Antennas, written examination (21 July 2020)

UNIVERSITÀ DEGLI STUDI DI BRESCIA

Exercise 1 (11 points)

a) Define the radiation pattern and explain its importance.

b) Explain the meaning of isotropic and omnidirectional radiation pattern.

c) Define the principal planes of the radiation pattern: E-plane and H-plane.

d) Write the mathematical expression of the radiation pattern of an ideal dipole.

e) Plot the radiation pattern of the ideal dipole in the E and H-plane.

f) Plot the radiation pattern of a small loop antenna in the E and H-plane.

g) Define beam solid angle, directivity, gain and radiation efficiency; explain the importance of these parameters.

h) Starting from the result of d), calculate the gain of an ideal lossless dipole.

Exercise 2 (12 points)

a) Obtain and explain the Friis transmission equation.

b) A lossless antenna is used to transmit a signal at the frequency of 76 GHz and the power at its input port is 20 mW; the directivity of this antenna is 15 dB. At a distance of 800 m there is a receiving lossless antenna having a directivity of 12 dB. What is the maximum power available at the receiver?

c) Define the radar cross section of an electromagnetic scatterer (a target). Give an approximate value for the radar cross section of a jet airliner and justify the answer.

d) Obtain and explain the radar range equation for a monostatic radar.

Exercise 3 (10 points)

A uniform array is composed of 6 isotropic antennas. The signal frequency is 1 GHz, the distance between two antennas is 15 cm and the phase delay from one antenna to the next is $-\pi$ radians.

a) Find the maximum directions and the null directions of the radiation pattern.

b) Plot the radiation pattern.