ASSIGNMENT 4

(due Thursday October 27, 2022)

1. (25 points) An infinitesimal electric dipole with constant current distribution of magnitude I_0 is placed symmetrically at the origin and is directed along the *x*-axis. Derive the dipole's far-zone field components E_θ and E_φ from its magnetic vector potential **A**.

2. (25 points) The normalized field pattern of an antenna is given by

$$\bar{E}_\theta = \begin{cases} \sin\theta \sin\varphi, & \text{if} \quad 0 \le \theta \le \pi \quad \text{and} \quad 0 \le \varphi \le \pi \\ 0, & \text{elsewhere} \end{cases}$$

Find:

a) the exact maximum directivity (dimensionless and in dB);
b) the HPBW in the azimuth plane, and the HPBW in the elevation plane;
c) the beam solid angle Ω_A.

3. (30 points) For the top-hat antenna of Assignment #3 (a capacitor-plate antenna with the following dimensions: radius of the plates $a = 0.01\lambda$, overall length $L = 0.02\lambda$, and operating frequency $f = 30$ MHz) and using *FEKO*, plot the field and power (or gain) radiation patterns in linear scale as follows: (a) 3-D pattern, (b) 2-D azimuthal pattern, and (c) 2-D elevation pattern. Plot the 2-D patterns in both formats, polar and rectangular. What is the directivity of the antenna? What is the gain of the antenna? Is it different from the theoretical value?

4. (20 points) In *FEKO*, re-build the above project only this time make your antenna from copper (set the conductivity of copper to $\sigma = 5.7 \times 10^7$ S/m) instead of perfect conductor. Set the wire radius to 3 mm using the "Mesh" menu. What is the radiation efficiency of the antenna?