BITS, PILANI – DUBAI CAMPUS

II Year, FIRST SEMESTER: 2013 – 2014

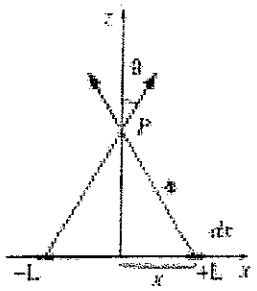
COMPREHENSIVE EXAMINATION

Course Code:	**EEE/ECE/INSTR F212**	Date:	**30.12.13**
Course Title:	**Electromagnetic Theory**	Maximum Marks:	**80**
Duration:	**3hrs**	Weightage:	**40%**

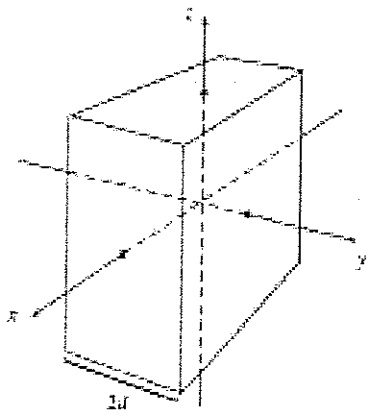
PART A

Note: Answer Part A and Part B in separate answer sheets. Refer Vector Derivatives on the last page

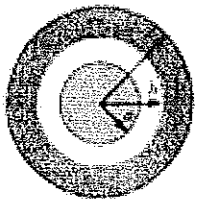
1. Find the electric field a distance Z above the midpoint of a straight line segment of length 2L which carries a uniform line of charge λ. (8)



2. An infinite plane slab of thickness 2d, carries a uniform volume charge density ρ. Find the electric field as a function of y, where y = 0 at the center. (8)



2. A certain coaxial cable consists of a copper wire , radius a, surrounded by a concentric copper tube of inner radius c. The space between is partially filled (from b out to c) with material of dielectric constant ε_r as shown. Find the capacitance per unit length of this cable. (6)

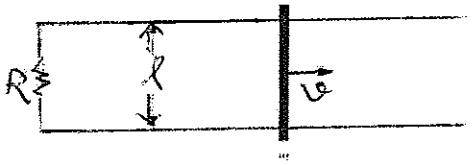


3. A spherical capacitor of radius a, carries a charge Q. It is surrounded by linear dielectric material of susceptibility χ_e, out to radius b. Find the energy of this configuration. (6)

4. Find the magnetic field at point P on the axis of a tightly wound solenoid (helical coil) consisting of n turns per unit length wrapped around a cylindrical tube of radius a and carrying current I. (6)

5. An infinitely long cylinder , of radius R, carries a "frozen-in " magnetization parallel to the axis, M = ks $\hat{z}$, where k is a constant and s is the distance from the axis; there is no free current anywhere. Locate all the bound currents and find the magnetic field inside and outside the cylinder. (6)

6. A metal bar of mass m slides frictionlessly on two parallel conducting rails a distance l apart. A resistor R is connected across the rails and a uniform magnetic field B, pointing into the page, fills the entire region.
   a) If the bar moves to the right at speed $\vec{v}$, what is the current in the resistor? In what direction does it flow.
   b) What is the magnetic force on the bar? In what direction?
   c) If the bar starts out with speed v_o at time t = 0, and is left to slide, what is its speed at a later time t? (2+2+2)



BITS, PILANI – DUBAI CAMPUS

II Year, FIRST SEMESTER: 2013 – 2014

Test II (Open Book)

Course Code:	**EEE/ECE/INSTR F212**	Date:	**06.11.13**
Course Title:	**Electromagnetic Theory**	Maximum Marks:	**40**
Duration:	**50 minutes**	Weightage:	**20%**

$\epsilon_o = 8.85 \times 10^{-12}\ C^2/Nm^2$, $\mu_o = 4\pi \times 10^{-7}\ N/A^2$, $e = 1.60 \times 10^{-19}\ C$, $m_e = 9.11 \times 10^{-31} kg$

1. A capacitor is charged with 9.6nC and has a 120V potential difference between its terminal. Compute its capacitance and the energy stored in it. (5)

2. Find the capacitance of 20cm coaxial cable having an inner conductor of radius 0.37mm, and an outer conductor of radius 1.47mm. A polyethylene dielectric ($\epsilon_r = 2.26$) is inserted between the two conductors. (5)

3. A certain homogeneous slab of loss less dielectric material is characterized by an electric susceptibility of 0.12 and carries an electric displacement vector (D) within it of $1.6nc/m^2$. Find E and P. (5)

4. Find the dielectric constant of a material in which the electric displacement vector (D) is 4 times the polarization. (4)

5. The potential field in a slab of dielectric material for which $\epsilon_r = 1.6$ is given by $V(x) = -5000x$ where x is the distance from the axis. Find D, E and P. (5)

6. An electron travels at $2.0 \times 10^7 m/s$ in a plane perpendicular to a uniform 0.010T magnetic field. What is the radius of the path. (5)

7. A cyclotron is accelerating deuterons which are nuclei of heavy hydrogen carrying a charge of +e and having mass of $3.3 \times 10^{-27} kg$. What is the required frequency of the oscillating electric field if B = 1.5T. (4)

8. What is the magnetic field at a point 50mm from a long wire carrying a current of 3A. (3)

9. A circular coil of radius 40mm consists of 250turns of wire in which the current is 20mA. What is the magnetic field at the center of the coil. (4)

BITS, PILANI – DUBAI CAMPUS

II Year, FIRST SEMESTER: 2013 – 2014

Test I (Closed Book)

Course Code:	**EEE/ECE/INSTR F212**	Date:	**02.10.13**
Course Title:	**Electromagnetic Theory**	Maximum Marks:	**50**
Duration:	**50 minutes**	Weightage:	**25%**

Divergence $\nabla \cdot \mathbf{v} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 v_r\right) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\, v_\theta\right) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi}$

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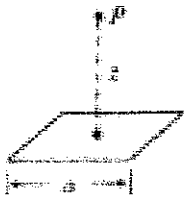
1. Compute the divergence of the function $\mathbf{v} = (r\cos\theta)\hat{r} + (r\sin\theta)\hat{\theta} + (r\sin\theta\cos\phi)\hat{\phi}$. (4)

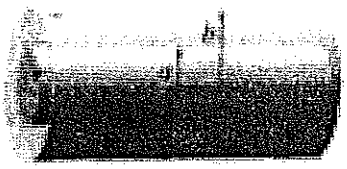
2. Find the electric field a distance Z above the centre of a square loop (side a) carrying uniform line charge λ. (10)



3. A hollow spherical shell carries charge density $\rho = k/r^2$ in the region $a \le r \le b$. Find the electric field in the three regions **(i) r < a , (ii) a < r < b and (iii) r > b.** (6)

4. 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). The surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral. Find the electric field in each of the three regions
   - i) inside the inner cylinder (s < a)
   - ii) between the cylinder (a < s < b)
   - iii) outside the cable (s > b)

   (10)



5. Find the potential inside and outside a uniformly charged solid sphere whose radius is R and whose total charge is q. Use infinity as your reference point. (10)

6. Find the energy stored in a uniform charged solid sphere of radius R and charge q. (10)

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II-Year I -Semester 2013-14
Quiz I

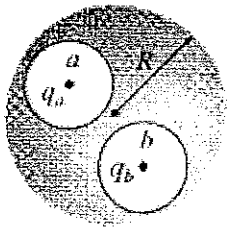
Course Name: Electromagnetic Theory
Course No: EEE/INSTR/ECE F 212

Date: 31-10-13;
Duration.: 20 minutes;

Weightage: 8%;
Max Marks: 16

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

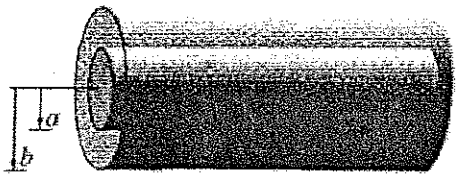
1. Two spherical cavities, of radii **a** and **b**, are hollowed out from the interior of a (neutral) conducting sphere of radius **R**. At the center of each cavity a point charge $\mathbf{q_a}$ and $\mathbf{q_b}$ are placed. Find the surface charges $\boldsymbol{\sigma_a}$, $\boldsymbol{\sigma_b}$ and $\boldsymbol{\sigma_R}$ and what is the field outside the conductor. (5)



2. A sphere of radius **R** carries a polarization $\mathbf{P(r)} = k\mathbf{r}$, calculate the bound charges σ_b and ρ_b. (3)

3. Show that the energy of an ideal dipole p in an electric field is given by $\mathbf{U} = -\mathbf{p}.\mathbf{E}$ (2)

4. Derive the capacitance per unit length of two coaxial metal cylindrical tubes, of radii **a** and **b**. (3)



5. The space between the plates of a parallel plate capacitor is filled with two slabs of linear dielectric material. Each slab has thickness **a**, so the total distance between the plates is **2a**. Slab 1 has a dielectric constant of **2** and slab 2 has a dielectric constant of **1.5**. the free charge density on the top plate is σ and on the bottom plate is $-\sigma$. Find the electric displacement **D** in each slab and the electric field E in each slab. (3)