**深 圳 大 学 实 验 报 告**

**课程名称：­ 电磁场与电磁波**

**实验名称： 平面波仿真实验**

**学 院： 电子与信息工程学院**

**专 业： 电子信息工程**

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| 1. **Theoretical analysis：**   **Question：**  Given an incident plane wave with the electric field intensity described by:  Where is the unit vector in the x-direction, is a phase constant, k is the wave number, and z is the direction of propagation.  The medium is structured as follows:  （1）To find the instantaneous expression for the total electric field intensity and the reflected field intensity in the region    Figure 1 - 1 Abstract graph  **Solution：**   1. Equivalent Impedance Calculation：   For Input the initial impedance  where is the characteristic impedance, is the load impedance, is the phase constant, and is the length of the transmission line.  For each layer of the medium, we can calculate the input impedance sequentially:     1. Calculation of Wave Impedance and Phase Constants for Each Layer：   For Wave Impedance ：  where is the wave impedance of free space.  For Phase Constants  where is the angular frequency, and is the speed of light.   1. Calculation of Reflected and Total Field Intensities：   For Reflection Coefficient  For Reflected Electric Field Intensity  For Total Electric Field Intensity |
| 1. **Simulation：**   **Simulation model（HFSS）：**  My adj：17/10=1.7    Figure 2 -1 simulation model    Figure 2 -2 The parameter setting of Relative Permittivity    Figure 2-3 Mag\_E    Figure 2-4 Mag\_H  **Simulation result：**    Figure 2-5 Total Electric Fields along z-axis between 0mm and 40mm    Figure 2-6 Scatter Electric Fields along z-axis between 0mm and 40mm |
| 1. **Comparison and Analysis:**   In this experiment, we analyzed the propagation and reflection characteristics of a given incident plane wave in a multilayer medium.  The electric field intensity is described as:  Where is the unit vector in the x-direction, is the phase constant, is the wave number, and is the direction of propagation.   1. **Total Electric Fields: Figure 2-5**   Figure 2-5 compares the calculated and simulated total electric field intensities over a range from 0mm to 40mm.  The overall trends of both calculated and simulated values align closely. Near the source, the electric field intensity gradually increases, peaking around 30mm, before beginning to decrease. The minimal differences between the simulation and calculation validate the accuracy of our model. This trend in electric field intensity is consistent with the propagation characteristics of electromagnetic waves in different medium layers, reflecting the interactions between reflected and transmitted waves.   1. **Scattered Electric Fields: Figure 2-6**   Figure 2-6 compares the scattered electric field intensities between calculated and simulated values.  Noticeable differences exist at various positions, particularly near the boundaries of the medium layers. These differences may result from higher-order effects or imperfections in handling boundary conditions in our theoretical model. Despite these discrepancies, the overall trend remains consistent, indicating that our basic assumptions and calculation methods are reasonable. The intensity of the scattered field shows significant peaks and valleys at the boundaries of the medium layers, reflecting the reflection and transmission effects at these interfaces.   1. **Expressions for Reflected and Transmitted Fields**   From the theoretical calculation we just did we get  For the reflected field in the region the reflection coefficient is calculated as:  The corresponding expression for the reflected electric field intensity is:  The total electric field intensity is given by:   1. **Analysis：**   From Figures 2-5 and 2-6, we can observe that our calculation method generally predicts the electric field intensity well. However, the discrepancies at certain positions suggest the need for further optimization of the model to account for more complex effects. These discrepancies may arise from the following factors:   * Higher-order effects: Our model primarily considers first-order effects, but in reality, wave propagation and reflection in different medium layers may involve higher-order interactions. * Boundary conditions: We adopted simplified boundary conditions for handling the medium layers, but the actual situation may be more complex, requiring more precise treatment. * Numerical errors: Numerical errors are inevitable in the calculation process, necessitating the use of higher-precision numerical methods to reduce these errors.   This study not only validates the basic theory of electromagnetic wave propagation in multilayer media but also provides references for practical engineering applications. Future research could delve deeper into the impact of higher-order effects and improve the treatment of boundary conditions to enhance calculation accuracy.  Through this study, we have established a foundational understanding of how electromagnetic waves interact with multilayer media, setting the stage for more advanced investigations and practical implementations. Further exploration could include refining our model to incorporate additional factors, leading to even more accurate predictions and a deeper comprehension of wave behavior in complex media environments. |
| 1. **Experimental conclusion：**   The experiment successfully demonstrated the complex interactions of electromagnetic waves with a multilayer medium. Periodic variations in total and scattered electric fields, observed in MATLAB and HFSS plots, indicate interference patterns caused by multiple reflections and transmissions.  The results confirmed theoretical predictions and validated the analytical approach in the MATLAB code. Peaks and valleys at medium layer boundaries reflect reflection and transmission effects, reinforcing our understanding of these phenomena.  This study validates electromagnetic wave propagation theory and offers valuable references for engineering applications. Future research can explore more complex effects to improve calculation accuracy, further enhancing our models and methodologies.. |
| 三、指导教师批阅意见：  成绩评定：  指导老师签名：  年 月 日 |