

Practice Problem Set on AC circuits and electromagnetic waves

Not to be turned in for credit!

Question 1 (1 point)

How is an LRC circuit similar to a mechanical harmonic oscillator? Which component of the circuit acts like a “mass”? Which component of the circuit acts like “friction”?

Question 2 (3 points)

An AC generator with a variable frequency is connected across a 45 cm piece of coaxial cable. If the cable has minimal resistance, at what frequency will the cable resonate? If the resistance of the cable is 2Ω per meter, what is the new resonant frequency?

Question 3 (3 points)

Two circular loops of wire with radius 8.5 cm are sitting one on top of another such that the total flux through the first loop travels through the second loop, and vice versa. What is their mutual inductance?

Question 4 (1 point)

What are Maxwell’s Equations? Which term of which equation was included by Maxwell in order to complete the description of electric and magnetic fields?

Question 5 (3 points)

A capacitor has a capacitance of 250 nF and a voltage is placed across it which grows as a function of time as: $V(t) = 240 \text{ mV/s}^3 \times t^3$. What is the displacement current as a function of time?

Question 6 (3 points)

An electromagnetic plane wave at a certain location has an electric field pointed up which is given as a function of time as $E = 54 \text{ V/m} \times \sin(6 \times 10^6 \text{ Hz} \times t)$. The magnetic field at the same location points south when the electric field points up. What is the Poynting vector at this location for this wave as a function of time? What is the wavelength of the wave?

Question 7 (3 points)

The wave in question 3 is incident on a square piece of foil which is 3.6 m long on each side. If the wave is completely absorbed by the foil for 35 seconds, how much energy does the foil absorb? How much momentum is absorbed by the foil for the same time interval? Assume the foil is set up in the south-up plane.