1. The amplitude of a satellite Radio Wave is described by the function:

\[ z(y, t) = 0.16 \sin(24 \times 10^9 \pi t + 160\pi y - \frac{\pi}{3}) \, e^{0.0003y} \, (Volts/m) \]  \hspace{1cm} (1)

(a) What is the amplitude A, the frequency f, the wavelength \( \lambda \), the reference phase \( \phi_0 \), and the attenuation factor \( a \)? The velocity of light in the air is \( c = 3 \times 10^8 m/sec \). (10 %)

(b) Assuming that the propagation path is nonmagnetic, what is the value of the phase velocity \( v_p \), the dielectric constant \( \epsilon_r \) and the conductivity \( \sigma \)? (5 %)

(c) The above wave propagates at a 75 - \( \Omega \) lossless coaxial line which is terminated in a 40-room motel. Each room’s transceiver is equivalent to a series combination of a resistor \( R = 3000 \)

\[ i \quad t \quad L = 39.8nH(= 1000/(8\pi)). \] Assuming that the operating frequency is 12 GHz, what is the reflection Coefficient \( \Gamma \) and the Standing Wave Ratio S at the load? If a value of SWR smaller than 5 is considered to be satisfactory matching, how could you characterize this matching? (15 %)

(d) Could you match this load with a quarter-wavelength transformer assuming that the only parameter you can modify is the position of the transformer along the feeding line? BONUS (10 %)

\( \text{f th l t i a l l o f t h a i o l i} \quad l = 20.25\lambda, \text{what is the input impedance} \, Z_{in} \text{ for the load of (c)? Does the load behave as an inductor or as a capacitor? (10 %})

2. The electric field of a remote-sensing uniform plane wave propagating in nonmagnetic lossless cosmic powder (assume that the intrinsic impedance is equal to the free space one) is given by:

\[ \vec{E} = (\hat{x} + \hat{y}) \, 15 \, e^{-j100\pi z} \, (\mu V/m) \] for a remote sensing satellite operating at 18GHz.

(a) Specify the polarization of the wave. (10 %)

(b) Calculate the magnetic field in phasor form. (10 %)

(c) What would be the polarization if the magnetic field was given by:

\[ \vec{H} = (\hat{x} + j\hat{y}) \, 5 \, e^{-j100\pi z} \, (\mu A/m)? \] (10 %)

3. A lossless 50\( \Omega \) microstrip transmission line, that is used in collision avoidance radars, is to be matched to a horn antenna with \( Z_L = (100 + j25) \, \Omega \) using a series short-circuited stub. Use the Smith chart to find:

(a) the reflection coefficient \( \Gamma \) and the standing-wave ratio without the stub, (5 %)

(b) the input impedance at 0.25 \( \lambda \) from the load, (5 %)

(c) the shortest line length for which the input impedance is purely resistive, (5 %)

(d) the stub length and the distance between the antenna and the stub (2 solutions).(a) Find the direction of wave propagation. (15 %)

GOOD LUCK !!!