ECE 4391 Electromagnetic Compatibility Quiz 1

June 4, 2003

Professor Leach Name_____

Instructions. *Problem 3 is on the back of this page.* Print your name in the space above and at the top of all other pages in your quiz. Be brief with your answers. Draw simple diagrams that illustrate your answers. The quiz is closed notes and closed calculator. **Honor Code Statements:** *I have neither given nor received help on this quiz.* Initials _____

Part 1: Answer any 10 questions.

1. What is the agency of the U. S. Government which regulates the use of radio and wire communications?

2. In general, why are the regulations for emission limits for computing devices designed for home use more stringent than the regulations for emission limits on computing devices designed for industrial use?

3. A computing device is defined as a product which has a clock frequency greater than what frequency?

4. In measuring conducted emissions from equipment, what is the purpose of the "line impedance stabilization network?"

5. Circuit analysis eliminates spatial variables from solutions and provides approximations as a function of time only. Circuit analysis assumes what three things?

6. What two undesirable things can occur when two dissimilar metals are in contact in a signal circuit in which a current flows?

7. In order for a shield to reduce electric field (capacitive) coupling to a conductor, what is required?

8. What are the basic differences between capacitively coupled noise and inductively coupled noise to a conductor?

9. A ground loop current I_S flowing in the shield around a center conductor generates what noise voltage in the conductor if the shield is grounded at both ends?

10. If the ground-loop current flowing on the shield in problem 9 is generated by a series voltage V_s induced in the shield from some other circuit, how does the noise voltage generated in series with the center conductor vary with frequency?

11. What is the best way to protect against interference caused by magnetic fields at a receptor?

12. What is the basic parameter that determines whether a shielded twisted pair or a coaxial cable is the optimum cable in a signal circuit?

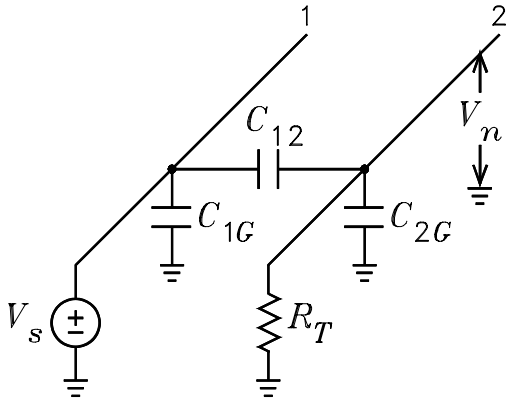
13. What is the primary purpose of a "safety ground?"

14. What is the preferred method for connecting circuits to a single-point ground in a chassis?

15. When should multi-point grounds be used as opposed to a single-point ground?

Part 2: Work the following problem:

16. The stray capacitance between conductors 1 and 2 is 100 pF. Each conductance has a capacitance to ground of 50 pF. Conductor 1 has a 20 V ac signal at a frequency of 75 kHz on it. What is the noise voltage picked up by conductor 2 if it is terminated in a resistance $R_T = 5\,\text{k}\Omega$?



ECE 4391 Electromagnetic Compatibility Quiz 2

June 23, 2003

Professor Leach Name_____

Instructions. Print your name in the space above and at the top of all other pages in your quiz. Be brief with your answers. Draw simple diagrams that illustrate your answers. The quiz is closed notes and closed calculator. **Honor Code Statements:** *I have neither given nor received help on this quiz.* Initials _____

1. High-gain amplifiers are often enclosed in a metallic shield to provide protection from electric fields.

   (a) Draw a circuit diagram to show how the system capacitances can cause an undesirable feedback loop that could result in unwanted oscillations.

   (b) How must the shield be connected to the amplifier to prevent the unwanted feedback?

2. A signal source is connected to an amplifier with cable consisting of a shielded twisted pair. To prevent noise currents from flowing in the shield, it must be grounded at only one point.

   (a) Draw a diagram showing where the shield should be connected if the source is grounded.

   (b) Draw a diagram showing where the shield should be connected if the amplifier is grounded.

3. (a) Describe a ground loop.

   (b) What two sources of noise are ground loops susceptible to?

   (c) Name two methods of breaking a ground loop.

4. A dc power supply is connected to a circuit by conductors called the "power distribution system."

   (a) How does the impedance of the distribution system differ for dc currents and high frequency transient currents?

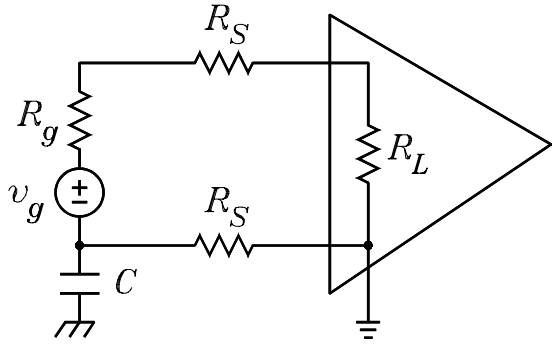
   (b) What is done at the load to minimize the impedance variation of the distribution system with frequency? Describe a potential problem with the circuit.

(c) Draw a diagram to show one way that undesirable coupling can be minimized between circuits connected to the same distribution system.

5. (a) What is the most important consideration in choosing a capacitor type?
   (b) Ideally capacitors used for bypassing and coupling should be ac short circuits at the operating frequency. Why do larger value capacitors not necessarily have the lowest impedance at higher frequencies?
   (c) Name one type of capacitor that is recommended for high frequency applications.
   (d) What type of capacitor has the largest capacitor to volume ratio?

6. (a) What two mechanisms generate noise in resistors?
   (b) Compare the noise performance of common resistor types.
   (c) What is the equivalent circuit of a ferrite bead placed around a current carrying conductor?
   (d) What is done to prevent undesirable magnetic field coupling into inductors?

7. The figure shows the circuit diagram of a grounded amplifier connected to a floating source through a cable. It is given that $R_g = 2\,\text{k}\Omega$, $R_S = 2\,\Omega$ and $R_L = 15\,\text{k}\Omega$. The capacitor C represents the parasitic capacitance to ground at the source. At $f = 5\,\text{kHz}$, the capacitor has the impedance $Z_C = -j75\,\text{k}\Omega$. What is the noise voltage across the amplifier input if the noise voltage between the two grounds is 100 mV rms at $f = 5\,\text{kHz}$? Explain any approximations that you use in obtaining your answer.



ECE 4391 Electromagnetic Compatibility Quiz 3
July 11, 2003

Professor Leach Name_____

Instructions. Print your name in the space above and at the top of all other pages in your quiz. Be brief with your answers. Draw simple diagrams that illustrate your answers. The quiz is closed notes and closed calculator. **Honor Code Statements:** *I have neither given nor received help on this quiz.* Initials _____

1. If an absorption-loss metal shield is to be designed to provide attenuation against a 60 Hz magnetic field, what type of metal should the shield be made of and why?

2. What is the shielding effectiveness of a shield made from a sheet of 20 gauge soft aluminum located a distance of 0.3 m from a 12 kHz electric field? The thickness of 20 gauge sheet metal is 0.0396 in or 1.0058 mm. Soft aluminum has the relative conductivity $\sigma_r = 0.61$.

3. What would be the shielding effectiveness of the shield of problem if it were located in the far field?

4. What are the two primary requirements for avoiding contact breakdown?

5. An RC contact protection network for inductive loads is the cheapest and most commonly used protection network. Briefly discuss its limitations. Draw a graph to illustrate how it limits the voltage across the contacts when they are opened.

6. A $10\,\mathrm{k}\Omega$ resistor is connected across the inputs to a noiseless amplifier that can be modeled as having the transfer function of a second-order band-pass filter with a center frequency of $f_0 = 100\,\mathrm{kHz}$, a quality factor $Q = 10$, and a gain $A_0 = 100$ at f_0. Calculate the rms noise voltage at the output of the amplifier.