Exercise 2

2.2
How far must a plane wave of frequency 60 GHz travel in order for the phase of the wave to be retarded by 180° in a lossless medium with $\mu_r = 1$ (a non-magnetic medium) and $\varepsilon_r = 3.5$?

2.8
Compare the attenuation of a plane wave travelling through a non-magnetic medium with $\sigma = 10^{-4}$ Sm^{-1} and $\varepsilon_r = 3$ at 100 MHz, 1 GHz, and 10 GHz.

2.10
A vertical polarised plane wave at 1900 MHz travels in the positive z-direction in a medium with constitutive parameters $\mu_r = 1$, $\varepsilon_r = 3$ and $\sigma = 10$ Sm^{-1}. The electric field magnitude at $z = 0$ is 1.5 Vm^{-1}. Calculate a) the wave impedance, b) the magnitude of the magnetic field at $z = 0$, c) the average power available in a 1.3 m^2 area perpendicular to the direction of the propagation at $z = 0$, d) the time taken for the wave to travel through 15 cm, and e) the distance travelled by the wave before its field strength drops to 1 fifth of its value at $z = 0$.

3.3
Prove the expression for the Brewster's angle (Eq. 3.19)

$$\theta_B = \tan^{-1} \frac{n_2}{n_1}$$

3.6
Polaroid sunglasses reduce glare from road surfaces by permitting only one polarisation to be transmitted. Using the Fresnel reflection coefficients, explain whether vertical or horizontal polarisation should be transmitted.