



**Mahindra University Hyderabad**  
École Centrale School of Engineering  
End Semester examination

Program: B. Tech.

Branch: ALL Year: II  
Subject: PHYSICS-II (PH 2102)

Semester: I (Fall 2024)

Date: 13-12-2024

Time Duration: 3 Hours

Start Time: 10:00 to 1:00 PM

Max. Marks: 60

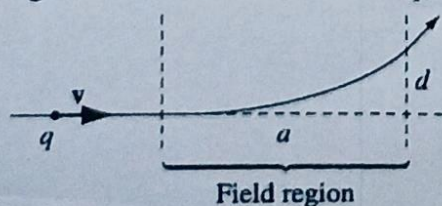
Instructions:

1) Answer all the questions.

2) Important: Answer all parts of a given question together. Otherwise, they won't be evaluated!

3) All the best!

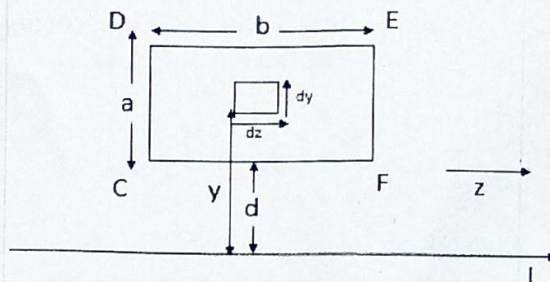
1. (a) Explain the skin depth of a conductor.  
(b) What is total internal reflection and mention its **two** technological applications.  
(c) Estimate transmission and reflection coefficients of a glass (of refractive index 1.5) - air (refractive index) interface. 2+4+4
2. (a) A long cylindrical magnet (length  $L$  and radius  $a$ ) carries a magnetization  $\vec{M}$  parallel to its axis and passes at constant speed  $v$  through a circular wire ring of slightly larger diameter. Plot the graph of generated emf as a function of time.  
(b) Write any **two** applications of mutual inductance.  
(c) Consider a conducting loop in a magnetic field that points up and is increasing in magnitude. What would be the direction of the  $\vec{B}_{ind}$ ? 4+2+4
3. a) What is a quarter wave plate and a half wave plate? Mention **one** application of each.  
(b) Why does one choose a **larger diameter** objective in a telescope?  
(c) Calculate the *fringe visibility* of an interference pattern with a maximum intensity of 0.9 and minimum intensity of 0.05. 4+3+3
4. (a) Find  $\int_{-3}^0 (x^3 - x^2 + 2x) \delta(x+2) dx$  and  $\int_{-1}^1 e^x \cos(x) \delta(x-2) dx$ .  
(b) The space between the plates of a parallel plate capacitor with a plate separation  $s$  and a surface area  $A$  is partially filled with a dielectric plate of dielectric constant  $\epsilon$ , and of thickness  $t < s$ . Assuming  $s, t \ll A$ , find the capacitance of the system. 5+5
5. (a) A particle of charge  $q$  enters a region of uniform magnetic field  $\vec{B}$  (pointing *into* the page). The field deflects the particle a distance  $d$  above the original line of flight as shown in the figure. Is the charge positive or negative? In terms of  $a, d, B$  and  $q$ , find the momentum of the particle.





(b) A current  $I$  is flowing through a thin and very long conductor along its length ( $z$ ) axis. Consider a rectangular loop of width  $a$  and height  $b$  in the  $y$ - $z$  plane as shown in the figure. Find the flux crossing the loop.

5+5



6. (a) Show that the wave described by the equation  $E(x, t) = A \cos(\omega x \pm vt)$ , where  $A$  is a constant vector, and  $\omega$  and  $v$  are constant scalars, satisfies the three-dimensional wave equation. Express the velocity of the wave in terms of  $n$ ,  $c$ , and  $\omega$ , where  $n$  is the refractive index of the medium.

(b) A glass dish with a plane parallel bottom and of refractive index (r.i.) 1.51 is half-filled with water. Then liquid CS<sub>2</sub> is poured on top of it, and on top of CS<sub>2</sub> (r.i. = 1.63), a thin cover glass of finite thickness and r.i. = 1.51 is placed on top of the dish. A beam of light making an angle of  $50^\circ$  with the vertical is incident on the horizontal cover glass. Obtain the angles that the incident beam makes with the vertical at each interface till it exits into air again.

5+5

.....End.....

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N.m}^2$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ N/A}^2$$