Dterm ECE221S – Quiz 4A –Monday, March 17, 2003

Family Name Given Name(s)	Student Number

Please Insert Your Name in Full and Student Number

1. Using Ampere's law $\left(\oint_C \mathbf{H}.d\mathbf{l} \;=\; I_{encl} \right)$ find the magnetic field due to an infinitely long wire (placed along the z-axis) carrying current *I*.
   (2 marks)

2. If I = 100A, calculate the total flux passing through a plane bounded by r = 1cm, r = 10cm, z = 5cm and z = 50cm. $\mu_0 = 4p \times 10^{-7}$ **(3 marks)**

Solution: 1): This question was done in class. From our usual application we know that the magnetic field **H** is in the f direction. As done in class choosing a circular loop of radius r, centered at the wire,

$$\oint_C \mathbf{H}.d\mathbf{l} \;=\; H_f \, 2pr \,.\, I_{encl} = I. \Rightarrow \;\; \mathbf{H} = \frac{I}{2pr}\mathbf{a}_r$$

2. The magnetic flux density $\mathbf{B} = \mu_0\mathbf{H}$. The flux through the plane is therefore

$y = \int_S \mathbf{B}.d\mathbf{s}$. In this case, d**s** = $dr\,dz\mathbf{a}_f$.

$$\int_S \mathbf{B}.d\mathbf{s} = \int_{z_1}^{z_2}\int_{u_1}^{r_2} \frac{m_0 I}{2pr} dr\,dz = (z_2 - z_1)\frac{m_0 I}{2p}\ln(r)\Big|_{r_1}^{r_2} \quad = \quad (z_2 - z_1)\frac{m_0 I}{2p}\ln\left(\frac{r_2}{r_1}\right)$$

$$= (50-5)\times 10^{-2} \times \frac{4p \times 10^{-7} \times 100}{2p}\ln(10) \;= 9\times 10^{-6}\ln(10) \;= 2.07\times 10^{-5}\,\text{Wb}$$