KOÇ UNIVERSITY
College of Sciences
PHYS 102 General Physics 2
Spring Semester 2015
Midterm 2 Exam
May 08, 2015 Friday, 17:30-19:00

Please read.

• Count to make sure that there are 5 pages in this question booklet
• Check your name, number, on front page, and student ID on each page.
• This examination is conducted with closed books and notes.
• Put all your personal belongings underneath your seat and make sure that pages of books or notebooks are not open.
• Absolutely no talking or exchanging anything (like rulers, erasers) during the exam.
• You must show all your work to get credit; you will not be given any points unless you show the details of your work (this applies even if your final answer is correct).
• Write neatly and clearly; unreadable answers will not be given any credit.
• If you need more writing space, use the backs of the question pages and put down the appropriate pointer marks.
• Make sure that you include units in your results.
• Make sure that you label the axis and have units in your plots.
• You are not allowed to use calculators during this exam.
• Turn off your mobile phones, and put away.
• You are not allowed to leave the class during the first 15 minutes, and last 15 minutes.

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1-(25 Points) For the circuit shown in the figure, the switch S is at position 2 for a long time and the capacitor is totally discharged. At the time t=0, the switch S is moved to position 1 and the capacitor is being charged. Express your answers in terms of some or all of the given quantities and related constants.

a) Write an expression for the charge on the capacitor as a function of time t.

b) Find the voltage across the resistor 2R as a function of time t.

c) After the capacitor is fully charged, the switch S is moved to position 2 at a new time t=0 and the capacitor is discharging. Draw graphs of the charge versus time and the current versus time for this discharging process. In each graph indicate the values of charge and current at time t=0.
2-(25 Points) The rectangular coil $abcd$ shown in the figure has $N=2000$ turns of a wire which carries a current of $I=0.50 \text{ A}$. The coil is initially oriented in such a way that its magnetic dipole moment is given by $\vec{\mu} = \mu(-0.80\hat{i} + 0.60\hat{j})$ where $\mu$ is the (positive) magnitude with units $\text{A.m}^2$. A uniform magnetic field $\vec{B} = (4.0\hat{i} + 3.0\hat{j}) \text{T}$ is present everywhere in the space.

a) Find the magnetic torque, in unit vector notation, on the coil in the initial position.

b) Find the magnetic force, in unit vector notation, on the side $bc$ of the coil in the initial position.

c) When the coil rotates until it is in stable equilibrium position, find the change in the coil’s potential energy, $\Delta U$, between its initial and final positions. (The coil has stable equilibrium position when its final magnetic dipole moment is parallel to the magnetic field.)
3-(25 Points) No points will be given for unjustified answers.

(i) Two long parallel wires 10 cm apart carry currents of 8 A in opposite directions. What is the magnetic field halfway between them?

Answer: (6 points)

(ii) Two long, parallel wires are separated by a distance of 5 cm. The currents, 20 A each, are in the same direction. Calculate the magnitude and direction of the force exerted by each wire on an 800 cm length of the other.

Answer: (6 points)

(iii) A solenoid 0.3 m long has 1000 turns of wire and is oriented with axis parallel to the earth’s magnetic field at a place where the latter is $2 \times 10^{-5}$ T. What should be the current in the solenoid be in order that its field exactly cancel the earth’s field inside the solenoid? (You may take $\pi=3$.)

Answer: (6 points)

(iv) A negative charge $q = -2.8 \ \mu C$ is located at the origin and has velocity $v = (20 \ km / s)(\hat{i} - \hat{j})$. At this instant what are the magnitude and direction of the magnetic field produced by this charge at the point $(x = 0.2 \ m, y = 0.2 \ m, z = 0)$? (You may take $\sqrt{2} \sim 1.4$.)

Answer: (7 points)
4-(25 Points) A very long straight wire and a short piece of half-square shaped wire are in close distance with each other as shown in the figure. Here, $a$ is the shortest distance between the wires, $L$ is the side-length of the short wire, and $I_1$ and $I_2$ are the time-independent currents.

Find the
(a) direction and
(b) magnitude
of the force exerted on the short wire by the long wire.

(c) What is the force exerted on the long wire by the short wire?