Physics 52 **Exam 2** **October 23, 1995**

Name ________________________

Work directly on these pages and show your work clearly. Properly labeled figures are important and will figure into the grading.

Perform the integrations on this exam. One may require a simple change of variable to eliminate a constant. in the denominator.

Mark one answer to each of the following five questions.

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
Total

1. [5 pts] In the equation $d\mathbf{F} = i d\mathbf{r} \times \mathbf{B}$, $d\mathbf{r}$ is in the direction $(\hat{\boldsymbol{x}} + 3\hat{\boldsymbol{y}}) / \sqrt{10}$ and **B** points in the $\hat{\boldsymbol{z}}$ direction. The force vector then points in the direction

(a) $(\hat{\boldsymbol{x}} - 3\hat{\boldsymbol{y}}) / \sqrt{10}$

(b) $(3\hat{\boldsymbol{x}} - \hat{\boldsymbol{y}}) / \sqrt{10}$

(c) $(3\hat{\boldsymbol{x}} + \hat{\boldsymbol{y}}) / \sqrt{10}$

2. [5 pts] In the equation $d\mathbf{B} = \frac{\mu_0}{4\pi} \frac{i d\mathbf{l} \times \hat{\mathbf{r}}}{r^2}$, $\hat{\boldsymbol{r}}$ points

(a) along the path followed by the current.

(b) from the current element to the point were **B** is to be determined.

(c) from the point were **B** is to be determined to the current element.

3. [5 pts] In the equation $\Phi_B = \int_S \boldsymbol{B} \quad d\boldsymbol{A}$, the magnetic field

(a) may change with time but must not vary over the infinitesimal area d**A**.

(b) must not be changing with time.

(c) must be perpendicular to d**A**.

4. [5 pts] The magnetic flux through an area can change because of

(a) a changing magnetic field.

(b) a change in the size or position of the area.

(c) both (a) and (b).

(d) neither (a) or (b).

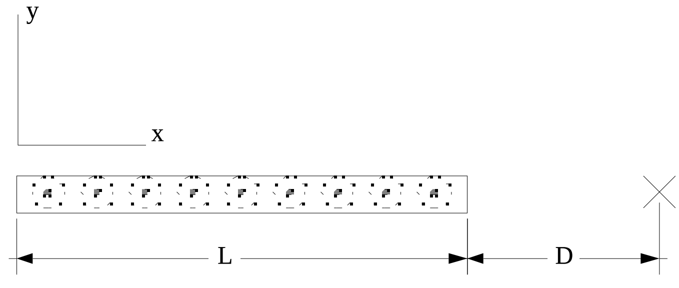
5. [5 pts] If $j = \sqrt{-1}$ the phase angle of the expression $1 + j2$ is

(a) Arctan ($\sqrt{5}$).

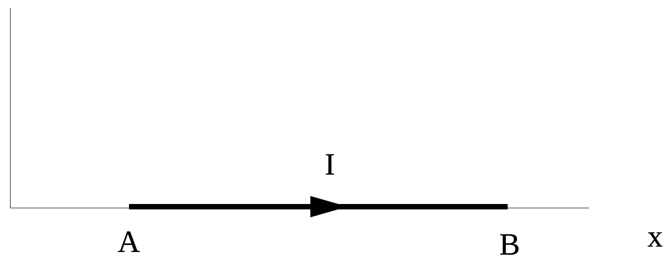
(b) Arctan (2).

(c) Arctan (0.5).

6. [*15 pts*] A long flat ribbon in the *x*-*z* plane carries a uniformly distributed current directed out of the paper as shown. The outwardly directed pointers within the ribbon are just meant to indicate a uniform current distribution throughout the transverse cross section shown. If the total current in the ribbon is I, determine an expression for the total magnetic field **B** at the point marked with the ×. The magnitude of the magnetic field around a single wire is $B = \frac{\mu_0 i}{2\pi r}$.

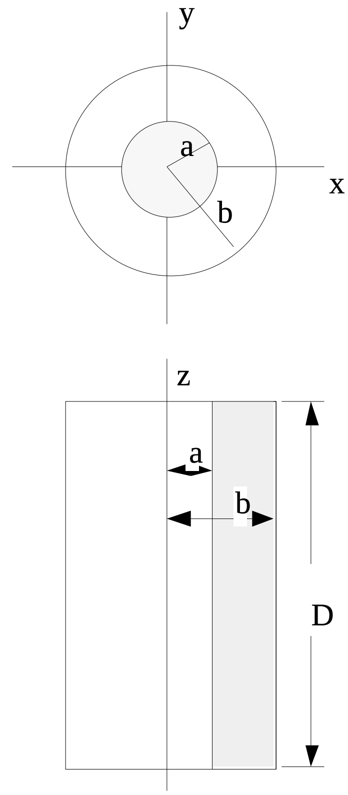


7. [*15 pts*] Consider a short length of current carrying wire running from point A to point B along the x-axis as shown. If an applied magnetic field $\boldsymbol{B} = (C + Dx)\hat{\boldsymbol{z}}$ exists at points along the wire, derive a vector expression for the total force exerted on the wire.

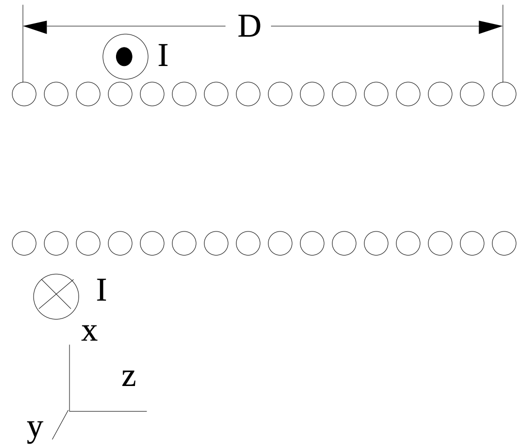


8. [*15 pts*] Determine the inductance of a long length D of a coaxial cable with an inner wire of radius a and an outer shell of radius b as shown in the figure. In addition to equations given elsewhere in this exam, you will need to remember that $L = \frac{\Phi}{I}$.

I'll tell you that to have a current, you must assume that the inner wire is connected to the outer shell at each end of the coax, and that if we assume $a << b$ then the flux of interest passes through the shaded rectangle indicated in the lower view of the coax. Clearly identify your unit vectors.



9. [*15 pts*] Use Ampere's law $\oint_C \mathbf{B} \cdot d\mathbf{r} = \mu_0 I$ to determine the magnetic field inside a long solenoid that has N turns distributed uniformly over a length D. Explain clearly how you eliminate the circle on the integral and the dot product using words, equations, pictures and unit vectors.



10. [*15 pts*] A ***square*** loop of wire is rotating about the *z*-axis in the direction shown. This region of space is filled with a uniform magnetic field $\mathbf{B} = B_0\hat{\mathbf{y}}$

(a) At the instant shown in the sketch indicate the direction of the induced current. Show this on ***both*** views.

(b) Also indicate the direction of the resulting force on ***all four sides*** of the square. Use both views where needed to make the direction clear.

(c) Are all four forces equal in magnitude?