國立中央大學104學年度碩士班考試入學試題

Problem 1 (10%)

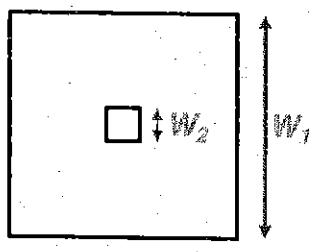
Consider a parallel-plate capacitor. The area of the parallel-plate capacitor is 1 mm^2. The distance between the two metal electrodes is 500 nm. The relative permittivity and the conductivity of the dielectric material between the electrodes are 565 and 5×10^{-7} S/m, respectively.

a) (5%) Please calculate the capacitance of the parallel-plate capacitor.

b) (5%) Please calculate the resistance of the parallel-plate capacitor.

Problem 2 (10%)

Consider two square conducting loops in free space as shown in the figure below. The small square loop is located at the center of the big square loop. The length of the edges of the big loop is W_1. The length of the edges of the small loop is W_2. Please find the mutual inductance between the two conducting loops. (You may assume $W_1 >> W_2$.)



Problem 3 (30%)

Consider a uniform plane wave which is left-hand circularly polarized and travels in the $+z$ direction. This wave is incident normally on a perfectly conducting wall at $z = 0$.

a) (10%) Write down the phasor expression for the electric field of the incident wave.

b) (10%) What is the polarization of the reflected wave? (Detailed explanation is required.)

c) (10%) Write down the expression for the Poynting vector of the reflected wave based on a cosine time reference.

Problem 4 (20%)

A load of $35+j50\ \Omega$ is connected to a 10 GHz signal generator with a 50-Ω air transmission line. The sinusoidal voltage source and the output impedance of the signal generator are $1\angle0°$ V and 50 Ω, respectively. The transmission line is lossless and its length is 3.6 cm.

a) (3%) Find the voltage at the output of the signal generator.

b) (3%) Find the voltage at the load.

c) (3%) Find the voltage standing-wave ratio on the transmission line.

d) (3%) Find the average power delivered to the load.

e) (6%) Based on the single-stub matching and the Smith Chart, find the position and length of a shorted-circuit stub to match the characteristic impedance, and draw all the results in your answer sheets.

f) (1%) What is the characteristic impedance of the transmission line?

g) (1%) Can the Smith Chart be used for impedance calculations on a lossy transmission line?

注意：背面有試題

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＊請在答案卷（卡）內作答

參考用

Problem 5 (15%)

a) (1%) What is meant by a cutoff frequency of a rectangular waveguide?

b) (1%) Explain why the rectangular waveguide cannot support TEM waves.

c) (1%) What is meant by the dominant mode of the rectangular waveguide?

d) (1%) What are cavity resonators? (1%) What are their most desirable properties?

e) (10%) An air-filled waveguide has the inner dimensions of 3 cm × 2 cm. At 10 GHz, determine the maximum average power transmitted along the waveguide without breakdown inside for the TE_{10} mode. The dielectric strength of air is 3 MV/m.

Problem 6 (15%)

a) (8%) Consider an infinitely long line charge with a line charge density ρ_l lying on the z axis in free space. The line charge moves along the z axis towards $+z$ direction at a constant velocity u. Please find the expressions of the electric field intensity and magnetic flux density in cylindrical coordinates.

b) (7%) Consider an infinitely long conducting wire carrying a dc current I. The conducting wire lies on the z axis in free space. The dc current flows in $+z$ direction. Please find the expressions of the electric field intensity and magnetic flux density in cylindrical coordinates.

注意：背面有試題

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The Smith Chart