ENEL 476 – Assignment #2

Due on Friday February 17 at 5 pm

Drop boxes on 2nd floor of ICT

Text questions 10.18, 10.32, 10.34 and 10.60

Additional question: An implanted antenna is located 3 mm beneath the skin. The skin has ε_r=45, σ=0.9 S/m and μ_r=1 at 404 MHz.

Assume that the waves propagating in the skin can be approximated with uniform plane waves and consider the skin as an infinite half space (i.e. you can consider it to be one region).

Assume that the electric field inside the skin and immediately adjacent to the antenna has amplitude of 10 V/m. The wave propagates in the z-direction and the magnetic field is oriented in the x-direction.

a) Find the attenuation constant, α.
b) Find the phase constant, β.
c) Find the intrinsic impedance, η.
d) Find an expression for the electric field in the skin, $\mathbf{E}(z,t)$.
e) Find an expression for the magnetic field in the skin, $\mathbf{H}(z,t)$.
f) Find an expression for the time-averaged Poynting vector in the skin, $\mathbf{P}_{av}(z)$. (3 marks)

Assume that the signal is transmitted out of the body and into free space (ε_r=1, μ_r=1, σ=0 S/m).

g) Find the transmission coefficient.
h) Find an expression for the electric field transmitted into free space, $\mathbf{E}^t(z,t)$.
i) Calculate the time-averaged Poynting vector for the transmitted field. Compare the power density in free space to the power density near the antenna.