HERIOT-WATT UNIVERSITY
DEPARTMENT OF COMPUTING AND ELECTRICAL ENGINEERING

22.3MB1 Electromagnetics

Tutorial 4

1. Plot a curve in dBm^{-1} versus frequency showing the attenuation in sea water from 10 KHz to 1 GHz, assuming μ_o and σ are constant over this frequency range and equal to $4\pi\times10^{-7}\,H/m$ and 5 Sm^{-1} respectively. Take $\in_r$ = 81. Comment on the implications of the results to the problem of communicating, by means of radio waves, with vehicles submerged in sea water.

2. Calculate the attenuation of an electromagnetic wave in sea water and in copper at 20 KHz given that σ for sea water is 5 Sm^{-1} and for copper is $5.8\times10^{7}Sm^{-1}$. Both can be assumed to non-magnetic. State the result in dBm^{-1}. Also compare the intrinsic impedances of the two media at 20 KHz.

   [5.45, 172.5, 1.86×10^{4}, 5.88×10^{5}, 0.178 Ω, $5.22\times10^{-5}\Omega$]

3. The electric field strength of a uniform plane electromagnetic wave in free space is 1 Vm^{-1} and the frequency is 300 MHz. If a very large thick flat copper plate is placed normal to the direction of wave propagation determine (a) the electric field strength at the surface of the plate; (b) the magnetic field strength at the surface of the plate; (c) the depth of penetration; (d) the conduction current density at the surface; (e) the conduction current density at a distance of 0.01 mm below the surface; (f) the surface current density J_s; (g) the power loss per square metre of surface area. For copper use $\sigma = 5.8\times10^{7}Sm^{-1}$, $\mu = \mu_o, \varepsilon = \varepsilon_o$.

   [(a) 33.8 μVm^{-1}, (b) 5.3 mAm^{-1}, (c) 0.00382 mm, (d) 1960 Am^{-2},
   (e) 143Am^{-2}, (f) 5.3 mAm^{-1}, (g) 0.0634μWm^{-2}]

