BITS, PILANI – DUBAI
International Academic City, Dubai
I-Year II-Semester 2007-08
COMPREHENSIVE EXAM (Closed Book)

Course Name:	Physics II;	**Course No.:**	PHY C132;
Date:	1st June'08;	**Weightage:**	40%;
Duration.:	3 Hrs;	**Max Marks:**	120

Note: *Divergence (Spherical polar):* $\nabla \cdot \mathbf{v} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\sin\theta\, v_\theta) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi}$

Curl (Cylindrical): $\nabla \times \mathbf{v} = \left[\frac{1}{s}\frac{\partial v_z}{\partial \phi} - \frac{\partial v_\phi}{\partial z}\right]\hat{\mathbf{s}} + \left[\frac{\partial v_s}{\partial z} - \frac{\partial v_z}{\partial s}\right]\hat{\boldsymbol{\phi}} + \frac{1}{s}\left[\frac{\partial}{\partial s}(s v_\phi) - \frac{\partial v_s}{\partial \phi}\right]\hat{\mathbf{z}}$

{$c = 2.998 \times 10^8$ m·s^{-1} ; $\mu_0 = 4\pi \times 10^{-7}$ N A^{-2}; $\varepsilon_0 = 8.85 \times 10^{-12}$ F·m^{-1};

$h = 6.63 \times 10^{-34}$ J·s; $e = 1.602 \times 10^{-19}$ C; $m_e = 9.1 \times 10^{-31}$ kg; $m_p = 1.67 \times 10^{-27}$ kg}

PART A

1. A long coaxial cable carries a uniform volume charge density ρ on the inner cylinder (radius a) ,and a uniform surface charge density on the outer cylindrical shell (radius b). This surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral. Find the electric field between the cylinders (a‹s‹b)? **(10)**

2. Find the energy stored in a uniformly charged solid sphere of radius R and charge Q? **(10)**

3. A long straight wire , carrying uniform line charge λ, is surrounded by rubber insulation out to a radius R. Find the electric displacement and electric field at any point s>R. **(10)**

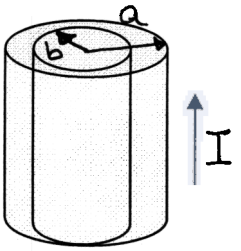
4. A sphere of radius R carries a polarization P(r) =kr $\hat{r}$ where k is a constant and r is the vector from the center. (a) Calculate the all bound charges (b) Find the electric field inside the sphere. **(5+5)**

PART B

5. A current I flows down a wire of radius a. (a) If it is uniformly distributed over the surface, what is the surface current density K.? (b) If it is distributed in such a way that the volume current density is inversely proportional to the distance from the axis, what is J. **(10)**

6. Figure shows a hollow cylindrical conductor of inner and outer radii ***b*** and ***a*** respectively, carrying a uniformly distributed current I, (a) using circular Amperian loop find Magnetic field B (b≤r≤a).

(b) test this formula for r = ***a***, r = ***b*** and ***b*** = 0 **(10)**

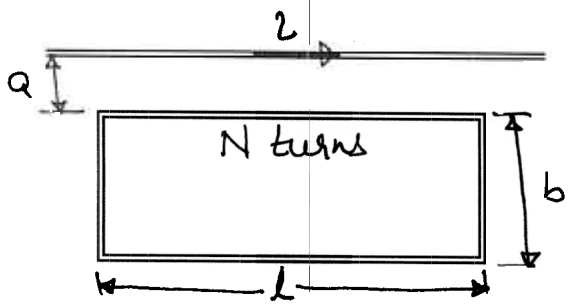


7. A long circular cylinder of radius R carries a magnetization $M = ks^2\hat{\varphi}$, where k is a constant, ***s*** is the distance from the axis and φ is the usual azimuthal unit vector. (a) Find the magnetic field due to M for points inside and outside the cylinder. (b) Find all the bound currents. **(10)**

8. A current I flows along the +x axis through a long straight wire of radius ***a***. If the wire is made of linear material with susceptibility χ_m and the current is distributed uniformly, what is the magnetic field a distance s (inside and outside) from the axis? **(10)**

PART C

9. A rectangular loop of N close-packed turns is positioned near a long straight wire as shown in the figure below. (a) What is the mutual inductance M for the loop-wire combination? (b) Evaluate M for N=100, a = 1.0 cm, b = 8.0 cm, and l = 30 cm. **(10)**



10. The stopping potential for electrons emitted from a surface illuminated by light of wavelength 491 nm is 0.710 V. When the incident wavelength is changed to a new value, the stopping potential is 1.43 V. (a) What is the work function for the surface? (b) What is this new wavelength? **(10)**

11. Consider a collision between an x-ray photon of initial energy 50 keV and an electron at rest, in which the photon is scattered backward and the electron is knocked forward. (a) What is the energy of the back-scattered photon? (b) What is the kinetic energy of the electron? **(10)**

12. An electron moves in the direction of increasing x with a speed of 1.88 x 10^6 m/s. Assume that this speed measurement has an error of 1.0%. (a) With what precision can you simultaneously measure its momentum? (b) What is the uncertainty in the position of this electron? **(10)**

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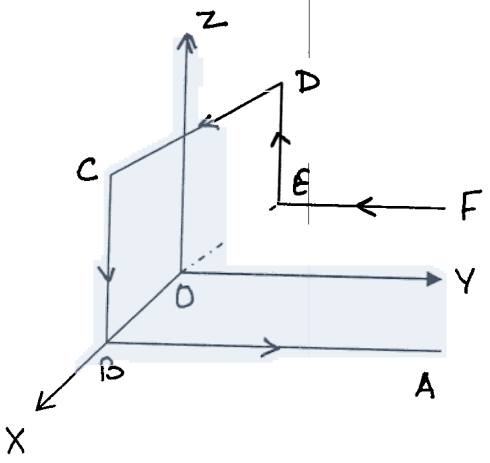
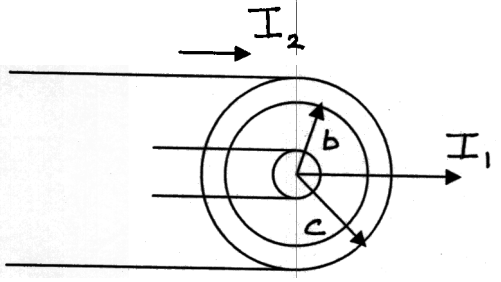
I-Year II-Semester 2007-08
TEST II (Open Book)

Course Name:	Physics II;	**Course No.:**	PHY UC132;
Date:	4th May'08;	**Weightage:**	20%;
Test No.:	TEST 2;	**Max Marks:**	60

1. A wire ABCDEF (with each side of length L) bent as shown in figure and carrying a current I is placed in uniform magnetic field B parallel to the positive y direction. What is the magnitude and direction of force experienced by the wire. [5]



2. In the long coaxial cable, a straight wire of radius **a** carries a current I_1 along the axis of a metal tube with inner radius **b** and outer radius **c**. If the current in the outer tube is I_2 and if I_1 and I_2 are in the same direction,
Find the magnetic field B by applying ampere's law. [15]
   a) for r<a
   b) for b<r<c
   c) for r>c .



Note:

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

$\epsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$

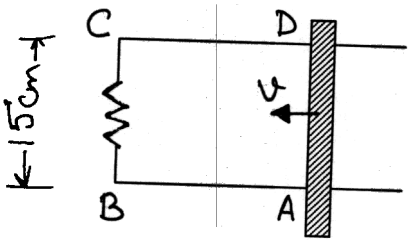
$m_e = 9.11 \times 10^{-31}\ kg.$

$e = .6 \times 10^{-19}\ C$

3. (a) An electron is moving in a circular orbit of radius 5.29×10^{-11}m in presence of magnetic field of 2T which is perpendicular to the plane of rotation. Calculate the change in magnetic moment of electron? [5]

(b)A long solenoid carries a current of 4A having 50 turns/cm. Find the magnetic field intensity H and the magnetic field B at the center of the solenoid. If an iron core of magnetization 4×10^{6}A/m is inserted in the solenoid, what will the value of H and B? [15]

4. The drawing shows a copper wire bent into a rectangular shape of dimensions shown and a resistance of 5.0 Ω is attached. The section ABCD is fixed, while the copper bar AD sweeps across at a rate of 150 cm in 2 secs. in the direction shown. The bar maintains electrical contact with the wire at all times. A uniform magnetic field exists everywhere perpendicular to the plane of the loop, and has a magnitude of 4.2×10^{-3} T. [into the page]



a) Find the magnitude and direction of the current induced in the loop ABCD. [2]

b) If the bar had an object of weight 3 kgs sitting on it, what is the direction and magnitude of acceleration of the object as soon as the current is induced in the bar? and its speed after 2.3 secs (consider the rod to be massless)?[4+4]

5. In a perfect LC circuit the maximum magnetic field in the inductor has a magnitude of 12 T.

a) What is the magnitude of an electric field that stores the same energy density as this magnetic field? [5]

b) What is the inductance of the inductor if the maximum current in the circuit is 5 A? and the inductor has a radius of [5]

5 cm and length 20 cm

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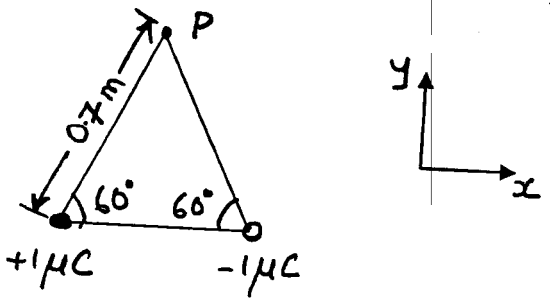
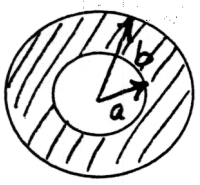
I-Year II-Semester 2007-08
TEST I (Closed Book)

Course Name:	Physics II;	**Course No.:**	PHY UC132;
Date:	23rd March'08;	**Weightage:**	25%;
Test No.:	TEST 1;	**Max Marks:**	75

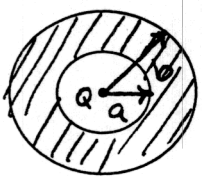
1. Two charges of +1 μc and - 1 μc are placed at the corners of the base of an equilateral triangle. The length of a side of the triangle is 0.7m. Find the electric field intensity at the apex of the triangle. [12]



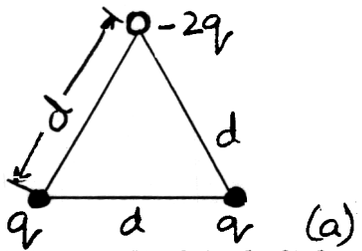
2. Find the electric field a distance r from a line of positive charge of infinite length and constant charge per unit length λ. [13]
3. A hollow spherical shell carries charge density $\rho = k/r^2$ in the region $a \le r \le b$. Find the potential at the center, using infinity as your reference point. [10]



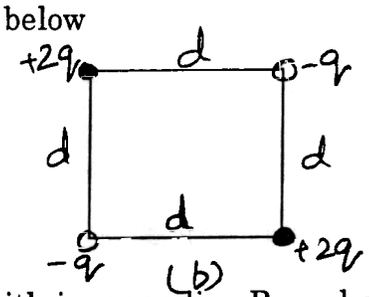
4. A metal sphere of radius a carries free charge Q. It is surrounded by linear dielectric material, of dielectric constant ε_r, out to a radius b. Find the energy of this configuration. [15]



5. What is the magnitude and direction of the net dipole moment of each of the charge distributions in (a) & (b) below [10]

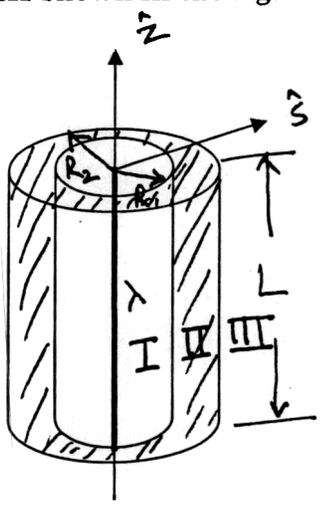


(a)



(b)

6. A long cylindrical, dielectric shell with inner radius R_1 and outer radius R_2 is placed along the z-axis with a linear free charge distribution, λ, placed at the central axis. The polarization is given by $P=(k/s^2)\hat{s}$ (in cylindrical coordinates)
(a) Find the bound surface charge density and volume charge density.
(b) Calculate the electric displacement vector D and electric field E in the three regions I, II and III shown in the fig. below. [15]



For Possible Use

$$\epsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$$

Spherical Coordinates: $d\tau = r^2 \sin\theta\, dr\, d\theta\, d\phi$

Cylindrical Coordinates: $d\tau = s\, ds\, d\phi\, dz$

Divergence: $\nabla \cdot v = \frac{1}{s}\frac{\partial}{\partial s}(s v_s) + \frac{1}{s}\frac{\partial v_\phi}{\partial \phi} + \frac{\partial v_z}{\partial z}$

X

GOOD LUCK