Physics 302
Winter Quarter 1992
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George Williams

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FINAL EXAM

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Discussion Instructor (circle): Condella Godfrey-Smith Guilkey Leong Nott Paul

Discussion Section # _____

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) Calculate the magnetic field at the center of a circular coil of 45 turns carrying a current of 1.75 A. The coil has a diameter of 35.0 cm.

$d = 2R \qquad B = \frac{\mu_0 N I}{2R} = \frac{4\pi\ 10^{-7}\ 45\ 1.75}{.35} = 2.83\ 10^{-4}\ T$

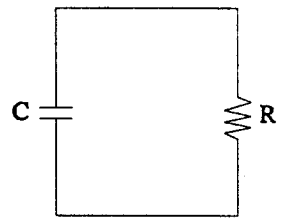
(b) Calculate the cyclotron frequency (in Hz) for electrons in a magnetic field of 4750 gauss.

$B = .4\ T \qquad f = \frac{qB}{2\pi m} = \frac{1.6\ 10^{-19}\ .475}{2\pi\ 9.11\ 10^{-31}} = 1.327\ 10^{10}\ Hz$

(c) Imagine that the magnetic field in some region of space varies as $B = B_0 + at + bt^2$, where B_0, a and b are positive constants. Calculate the maximum emf that is induced at t = 10 s in a coil of 45 turns and a diameter of 35.0 cm if placed in this region of space.

$\mathcal{E} = NA\frac{dB}{dt} = N\pi\left(\frac{d}{2}\right)^2(a+2bt) = 45\ \pi\left(\frac{.35}{2}\right)^2(a+20b) = 4.33(a+20b)$
$= 4.33a + 86.6b$

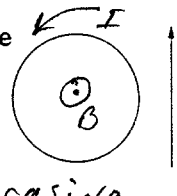
(d) If the capacitor shown has a charge of 45.0×10^{-3} C at t = 0, calculate the voltage across the capacitor at t = 5.00 s. (C = 4500 μF, R = 4800 Ω)



$Q(t) = Q_0 e^{-t/RC} \qquad V = \frac{Q}{C} \qquad RC = 21.6\ sec$

$V(t) = \frac{Q_0}{C} e^{-t/21.6} = \frac{45\ 10^{-3}}{4.5\ 10^{-3}} e^{-\frac{5}{21.6}} = 10\ e^{-.231} = 7.93\ V$

(e) A wire carries a current in the direction shown. The wire and the loop are in the plane of the paper. If the magnitude of the current in the wire is decreasing with time, is the induced current in the loop clockwise or counterclockwise?



Counter-clockwise, trying to keep $\vec{B}$ from decreasing

(f) A bolt of lightning with a peak current of 65,000 A strikes a tall metal post stuck in the ground. Calculate the peak value of the magnetic field 10.0 cm from the post. Center of post

$B = \frac{\mu_0 I}{2\pi r} = \frac{2\ 10^{-7}\ 6.5\ 10^4}{10^{-1}} = .1300\ T$