

所別： 電機工程學系 碩士班 電波組(一般生)共3頁 第1頁科目： 電磁學

本科考試禁用計算器

*請在答案卷(卡)內作答**Problem 1 (30%)**

An infinitely long, straight, solid, nonmagnetic conductor with a circular cross section of radius b carries a steady current I . The conductor is aligned along the z -axis of the cylindrical coordinates, and the current flows in the positive z -direction.

- (10%) Determine the ϕ -directed magnetic flux density both inside and outside the conductor.
- (12%) Write down the fundamental postulates of magnetostatics in nonmagnetic media both in differential and integral forms.
- (8%) Based on the postulates in b), explain why the magnetic flux density in a) is ϕ -directed.

Problem 2 (15%)

You are given the expressions for the electric field and magnetic field intensities, i.e., $\vec{E}(x, y, z, t)$ and $\vec{H}(x, y, z, t)$, of a uniform plane wave.

- (10%) Please describe how you determine whether the plane wave is linearly polarized, circularly polarized, or elliptically polarized.
- (5%) If the plane wave is circularly polarized, please describe how you determine whether it is left-handed or right-handed.

Problem 3 (15%)

Consider a uniform plane wave propagating in a lossy nonmagnetic dielectric material. The frequency of the plane wave is 40 GHz. The dielectric constant and conductivity of the dielectric material are 12 and 2 S/m, respectively. Assume that all the losses are due to the non-zero conductivity.

- (5%) Please calculate the loss tangent.
- (10%) Please calculate the attenuation constant.

Problem 4 (20%)

A 1-GHz transmitter with an output impedance of 50Ω has a maximum average output power of 1 W when it is connected a $50\text{-}\Omega$ antenna using a 10-m lossless transmission with a characteristic impedance of 50Ω .

- (4%) What is the definition of the characteristic impedance of the transmission line?
- (4%) The transmitter can be regarded as a voltage source V_g with an internal impedance Z_g of 50Ω . Find the magnitude of V_g .
- (4%) If the antenna is replaced by an unknown-load antenna and the average power delivered to the unknown-load antenna is 0.19 W, find the magnitude of reflection coefficient and voltage standing-wave ratio of the unknown-load antenna.
- (8%) If the input impedance of the antenna is changed to $50+j50 \Omega$, find the input reflection coefficient and the average power delivered to the antenna.

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Problem 5 (20%)

- a) (2%) What type of coordinate system is used in a Smith Chart?
- b) (2%) What are the two families of circles and arcs that make up a Smith chart?
- c) (2%) On the Smith chart shown in next page, what is the only straight line shown?
- d) (2%) What is the process of normalization with regard to a Smith chart?
- e) (12%) A $50\text{-}\Omega$ transmission line is connected to a load impedance Z_L , which is equal to $20 - j25\ \Omega$. A single-stub (short-circuited stub) tuner is used to match the load to the line, and the schematic is shown in Fig. 1. Use the Smith chart to find all the possible position l and length d of the tuner, and determine the reflection coefficient and the voltage standing-wave ratio of the load.

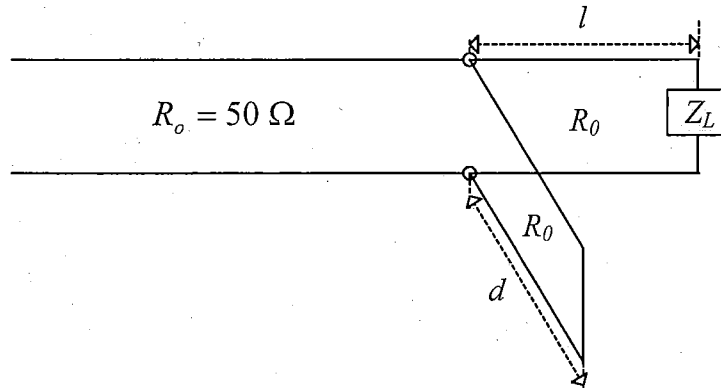


Fig. 1. Schematic of impedance matching by single-stub tuner.

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The Smith Chart

