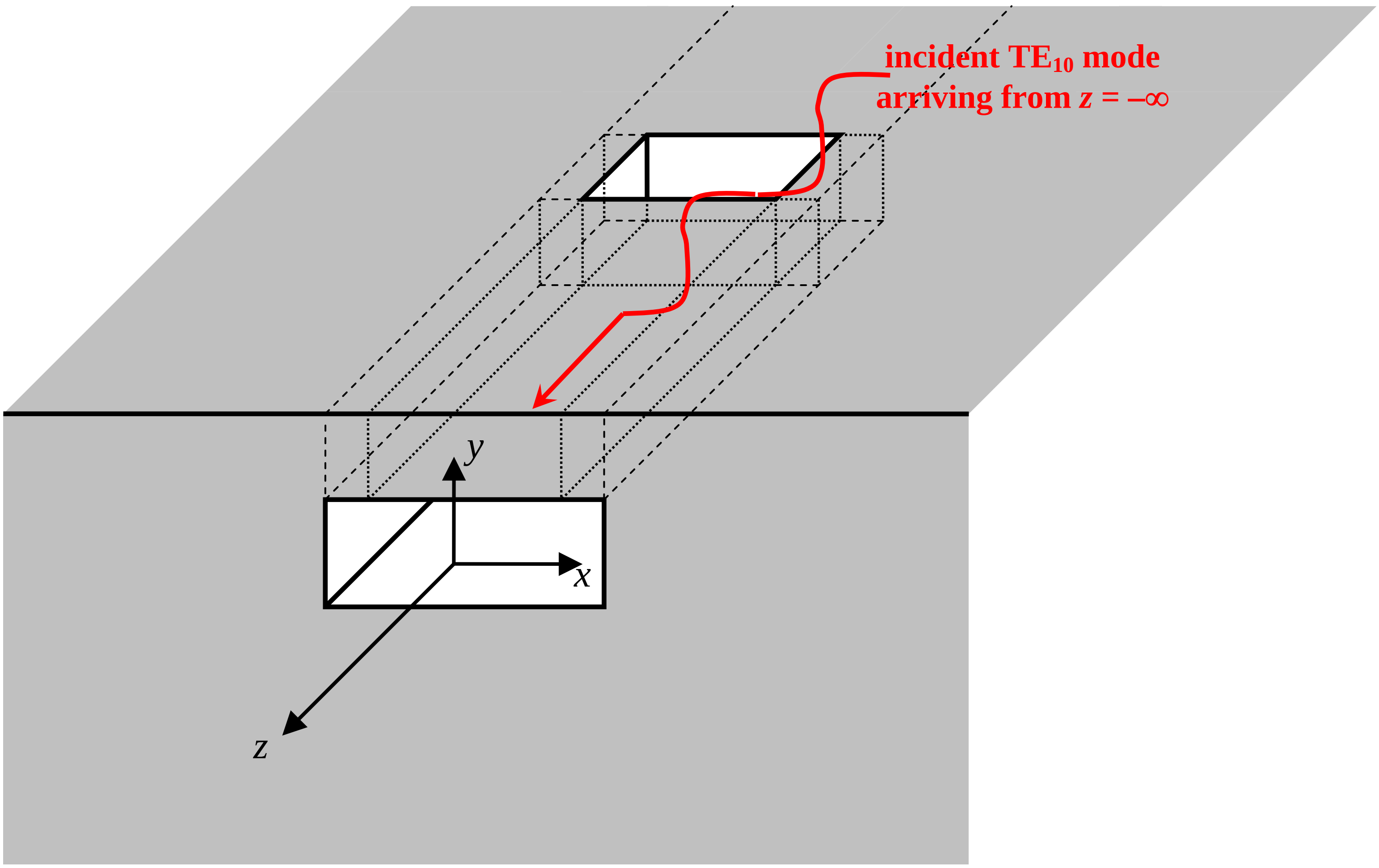

Fig. 1: Infinitely-long rectangular waveguide 'dug out' from an infinite PEC ground (lower half-space), with a rectangular slot cut through the upper wall.

With the lateral (side) view of this slotted-wall waveguide structure given by Fig. 2 as the schematic for analysis, address or solve the following problems in full detail.

Problem 1.

a. State the theorem that can be used to decompose the original problem structure of Fig. 2 into various canonical regions.

b. Identify what these canonical regions are.

c. Describe and explain in detail, just how exactly this theorem is used to break down this original problem into various sub-problems.

Problem 2.

Divide the analysis model of Fig. 2 into the canonical regions identified in Problem 1. Draw out every region separately, indicating clearly in each of them, the locations of the equivalent currents responsible for the fields within it. The type of these currents must be specified, i.e. electric or magnetic, and they may be represented (denoted) by any symbols you wish to assign them, so long they remain consistent throughout your answers. You are also at liberty to label surfaces with any notation.

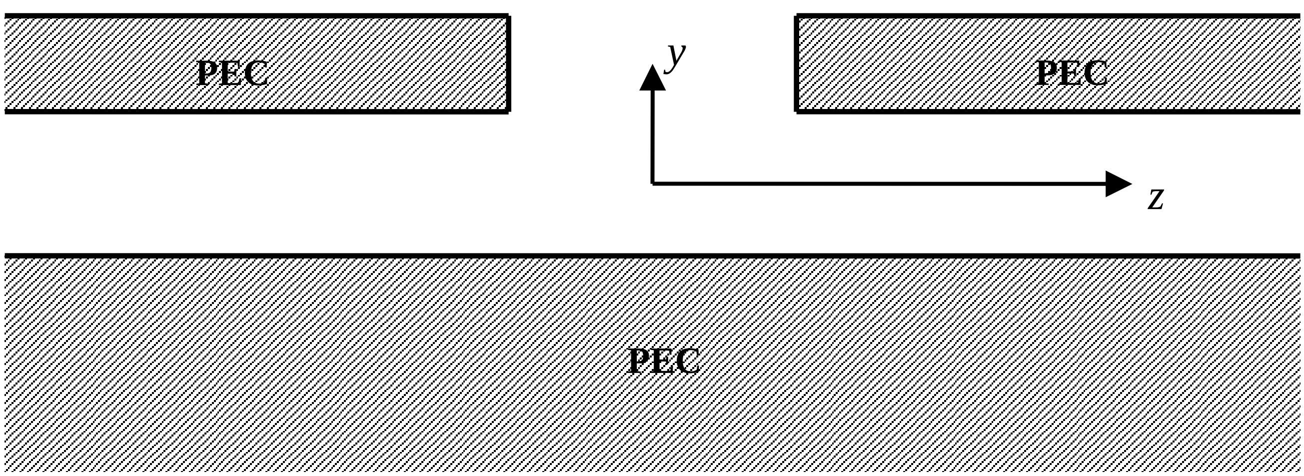

Fig. 2: Lateral (side) view of the problem structure – to be used as the analysis model.

Problem 3.

Explain what kinds of dyadic Green's functions is used for each canonical region. One of them is of a type that is none of the Green's functions for the waveguide, cavity, or shorted waveguide taught in class. You have to state what it is.

Problem 4.

Using the method of moments and the dyadic Green's functions identified in Problem 3, formulate the solution for this problem. The various key steps taught in class must all be shown, described, and explained clearly. These include the derivation of the integral equation and the construction of the matrix equation associated with the linear system of equations for solving the unknown amplitude coefficients of the basis functions expanding the equivalent currents. You are free to assign whatever symbols, names or notations to the quantities involved in the process.