PHY2061 Name:_______________________ ___

11-18-04

Exam 3

Closed book exam. A calculator is allowed, as is one 8.5×11” sheet of paper with your own written notes. Please show all work leading to your answer to receive full credit. Answers should be calculated to 2 significant digits. Exam is worth 100 points, 25% of your total grade.

UF Honor Code: “On my honor, I have neither given nor received unauthorized aid in doing this exam.”

Sphere: $S = 4\pi r^2$ $\quad V = \frac{4}{3}\pi r^3$ $\quad \pi = 3.1415927$ $\quad m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$

$K = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \mathrm{N\,m^2/C^2}$ $\quad \varepsilon_0 = 8.8542 \times 10^{-12}\ \mathrm{C^2/N\,m^2}$ $\quad e = 1.6022 \times 10^{-19}\ \mathrm{C}$

$\mathbf{F} = K\frac{q_1 q_2}{r^2}\hat{\mathbf{r}}_{12}$ $\quad \Phi_E = \oint \mathbf{E}\cdot d\mathbf{A} = \frac{q_{enc}}{\varepsilon_0}$ $\quad \nabla\cdot\mathbf{E} = \frac{\rho}{\varepsilon_0}$ $\quad \mathbf{E} = -\nabla V$

$V = \frac{U}{q_0}$ $\quad \mathbf{E} = \frac{\mathbf{F}}{q_0}$ $\quad W = -\Delta U = q_0\int \mathbf{E}\cdot d\mathbf{s}$ $\quad \Delta V = -\int \mathbf{E}\cdot d\mathbf{s}$

$\nabla = \hat{x}\frac{\partial}{\partial x} + \hat{y}\frac{\partial}{\partial y} + \hat{z}\frac{\partial}{\partial z}$ $\quad \nabla\cdot\mathbf{F} = div(\mathbf{F}) = \frac{\partial F_x}{\partial x} + \frac{\partial F_y}{\partial y} + \frac{\partial F_z}{\partial z}$ $\quad \int_V \nabla\cdot\mathbf{F}\, dV = \oint \mathbf{F}\cdot d\mathbf{A}$

$\mathbf{F} = grad(f) = \nabla f$

$Q = C\Delta V$ $\quad U = \frac{1}{2}C(\Delta V)^2 = \frac{Q^2}{2C}$ $\quad C_{eff} = C_1 + C_2$ $\quad \frac{1}{C_{eff}} = \frac{1}{C_1} + \frac{1}{C_2}$

$\Delta V = iR$ $\quad P = Vi = i^2 R = \frac{V^2}{R}$ $\quad R_{eff} = R_1 + R_2$ $\quad \frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2}$

$R = \rho\frac{L}{A}$ $\quad i = \frac{dq}{dt}$ $\quad c = 3.0 \times 10^8\ \mathrm{m/s}$ $\quad 1\ \mathrm{eV} = 1.6022 \times 10^{-19}\ \mathrm{J}$

$\mathbf{F} = q(\mathbf{E} + \mathbf{v}\times\mathbf{B})$ $\quad \mathbf{F} = i\,\mathbf{L}\times\mathbf{B}$ $\quad k = \frac{K}{c^2} = \frac{\mu_0}{4\pi} = 10^{-7}\ \mathrm{T\cdot m/A}$

$\mu_0 = 4\pi k = 1.257 \times 10^{-6}\ \mathrm{T\cdot m/A}$

$d\mathbf{B} = k\frac{i\, d\mathbf{s}\times\mathbf{r}}{r^3}$ $\quad \oint \mathbf{B}\cdot d\mathbf{s} = \mu_0 i_{enc}$ $\quad \mathbf{B}_{wire} = \frac{\mu_0 i}{2\pi r}\hat{\mathbf{r}} = \frac{2ki}{r}\hat{\mathbf{r}}$

$\boldsymbol{\mu} = i\mathbf{A}$ $\quad \boldsymbol{\tau} = \mathbf{r}\times\mathbf{F}$ $\quad \boldsymbol{\tau} = \boldsymbol{\mu}\times\mathbf{B}$ $\quad U = -\boldsymbol{\mu}\cdot\mathbf{B}$ $\quad F_z = \mu_z\frac{dB_z}{dz}$

$\Phi_B = \int \mathbf{B}\cdot d\mathbf{A}$ $\quad \mathcal{E} = -N\frac{d\Phi_B}{dt}$ $\quad \Delta V_L = L\frac{di}{dt}$ $\quad L = \frac{N\Phi_B}{i}$

$U = \frac{1}{2}Li^2$ $\quad u = \frac{U}{V} = \frac{B^2}{2\mu_0} + \frac{\varepsilon_0 E^2}{2}$

$\tau_{RC} = RC$ $\quad \tau_{LR} = \frac{L}{R}$ $\quad \omega_{LC} = \frac{1}{\sqrt{LC}}$ $\quad \Delta V_S = \frac{N_S}{N_P}\Delta V_P$

$\mathbf{a}\cdot\mathbf{b} = a_x b_x + a_y b_y + a_z b_z$ $\quad \mathbf{a}\times\mathbf{b} = (a_y b_z - b_y a_z)\,\mathbf{i} - (a_x b_z - b_x a_z)\,\mathbf{j} + (a_x b_y - b_x a_y)\,\mathbf{k}$

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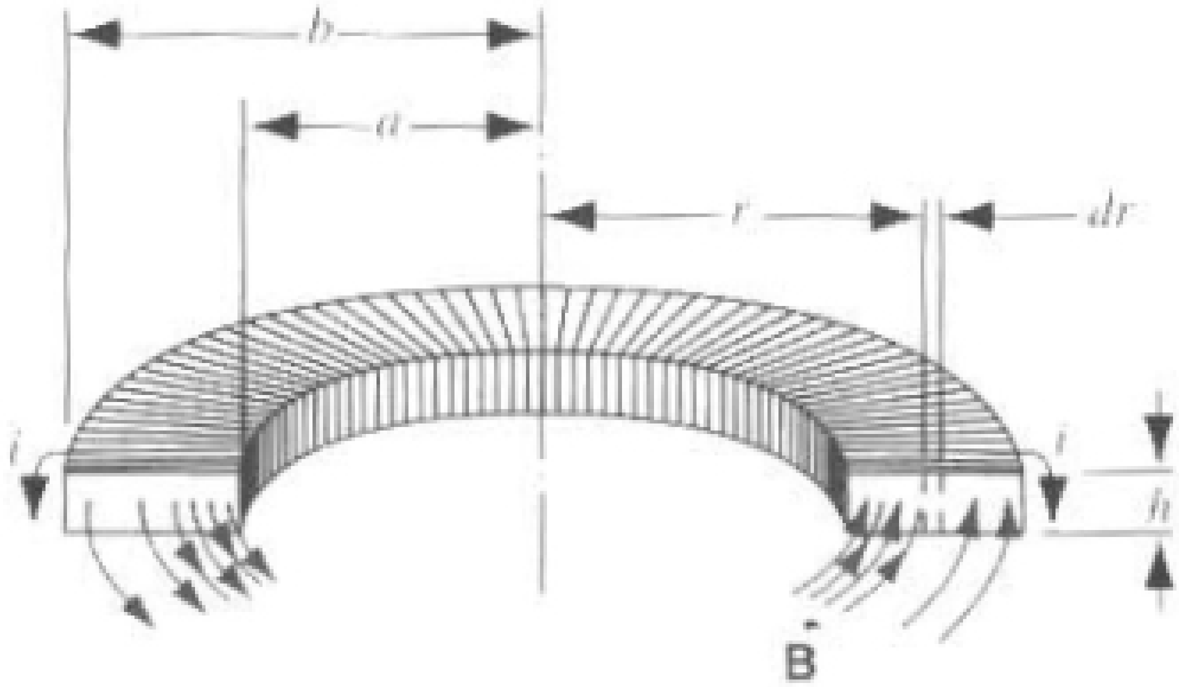

1. Consider the toroid shown with an inner radius a = 5 cm and an outer radius b = 6 cm. The total number of turns of wire wound around the toroid is N = 400. The core of the toroid has a rectangular cross-section with a thickness h = 0.5 cm.

   (a) [6 points] If the wire carries a current of 2A, what is the magnitude of the magnetic field inside the toroid at a radius midway between the inner and outer radii?

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1. Continued
(b) [8 points] Calculate the inductance of the toroid.

2. [8 points] A long straight wire with a cylindrical cross-section has a radius of 0.3 mm and carries a current of 100 mA uniformly spread across its cross-section. What is the ratio of the magnetic field at a radius of 0.1 mm to that at the surface of the wire?