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

# KOÇ UNIVERSITY

## College of Sciences
## PHYS 102 General Physics 2
## Spring Semester 2019
## Midterm 1 Exam
## March 6, 2019 Wednesday, 19:00-20:40

# 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.
- Write your final answers into the boxes. No points will be given to unjustified answers. Incomplete calculations will not be graded.

**P102_Index:**

| 1 | 2 | 3 | 4 | Total |
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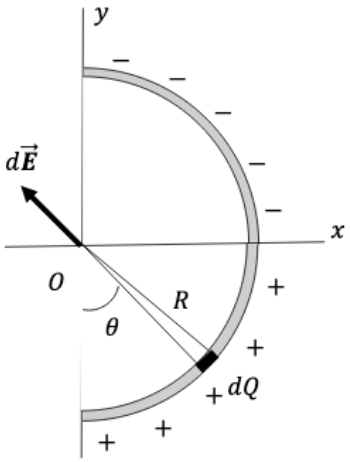
**Q1-(25 pts)** A thin non-conducting rod is bent into a semicircle of radius *R*. A charge *-Q* is uniformly distributed along its top half and a charge *+Q* is uniformly distributed along its bottom half, as shown in the figure.




(a-15pts) Find the magnitude of the electric field at the origin O.

(b-5pts) What is the direction of the electric field at the origin O?

(c-5pts) Determine the acceleration of an electron (charge *–e*, mass *m*) placed at the origin O.



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

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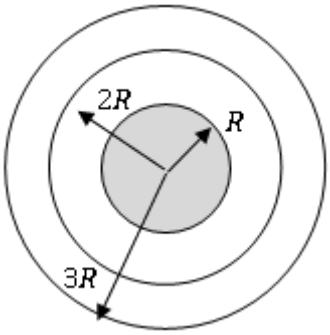
**Q2-(25 pts)** A non-conducting sphere of radius $R$ has total charge $Q$ that is distributed uniformly through its volume. The sphere is inside a concentric, isolated, conducting spherical shell of inner radius $2R$ and outer radius $3R$. Given that the electric field at the surface of the non-conducting sphere and at the outer surface of the conductor shell are equal.




(a) Determine the charge density at the inner surface of the conductor.

(b) Determine the net charge on the conductor.

(c) Determine and plot the magnitude of the electric field in the range $0 \leq r < \infty$.



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

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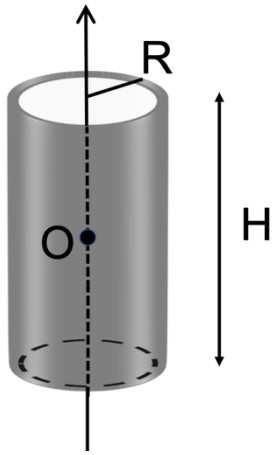
**Q3-(25 pts)** A hollow cylinder of radius $R$ and height $H$ carries a total charge $Q$ uniformly distributed over its surface (see the figure).




(i) Find the electric potential at the origin $O$.
(Hint: $\int \frac{dx}{\sqrt{a^2+x^2}} = \ln\left(\sqrt{a^2+x^2}+x\right)$ +const.)

(ii) Verify that your result reduces to that of a ring of charge if $H \ll R$.
(Hint: $\ln(1+x) \cong x$, $\sqrt{1+x} \cong 1 + x/2$, for $x \ll 1$.)



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

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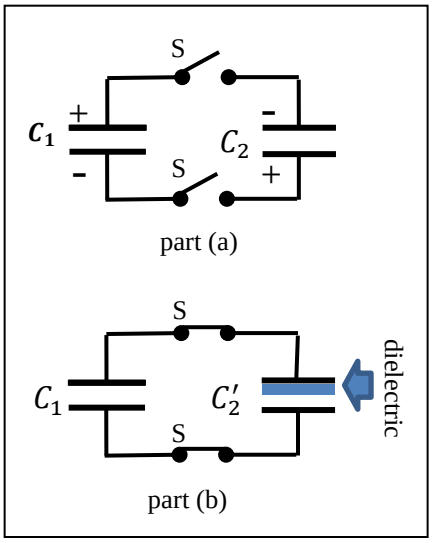
**Q4-(25 pts)** Two <u>different</u> capacitors $C_1$ and $C_2$ (where $C_1 > C_2$) are charged to the same initial potential difference $V_0$. The charged capacitors are connected with <u>opposite polarity</u> and the switches (S) are closed. Equilibrium has been reached.




(a-15pts) Determine the new electric potential on $C_1$ and the ratio of the initial and final total electrostatic energy stored in the capacitors ($U_{final}/U_{initial}$) in terms of $C_1$, $C_2$ and $V_0$.

(b-10pts) With the switches in closed position, a slab of dielectric constant $K > 1$ is inserted to fill the <u>upper half space</u> in the second capacitor as shown in the figure and equilibrium has been reached. Determine the new electric potential on $C_1$ in terms of $C_1$, $C_2$, $V_0$ and $K$.



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