



## Assignment: Antennas and Propagation

This assignment involves participation in the online [IEEE RFID 2020 conference](#), 28 Sep – 16 Oct 2020.

### Questions (Attach Responses):

1. A dielectric sphere with radius  $r$  has the following permittivity profile:  
Answer the following questions based on this information.
  - a. If an electromagnetic wave strikes this object at  $\theta=0$  degrees of elevation, where does the reflected/scattered waves travel?
  - b. What is this type of sphere called? What manufacturing innovation has made fabrication of this device much more practical?
  - c. What applications does it have for radiolocation?
2. A tunnel diode, when biased intermittently and placed at the load of an RF tag antenna, reflects more power than is received. Answer the following questions based on this scenario.
  - a. What application does this type of device allow? Cite a paper to reference your answer.
  - b. If an RF tag reflects with 30 dB of gain switching between active bias and matched load (compared to open-circuit and matched load), what is the equivalent impedance load of the active bias if this load is purely resistive?
3. A *bistatic* backscatter link involves a transmitter, a backscatter RFID tag, and a receiver at three different locations. Transmitter, tag, and reader antennas all have 0 dBi antenna gains with negligible tag losses in free space at 915 MHz. If the transmitter sends 1 Watt of power into the transmit antenna and illuminates an RF tag 10 m away, how far away can the bistatic receiver unit be and still receive a signal level of -80 dBm (the receiver's minimum level for reliable signal decoding).
4. Patch antennas are often used to transmit and receive in RFID readers.
  - a. How does a V-shaped dual patch array differ from a conventional square patch antenna?

- b. How does the V-shaped dual patch array differ electrically from a conventional square patch antenna? Use either paper citation or a computer simulation of a square patch antenna to compare.
  - c. What application does a V-shaped dual patch array enable?
- 5. A rotary craft with 10 cm blades rotating at 800 revolutions/minute. The Doppler signature from a radar interrogator can produce some interesting information for detecting the presence of a rotary craft vehicle.
  - a. What is the base Doppler frequency measured if interrogated with a 2.4 GHz continuous wave radar?
  - b. Explain how the radar signature can be used to differentiate types of rotary craft.