ECE 498YS3/YS4 Homework 1 Due: Thursday, September 5, 2024, 11:59PM Central Time

Recommended Reading: C. Paul: Chapter 1-2

Purpose: This homework addresses the following learning objectives:

1. Understand and apply the concepts of wavelength and frequency in both metric and English units.
2. Calculate voltages in different units (dBμV and dBm) and understand their significance in electromagnetic compatibility.
3. Develop and use expressions to convert RMS voltage to dBm, which is crucial for analyzing signal strength.
4. Evaluate the compliance of radiated emissions with FCC standards, which is an essential skill for ensuring electronic device compatibility.
5. (For graduate students and as a bonus for undergraduates) Analyze signal transmission through coaxial cables, considering attenuation and resulting voltage levels.

Tasks and Criteria for Success: Use the following steps to complete the problems and answer the specific questions posed. Our rubric is based on these steps; if you skip a step, you will have points taken off.

1. Assemble Facts
   a) Clearly state the objectives of each problem.
   b) Identify and list all given data and relevant constants.
2. Analyze
   a) Clearly state any assumptions made to simplify the problem.
   b) Identify the appropriate equations and principles needed to solve the problem.
   c) Determine any necessary conversions between units (e.g., metric to English units).
3. Calculate
   a) Write down the relevant equations in their standard forms.
   b) Substitute the given data and constants into the equations.
   c) Show all steps of your calculations in a clear and logical order.
4. Finalize
   a) Highlight your $\boxed{\text{final answers}}$ with a box and include the requested units.
   b) Check your results for accuracy and consistency.

1. Determine the wavelength at the following frequencies in metric and in English units:
   a) LORAN C long-range navigation 90Hz in km and mile.
   b) Submarine communication (in air) 1kHz in km and mile.
   c) GPS Satellite L1 (1575.42 MHz) in cm and in.
   d) 5G cell phone 28 GHz in mm and mil (1 mil = 0.001 inch).

2. Determine the following voltages in $dB\mu V$ and dBm (assume $50\,\Omega$ system).
   a) $0.3\ \mu V$.
   b) $300\ mV$.
   c) $1\ V$.

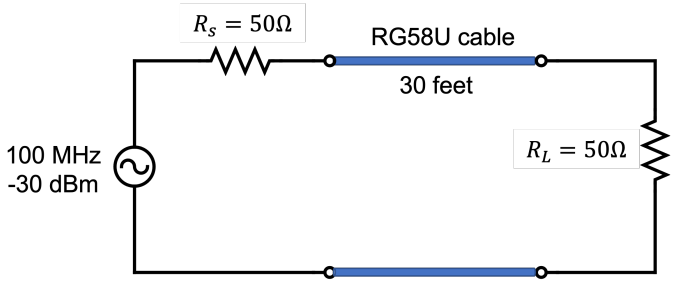
3. Determine a simple expression to convert (RMS) voltage V_{RMS} to dBm with $50\,\Omega$ of system impedance.

4. The radiated emmisions from a product are measured at 50 MHz at 15 m away and are found to be 21 $\mu V/m$.

   a) Explain if the product comply with the FCC Class B limit.

   b) By how much does the product pass or fail at 15 m away?

5. A 50 Ω source is connected to a 50 Ω receiver using 30 ft of RG58U coaxial cable. Cable loss is $4.5dB/100feet$. If the source output is 100 MHz and −30 dBm, determine the voltage at the receiver in mV and $dB\mu V$.



6. **Required for graduate students and is optional for undergraduate student:**
   Are the FCC's or the European Union's CISPR Class B radiated emission limits more restrictive
   a) In the frequency range of 30 to 88 MHz?
   b) In the frequency range of 88 to 230 MHz?
   c) In the frequency range of 230 to 960 MHz?
   d) In the frequency range of 960 to 1000 MHz?
   e) Draw a table for worse case combination of the FCC and CISPR radiated emission limits when measured from 30MHz to 1GHz. (Rows: frequency ranges, columns: Class A and Class B both measured at 3m.)