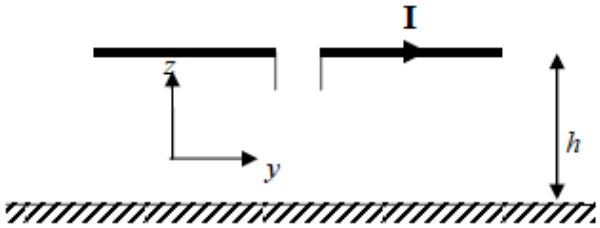
Microwave Engineering and Antenna – Tutorial 3

Question 1

A very short ($l \leq \lambda/50$) vertical electric dipole is mounted on a pole a height h above the ground, which is assumed to be flat, perfectly conducting, and on infinite extent. The dipole is used as a transmitting antenna in a VHF ($f = 50\,\text{MHz}$) ground-to-air communication system. In order for the communication system transmitting antenna signal not to interfere with a nearby radio station, it is necessary to place a null in the vertical dipole system pattern at an angle of $80°$ from the vertical. What should the shortest height (in meters) of the dipole be to achieve the desired specifications?

Question 2

A resonant, $\lambda/50$ dipole is placed a distance h above an infinite ground plane ($\sigma = \infty$) so that the beam peak in the elevation plane ($\phi = 0°$) is at $30°$. The dipole is made out of copper wire ($\sigma = 5.7 \cdot 10^7\ \text{S/m}$) of radius $1.5 \cdot 10^{-4}\,\lambda$.



Find

a) height h,

b) directivity in dB,

c) gain in dB at frequency $f = 250$ MHz,

d) reflection efficiency, if the dipole is fed by a 50 Ω line.

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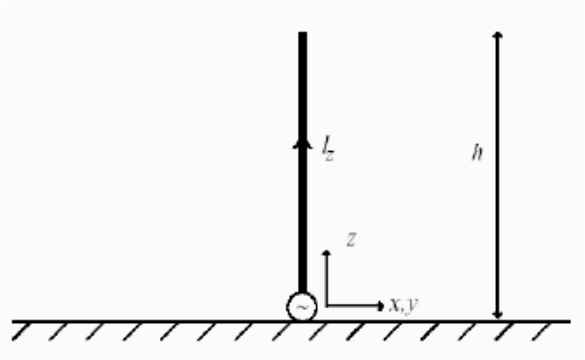
Question 3

A monopole antenna is placed on an infinite conducting ground plane as shown in the figure below. Its current distribution is triangular, i.e. $I_z(z) = I_0\left(1 - z/h\right)$. The length of the monopole is $h = 10$ mm and the frequency is $f = 0.3\,\text{GHz}$.

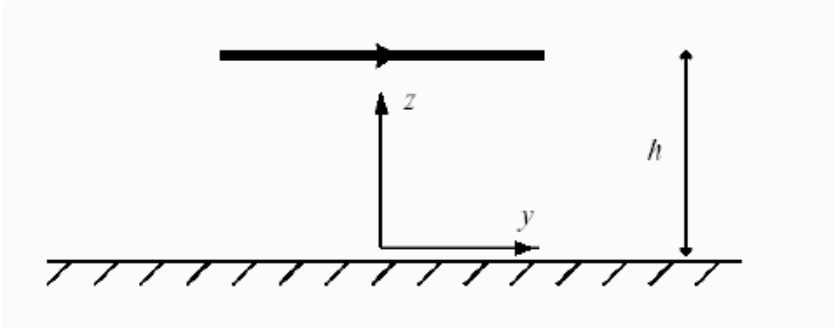


a) Find the far-field of the antenna.

b) Find the radiation resistance.

c) Find the maximum directivity.

Now consider a dipole working at 600 MHz with the same length ($L = 10\,\text{mm}$), placed at a distance h from the ground plane. The length L is such that the dipole can be considered infinitesimal with a uniform current distribution I_0.



d) Determine the minimum distance h required for the radiation pattern to have a null in the direction $\phi = 90°$ and $\theta = 45°$.

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Question 4

A resonant 6-turn loop of "closely spaced turns" is operating at 50 MHz. The radius of the loop is $\lambda/30$, and the loop is connected to a 50-Ω transmission line. The radius of the wire is $\lambda/300$, its conductivity is $\sigma = 5.7 \cdot 10^7$ S/m, and the spacing between the turns is $\lambda/100$. Determine the

a) directivity of the antenna (in dB),

b) radiation efficiency taking into account the proximity effects of the turns,

c) reflection efficiency,

d) gain of the antenna (in dB).