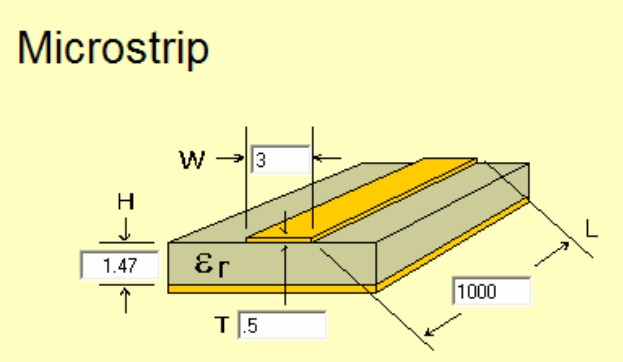
EXTRA CREDIT

Listed below are some of the topics that one could find on the final exam in this course. For 10 of these topics, extra credit questions are provided that are now available on the Fields and Waves I LMS website. To receive credit for answering these questions, half must be completed by 2 May, with the rest completed by the final exam date. Also, credit obtained in this way will be applied to replace missing Lecture Quizzes and, possibly, a limited number of points will be added to the overall course grade. Usually, this is less than 20 points, but the decision on what the actual number will be will be determined after 2 May. Please check the extra credit topic on the class announcement page for further information.

1. Resistance – While planning a picnic at a public park, you decide to play music with a boom box. However, the nearest outlet is 400 meters away. In spite of this distance and the annoyance you will ultimately cause anyone else trying to enjoy the peace and quiet of the park, you decide to string several extension cords together to provide power for your box. Which of the following represents good engineering thinking when considering how to do this? That is, which statements are correct and contribute something to figuring out the best way to power the box?
    a. You check the specs on your boom box to see what its power requirements are and find it requires about 500W.
    b. You check the specs on your boom box to see what its power requirements are and find it requires about 50W.
    c. You decide to determine the voltage drop experimentally on a 100 foot cord you have at home so you can scale the results up to 400 meters. You do this by plugging the cord into the outlet and measuring the resulting voltage at the output end.
    d. Knowing that you should use the largest available gauge wire for the extension cords, which is 10 gauge, you decide to buy 14 of them so you can string them together.
    e. After reading several online references on setting up temporary electrical systems (e.g. light shows, sound systems, etc.), you find that you should design a system that produces no more than 5% voltage drop in the wires for the given load. You calculate that you can make this work with 16 gauge wire as long as you make one long wire run, with no connectors to cause additional drops and as long as no one plugs anything else in for the picnic.
    f. Realizing that someone will likely want to plug something else in, you plan on at least a 5A load, which means that you will have to use 4 gauge wire.
    g. You decided to run the box on batteries and stock up on a sufficient number to run for several hours.

2. Transmission Line Properties – For a Polyimide insulated stripline with the dimensions shown below, what is the characteristic impedance, the propagation velocity and the average surface charge density on the strip conductor that forms the top electrode? The voltage on the top conductor is 2 V and the bottom plane (ground plane) is grounded. *Hint: Use AppCAD*



a. $Z_o = 100\Omega \;\; u = 0.626c \;\; \rho_L = 2.1x10^{-10}\, Coul./m$

b. $Z_o = 50\Omega \;\; u = 0.626c \;\; \rho_L = 21x10^{-10}\, Coul./m$

c. $Z_o = 100\Omega \;\; u = 0.542c \;\; \rho_L = 21x10^{-10}\, Coul./m$

d. $Z_o = 50\Omega \;\; u = 0.626c \;\; \rho_L = 2.1x10^{-10}\, Coul./m$

e. $Z_o = 50\Omega \;\; u = 0.542c \;\; \rho_L = 2.1x10^{-10}\, Coul./m$

f. $Z_o = 100\Omega \;\; u = 0.542c \;\; \rho_L = 2.1x10^{-10}\, Coul./m$

3. Transmission Line – Steady State – For a sinusoidal voltage wave propagating down a lossless 50 Ohm transmission line, it is found that only 10% of the power propagating toward the load resistance is dissipated in the load. This could happen for at least two different resistive loads. For which of the following will this be the case? *Hint: AppCAD might be useful for this one too.*

a. $R_L = 1.3\Omega$ or $R_L = 950\Omega$

b. $R_L = 2.6\Omega$ or $R_L = 950\Omega$

c. $R_L = 1.9k\Omega$ or $R_L = 950\Omega$

d. $R_L = 1.3\Omega$ or $R_L = 2.6\Omega$

e. $R_L = 1.3\Omega$ or $R_L = 1.9k\Omega$

f. $R_L = 2.6\Omega$ or $R_L = 1.9k\Omega$

4. Transmission Line – Pulses – A pulsed voltage source produces a 20V, 1 nanosecond pulse at the input of a lossless transmission line. If the source and load impedances are both 50 Ohms, what is the characteristic impedance of the line if the second pulse observed at the source is -3.5 V?
   a. $Z_o = 25\Omega$
   b. $Z_o = 100\Omega$
   c. $Z_o = 50\Omega$
   d. $Z_o = 200\Omega$
   e. $Z_o = 125\Omega$
   f. $Z_o = 20\Omega$

5. Uniform Plane Wave Propagation in Lossless or Lossy Media – A uniform plane wave (average power density = 10 W per square meter) is incident normally on the boundary of a lossy medium for which the complex relative permittivity is $\varepsilon_r = 8 - j8$. What is the approximate reflected power density and the power density absorbed as heat in the lossy medium? That is, which of the following answers is the closest to the actual answers?
   a. $S_{reflected} = 7 W/m^2$ and $S_{absorbed} = 3 W/m^2$
   b. $S_{reflected} = 3.3 W/m^2$ and $S_{absorbed} = 6.7 W/m^2$
   c. $S_{reflected} = 4.5 W/m^2$ and $S_{absorbed} = 5.5 W/m^2$
   d. $S_{reflected} = 5.5 W/m^2$ and $S_{absorbed} = 4.5 W/m^2$
   e. $S_{reflected} = 6.7 W/m^2$ and $S_{absorbed} = 3.3 W/m^2$
   f. $S_{reflected} = 3 W/m^2$ and $S_{absorbed} = 7 W/m^2$

6. Magnetic Circuit – Which of the following statements are true?
   a. In a magnetic circuit consisting of several reluctances, the largest reluctance plays the dominant role in determining the magnetic flux.
   b. In a magnetic circuit consisting of several reluctances, the smallest reluctance plays the dominant role in determining the magnetic flux.
   c. The total magnetic flux leaving any node in a magnetic circuit is zero
   d. The dominant reluctance in a magnetic circuit contains more magnetic energy than any other reluctance
   e. For two reluctances that are identical except for their cross sectional area, the one with the largest area has the largest value of reluctance
   f. For two reluctances that are identical except for their cross sectional area, the one with the smallest area has the largest value of reluctance

7. Electric and Magnetic Forces – A cylindrical rod of highly magnetic material, with $\mu = \mu_r \mu_o = 5000\mu_o$, 10cm long and 2cm in diameter, is in a uniform magnetic field $\vec{B} = \hat{z}B_o = \hat{z}0.5Tesla$. The cylinder axis aligns with the direction of the magnetic field. What force is experienced by the magnetic rod?
   a. *31.25Newtons*
   b. *62.5Newtons*
   c. *625Newtons*
   d. *0Newtons*
   e. *687.5Newtons*

8. Solving Laplace's and/or Poisson's Equations – A spherical shell of uniform surface charge density ρ_{so} is located at a radius $r = a$. If the voltage is referenced to zero at a radius $r = 3a$, what is the value of the potential at the origin $r = 0$?
   a. $\frac{2\rho_{so}a^2}{3\varepsilon_o}$
   b. $\frac{\rho_{so}a}{\varepsilon_o}$
   c. $\frac{4\rho_{so}a}{3\varepsilon_o}$
   d. $\frac{2\rho_{so}a}{3\varepsilon_o}$
   e. $\frac{\rho_{so}a^2}{3\varepsilon_o}$
   f. $\frac{\rho_{so}\pi a^2}{3\varepsilon_o}$

9. Using Ampere's Law to find Magnetic Fields – A very long, straight, cylindrical wire, diameter = a, carries a current I. The amount of magnetic flux per unit length found in the wire (for $0 \le r \le a$) is
   a. $\frac{\mu_o I}{8\pi} Wb$
   b. $\frac{\mu_o I}{8} a^2 Wb$
   c. $\frac{\mu_o I}{4\pi} Wb$
   d. $\frac{\mu_o I}{4} a^2 Wb$

e. $\frac{\mu_o I}{2\pi} Wb$

f. $\frac{\mu_o I}{2} a^2 Wb$

10. Approximately 10 things everyone should know for Fields and Waves – Most of the following statement are true. **Circle the letters of any statements that are not true.**
    a. The static electric field inside a conductor is zero
    b. A matched transmission line has the same source impedance, characteristic impedance and load impedance
    c. For a uniform plane wave propagating in a lossless medium, the average energy stored in the electric field is equal to the average energy stored in the magnetic field
    d. For a lossless transmission line, the power input to the line equals the power delivered to the load
    e. Just like with charges, where opposite charges attract one another, two parallel current carrying wires carrying oppositely directed currents will also attract one another.
    f. The charges stored in a capacitor reside on the surface of the conducting electrodes, not inside the conductors
    g. Magnetic forces tend to be much larger than electric forces
    h. The penetration of electromagnetic fields into conducting materials is inversely proportional to the square root of the conductivity
    i. The range of material parameters is greatest for conductivity σ, next greatest for permeability μ, and least for permittivity ε.
    j. Magnetic flux tends to follow the path of least reluctance
    k. For a lossless transmission line, the input voltage equals the voltage across the load.
    l. For pulsed voltage sources, the input impedance of a transmission line is always equal to the characteristic impedance of the line.
    m. The input impedance of a half wavelength long lossless transmission line is equal to the load impedance.
    n. For dielectric (non-magnetic) media, Brewster's angle is always less than the critical angle.

Some other topics, but no questions were generated this term:

11. Capacitance
12. Inductance
13. Using Gauss' Law to find Electric Fields
14. Mutual Inductance and Induced Voltage
15. Uniform Plane Wave at Normal Incidence
16. Uniform Plane Wave at Oblique Incidence
17. Material Properties