Name, Surname:	Student ID Number:
Exam Room:	Signature:

KOÇ UNIVERSITY

College of Sciences

PHYS 102 General Physics 2

Fall Semester 2022

Midterm 2 Exam

December 30, 2022 Friday, 19:00-21:00

Please read.

- Please turn off mobile phones and stow away your belongings. Have your student ID ready for attendance check. Only exam booklet, pencil and eraser are allowed throughout the exam.
- Check that there are 4 question sheets in this question booklet.
- Use only black pencil for writing.
- Write your **name, number, on front page, and student ID on each page.**.
- Write neatly and clearly; unreadable answers will not be given any credit.
- **Final answers must be written into the respective answer box. It may not get credit otherwise.**
- A final answer that is not based on a reasonable, consistent solution attempt on the exam paper may not get credit even if it coincides with the correct answer.
- Use the back pages in case you need more blank space. Label the continuing solution clearly.

IMPORTANT: Do not continue the solution of a question on a different question sheet!

- Mathematical expressions in the result must be simplified as possible. Mathematical and physical constants may be left in symbolic form, unless their numerical value for a calculation is explicitly requested in the problem.
- If applicable, make sure to include units in your final answer.
- In graphing questions, use proper scaling, label the axes and indicate units.
- Using calculators is not allowed.
- Students must respect the time restrictions on leaving/entering the exam room as stated by the exam proctors.

Integrals:

$$\int x^n dx = \frac{x^{n+1}}{n+1} \quad (n \neq -1) \qquad \int \frac{dx}{x} = \ln x \qquad \int e^{ax} dx = \frac{1}{a} e^{ax}$$

$$\int \sin ax\, dx = -\frac{1}{a}\cos ax \qquad \int \cos ax\, dx = \frac{1}{a}\sin ax \qquad \int \frac{dx}{\sqrt{a^2 - x^2}} = \arcsin\frac{x}{a}$$

$$\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln\left(x + \sqrt{x^2 + a^2}\right) \qquad \int \frac{dx}{x^2 + a^2} = \frac{1}{a}\arctan\frac{x}{a} \qquad \int \frac{dx}{(x^2 + a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2 + a^2}}$$

$$\int \frac{x\, dx}{(x^2 + a^2)^{3/2}} = -\frac{1}{\sqrt{x^2 + a^2}}$$

P102_Index:

1	2	3	4	Total

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Q1-(25 pts) A bulb with resistor R is connected across the terminals of a battery which has emf ε and internal resistance. It is found that 85% of the power is delivered to the bulb. Answer the following accordingly.

a) (15 pts) Determine the internal resistance of the battery in terms of R.

b) (10 pts.) For $R = 6.8\Omega$, determine the potential difference across the terminals of the battery in the circuit in terms of ε.

Solution continues on the back side of the page **Yes** □ **No** □

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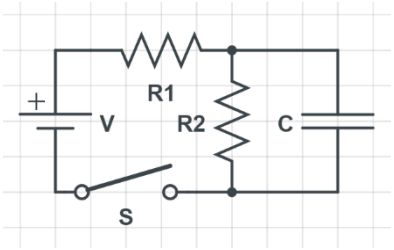
Q2- (25 pts) The circuit in the figure contains an ideal battery V, resistors R_1, R_2, an uncharged capacitor C and a switch. Answer the following in terms of these given parameters only.



a) [5 pts.] At time $t = 0$, the switch is closed. Calculate v_{R1} (the potential across R_1) and i_{R2} (the current through the resistor R_2) at $t = 0$.

$v_{R1} =$

$i_{R2} =$

b) [8 pts.] When fully charged, calculate the amount charge stored in the capacitor.

$Q_f =$

c) [12 pts.] When the capacitor is fully charged, the switch is opened. Calculate the time required for v_{R2} (the potential across R_2) to decrease to $\frac{1}{5}$ th of the value it had before the opening of the switch.

$t_{1/5} =$

Solution continues on the back side of the page **Yes** □ **No** □

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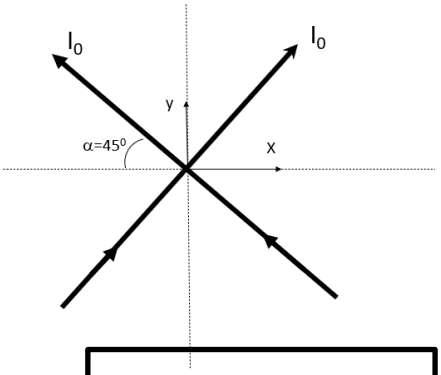
Q3- **(25 pts)** Two infinitely long current-carrying straight wires cross at 90-degree angle as shown in the Figure. The wires carry the same amount of current I_0 and they do not have electrical contact.

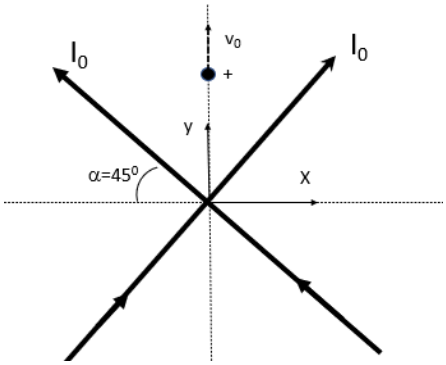


a) Calculate the magnetic field along the given x-axis and y-axis as a function of distance from the origin. Indicate the direction of magnetic field clearly.

B(x, y=0) =

B(x=0, y) =

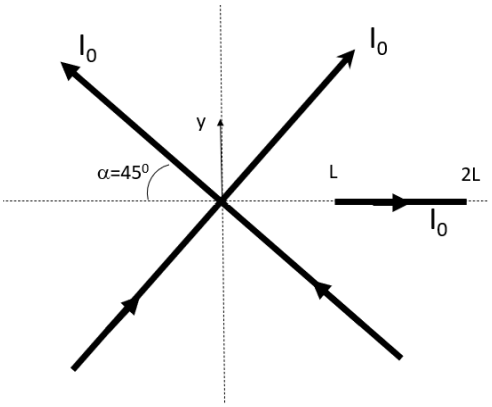
b) Suppose that a positively charged particle starts to move with $\vec{v} = v_0\hat{j}$ initial velocity on the y-axis. Calculate the force acting on the particle and plot the trajectory.



$\vec{F} =$

c) Part of a cable is located on the x-axis between points $x = L, x = 2L$. The cable carries a current I_0 in the $\hat{\imath}$ direction. Calculate the magnetic force $\vec{F}$ acting on this part of the cable.

$\vec{F} =$



Solution continues on the back side of the page **Yes** □ **No** □

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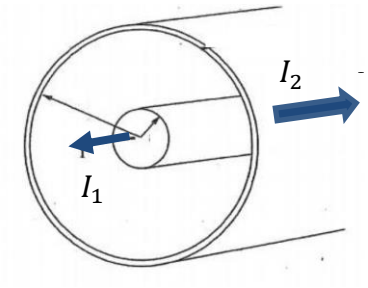
Q4- (25 pts) A solid cylindrical conductor of radius R and a thin hollow cylindrical conductor of radius $3R$ form a coaxial cable that is infinitely long. The inner conductor carries current $I_1 = 3.0\,A$, the outer conductor carries a current $I_2 = -9A$ (in opposite direction). The currents are uniformly distributed respectively through the inner solid conductor and on the surface of the outer conductor. Take the origin on the center axis (z-axis) of the cables.



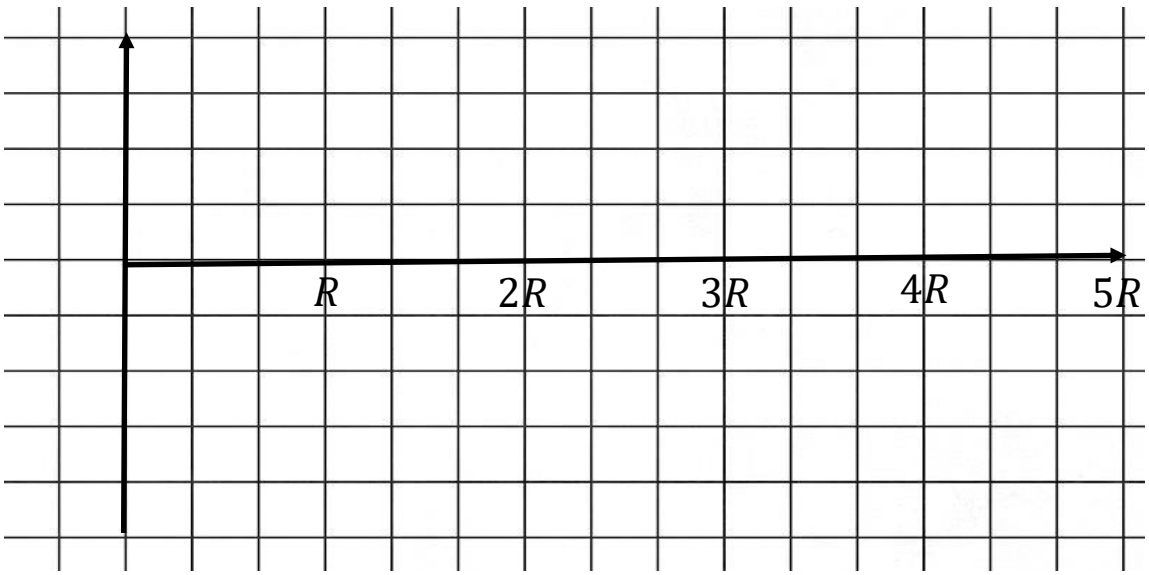
a) Calculate the magnitude and the direction of the magnetic field $\vec{B}(r)$ for the regions given below as a function of distance (r) from the center.

r> 3R, B(r) =

R < r < 3R, B(r) =

r< R, B(r) =

b) Plot the magnetic field $\vec{B}(r)$ as a function of distance from the center, taking the direction into account.



Solution continues on the back side of the page **Yes** □ **No** □