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

KOÇ UNIVERSITY

College of Sciences
PHYS 102 General Physics 2
Spring Semester 2022
Final Exam

June 2, 2022 Thursday, 11:45 – 13:40

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

P102_Index:	Student ID Number:
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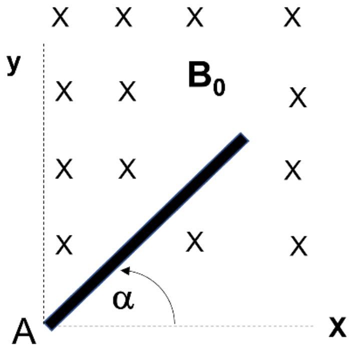
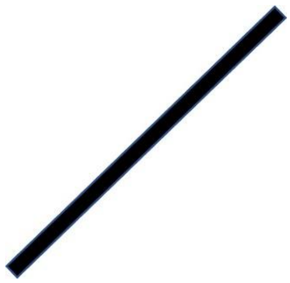
Q1-(25 pts) A thin uniform bar has mass $\mathbf{m_0}$ and length **L**. It pivots without friction about an axis perpendicular to the bar at point A in. The gravitational field (**g**) on the bar acts in the -y direction. The bar is in a **uniform magnetic field** that is directed into the page and has magnitude $\mathbf{B_0}$.



a) What must be the current (I, flowing between two end points) for the bar to be in rotational equilibrium when it is at an angle **a** above the horizontal? (Show all your calculations)

I=

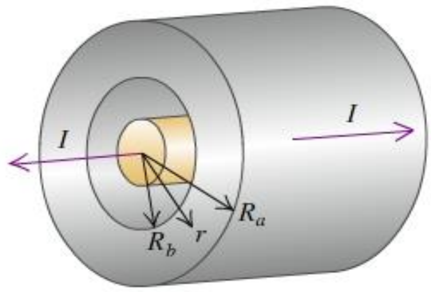
b) For the bar to be in rotational equilibrium, show the direction of the current with an arrow on the bar given below.



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

P102_Index:	Student ID Number:
Exam Room:	Signature:

Q2-(25 pts) A solid cylindrical conductor is supported by insulating disks on the axis of a conducting tube with outer radius R_a and inner radius R_b. The central conductor and the conducting tube carry equal current of I in opposite directions. The current is distributed uniformly over the cross section of the cylindrical conductor. The central conductor's thickness is negligible.



a) (8 pts.) Calculate the magnetic field at a distance r from the axis of the conducting tube for $r > R_a$.

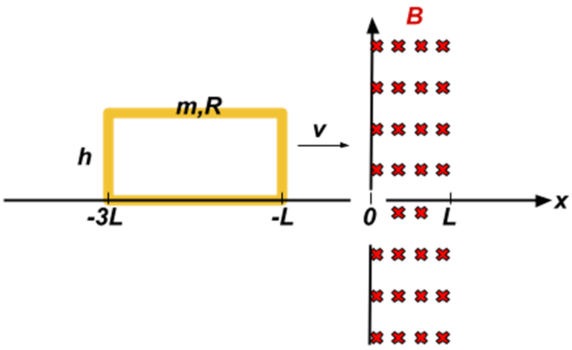
b) (9 pts.) Calculate the magnetic field at a distance r from the axis of the conducting tube for $R_b < r < R_a$.

c) (8 pts.). Calculate the magnetic field at a distance r from the axis of the conducting tube, where $r < R_b$ and outside the central conductor.

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

P102_Index:	Student ID Number:
Exam Room:	Signature:

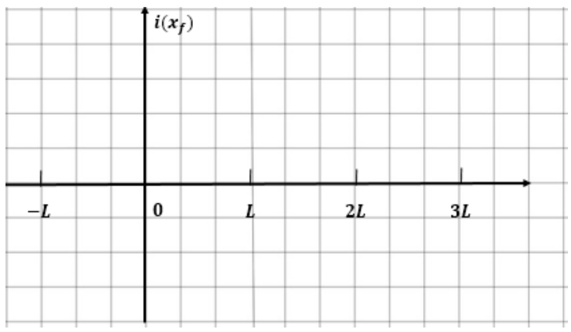
Q3-(25 pts) A rectangular conducting wire loop with mass m, resistance R, and dimensions $h \times 2L$ is moving with an initial speed v towards a region 0<x<L where a constant uniform magnetic field B is present that is directed perpendicular to the plane of the loop (into the page), as shown. The magnetic field is nonzero only in the region $0 < x < L$, where it has a uniform intensity B. Lorentz force is the only force acting on the loop.
Let x_f be the horizontal position of the loop's front edge ($x_f = -L$ in the figure). Assume that the initial speed is large enough, so that $x_f \to \infty$ as $t \to \infty$.



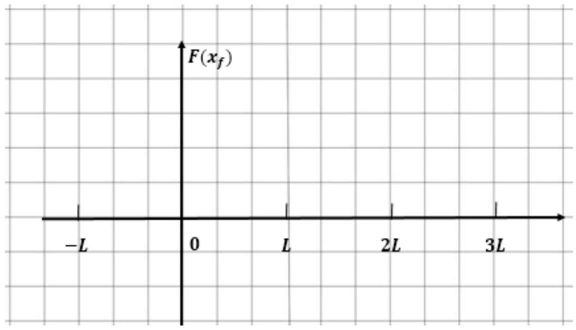
a) (6 pts.) What is the maximum current induced in the loop?

b) (7 pts.) Using Newton's second law, find a first-order differential equation for the loop's speed $v(t)$, valid for $0 \leq x_f \leq L$.

c) (6 pts.) Sketch the current on the loop as a function of $x_f \in [-L, 3L]$. Assume the clockwise orientation to be positive and counter-clockwise orientation to be negative.



d) (6 pts.) Sketch the net horizontal force on the loop as a function of $x_f \in [-L, 3L]$. Assume a force to the right to be positive.



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

P102_Index:	Student ID Number:
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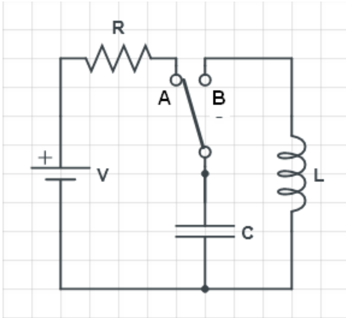
Q4-(25 pts) In the circuit, $V = 12V, R = 300\Omega, C = 100\ \mu F, L = 80\ mH$. The capacitor is initially empty. **At time $t = 0$, the switch is set to position "A".**

******All numerical results must be given in SI units. Show your calculation steps explicitly for each part*****



a) (5 pts.) Calculate the maximum current that passes through the capacitor.

b) (7 pts.) How much energy is dissipated on the resistor until its voltage became $2V/3$?

When the voltage on the capacitor became $V/2$, the switch is set to position "B" and the time is reset to $t = 0$. Answer the following accordingly.

c) (7 pts.) Calculate the current through the inductor, when the capacitor has $3/7$ of its initial charge.

d) (6 pts.) Find the ratio of the energy of the inductor L to the capacitor at time $t = \frac{\pi}{3\omega}$ where ω is the electrical oscillation frequency.

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