ECE 4391 Electromagnetic Compatibility Quiz 2

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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. Numerical values are $V_T = 0.025$ V, $4kT_0 = 1.6 \times 10^{-20}$ J, $q = 1.6 \times 10^{-19}$C, $k = 1,38 \times 10^{-23}$ J/K. **Honor Code Statements:** *I have neither given nor received help on this quiz.* Initials _____

1. Compare the properties of an EM field in the near field of a source compared to the far field of a source.

2. In the near field of a source, the wave impedance can be less than or greater than that in the far field of the source. What characteristics of the source determine this?

3. What are the two primary loss mechanisms in a metallic sheet used as a shield?

4. If the far field of a source, one loss mechanism for a metallic sheet shield predominates at low frequencies and the other predominates at high frequencies. Explain and sketch a graph to show how they combine to form the total shielding effectiveness as a function of frequency.

5. In the near field of a source, which loss mechanism for a metallic sheet shield predominates for (a) electric field sources and (b) for magnetic field sources?

6. Why can a long thin seam in a cabinet couple more undesired radiation than a round hole of the same area?

7. What are the two types of electrical breakdown that can occur between two contacts? Discuss the basic rules to prevent each from occurring.

8. Name four intrinsic noise mechanisms in electronic devices. Which two can be modeled the most accurately with a general equation?

9. What was the basic circuit that Nyquist used to derive his famous equation for the thermal noise generated by a resistor?

10. If two resistors are connected in parallel, why doesn't the temperature of either resistor increase when it absorbs noise power from the other resistor?

11. An amplifier has a source voltage v_s in series with a source resistance R_S connected to its input. A resistor R_1 is in parallel with the amplifier input. Draw the circuit using the $v_n - i_n$ amplifier noise model for the amplifier.

    (a) Obtain the expression for the instantaneous v_{ni}. Include the noise generated by R_S, R_1, v_n and i_n.

(b) Convert the expression into the mean-square value $\overline{v_{ni}^2}$ using $\overline{v_t^2} = 4kTRB$ for the mean-square thermal noise generated by a resistor. Neglect correlation effects between v_n and i_n.

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(c) Use the result of part (b) to determine the value of R_1 which minimizes $\overline{v_{ni}^2}$.

12. A BJT has $r_x = 100\ \Omega$, $I_C = 200\ \mu$A, and $\beta = 100$.

(a) If $\overline{v_n^2} = 4kTr_xB + 2qI_CB\left(V_T/I_C\right)^2$, calculate the spot noise value of v_n.

(b) If $\overline{i_n^2} = 2qI_BB + 2qI_CB/\beta^2$, calculate the spot noise value of i_n.

(c) What is the optimum source resistance that minimizes the noise figure?

(d) What is the value of the noise figure with R_S equal to the optimum source resistance?