Physics 172
Winter Quarter 1983
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George Williams

FINAL EXAMINATION

7

Ave. 17.8

Name: Grader : Zhu

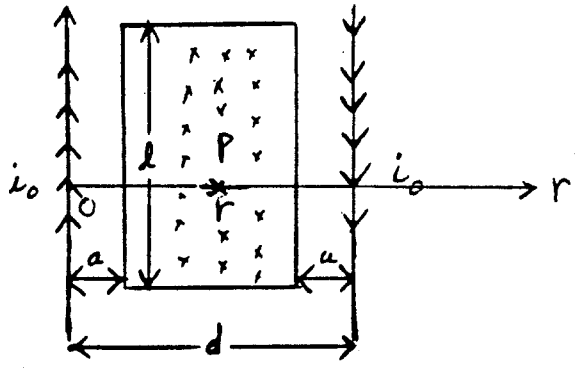
Discussion Instructor (CIRCLE ONE): Aamodt Galler Giddings Leaver

Discussion Section #_____ Mabud Saffer Sewell Stone

Two long straight wires are parallel and a distance d apart.

(a) Calculate the magnitude of the magnetic flux through the rectangular region shown. Each wire carries a current i_0, in the direction shown by the arrows.

(b) Now allow the current in both wires to vary as $i = i_0 e^{-kt}$, where k is a constant. Calculate the emf generated in the rectangular loop as a function of time.



SOLUTION:

15 (a) The magnetic field at point P (shown in figure) being given by superposition is

8 $$B(r) = \frac{\mu_0 i_0}{2\pi r} + \frac{\mu_0 i}{2\pi(d-r)}$$ (the direction of $\vec{B}$ is into page)

Then, the flux is

$$\Phi = \int_S \vec{B}(r)\cdot d\vec{S} = \int_a^{d-a} \left(\frac{\mu_0 i_0}{2\pi r} + \frac{\mu_0 i}{2\pi(d-r)}\right) l\, dr$$

7 $$\boxed{\Phi = \frac{\mu_0 i_0 l}{\pi} \ln\frac{d-a}{a}}$$

10 (b) If $i = i_0 e^{-kt}$, Now the flux is

$$\Phi = \frac{l\mu_0 i_0 e^{-kt}}{\pi} \ln\frac{d-a}{a}$$

emf is: $$\boxed{\mathcal{E} = -\frac{d\Phi}{dt} = \frac{l\mu_0 i_0 k e^{-kt}}{\pi} \ln\frac{d-a}{a}}$$