BITS, PILANI – DUBAI CAMPUS

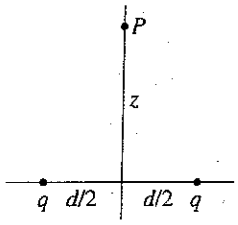
II Year, FIRST SEMESTER:2012 – 2013

COMPREHENSIVE EXAMINATION

Course Code:	**EEE/ECE/INSTR F212**	Date:	**08.01.13**
Course Title:	**Electromagnetic Theory**	Maximum Marks:	**80**
Duration:	**3 hrs**	Weightage:	**40%**

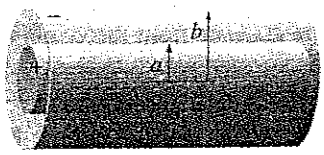
PART A

1. Find the electric field a distance Z above the midpoint between two equal charges, q a distance d apart and also calculate the electric field with right hand charge –q instead of +q. (7M)

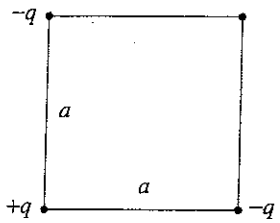


2. Use Gauss's law to find the electric field inside and outside a spherical shell of radius R, which carries a uniform surface charge density σ. (6M)

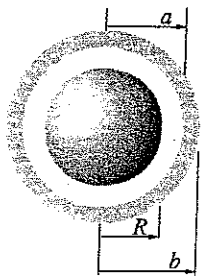
3. A long coaxial cable carries a uniform volume charge density ρ on the inner cylinder (radius a) and a uniform surface charge density on the outer cylindrical shell (radius b). The surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral. Find 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) (7M)



4. Three charges are situated at the corners of a square as shown in figure. How much work does it take to bring in another charge,+q from far away and place it in the fourth corner. How much work does it take to assemble the whole configuration of four charges. (7M)



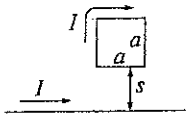
5. A metal sphere of radius R carrying charge q, is surrounded by a thick concentric metal shell (inner radius a, outer radius b).The shell carries no net charge.
   a) Find the surface charge density σ at R, at a and at b.
   b) Find the potential at the center, using infinity as the reference point. (7M)



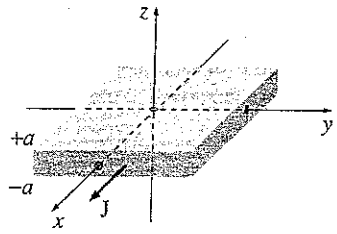
6. Find the capacitance of two concentric spherical metal shells, with radii a and b. (6M)

PART B

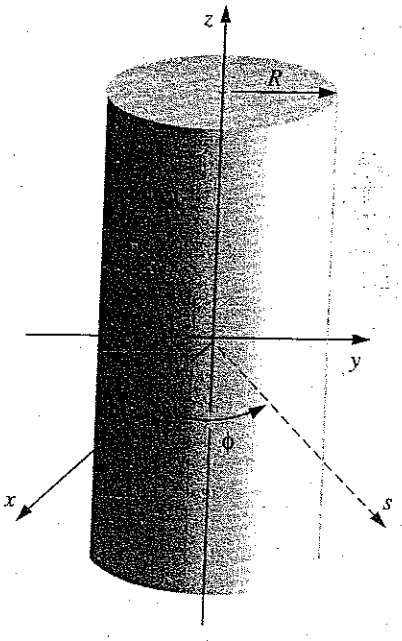
1. Find the force on a square loop placed as shown in figure near an infinite straight wire. Both the loop and the wire carry a steady current I. (6M)



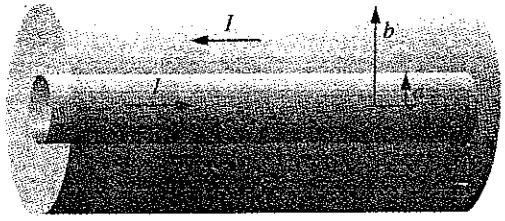
2. A thick slab extending from Z = -a to Z = +a carries a uniform volume current $J = J\hat{x}$. Find the magnetic field , as a function of z, both inside and outside the slab. (6M)



3. A long circular cylinder of radius R carries a magnetization $M = ks^2 \hat{\phi}$, where k is a constant, s is the distance from the axis and $\hat{\phi}$ is the usual azimuthal unit vector. Find the magnetic field due to M, for points inside and outside the cylinder. (6M)



4. A coaxial cable consists of two very long cylindrical tubes, separated by linear insulating material of magnetic susceptibility χ_m . A current I flows down the inner conductor and returns along the outer one, in each case the current distributes itself uniformly over the surface. Find the magnetic field in the region between the tubes and also calculate the bound currents . (6M)

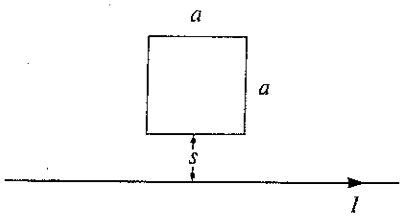


5. A square loop of wire (side a) lies on a table, a distance s from a very long straight wire, which carries a current I as shown in figure.

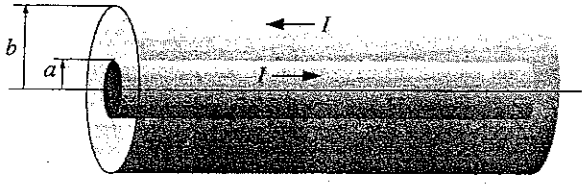
a) Find the flux of B through the loop.

b) If someone now pulls the loop directly away from the wire, at speed v, what emf is generated? In what direction (clockwise or counterclockwise) does the current flow/?

c) What if the loop is pulled to the right at speed v, instead of away? (2+2+1=5M)



6. A long coaxial cable carries current I (the current flows down the surface of the inner cylinder, radius a and back along the outer cylinder , radius b) as shown in figure. Find the magnetic energy stored in a section of length l, and also calculate the self inductance. (6M)



7. Write the Maxwell's equation in free space in differential as well as integral form. Also derive the wave equation for electric field and magnetic field in vacuum. (5M)

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II Year, FIRST SEMESTER:2012 – 2013

TEST- II (Open Book)

Course Code:	**EEE/ECE/INSTR F212**	Date:	**13.12.12**
Course Title:	**Electromagnetic Theory**	Maximum Marks:	**40**
Duration:	**50 minutes**	Weightage:	**20%**

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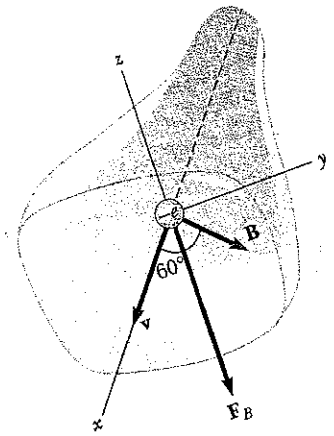
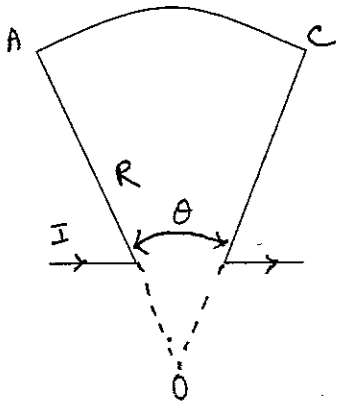
1. An electron in a television picture tube moves toward the front of the tube with a speed of 8.0×10^6 m/s along the x- axis. The neck of the tube is surrounded by a coil of wire that creates a magnetic field of magnitude 0.025T, directed at an angle of 60° to the x axis and lying in the xy plane. Calculate the magnetic force on and acceleration of the electron. (Charge of an electron $= 1.6 \times 10^{-19}$ C and Mass of an electron is 9.1×10^{-31}kg). (4)

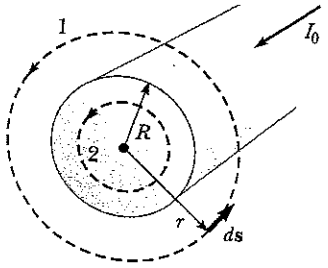


2. A current I is uniformly distributed over a wire of circular cross section with a inner radius a and outer radius b. Find the volume current density J. Suppose the current density in the wire is proportional to the distance from the axis $J = k/s^2$ for some constant k. Find the total current in the wire. (4)

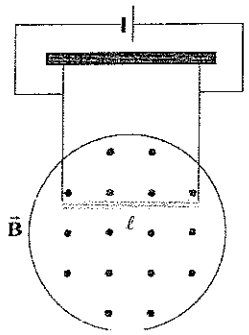
3. What is the magnetic field at point O due to current in the loop through segments OA, AC, and CO. (4)



4. A long straight wire of radius R carries a steady current I_0 that is uniformly distributed through the cross-section of the wire. Calculate the magnetic field a distance r from the center of the wire in the region $r \geq R$ and $r < R$. (4)



5. A conducting rod having a mass density λ kg/m is suspended by two flexible wires in a uniform magnetic field which points out of the page, as shown in Figure. If the tension on the wires is zero, what are the magnitude and the direction of the current in the rod? (4)



6. A free current (volume current density = $J_0 \hat{z}$) flows down a long straight wire of radius R. if the wire is made of linear material with susceptibility X_m, and the current is distributed uniformly. Calculate
   (a) Magnetic field B inside and outside the wire due to free current only (with proper direction) (5)
   (b) Find all the bound currents (with proper direction) (5)
   (c) Calculate the net bound current flowing down the wire (2)
   (d) Calculate magnetic field B due to free and bound current together , inside and outside the wire (with proper direction). (5)

7. What torque is necessary to hold the axis of a magnet at an angle of 50^0 to the magnetic Meridian where the horizontal component of earth's magnetic field is 20μ T? The length of the magnet is 125mm, and its pole strength is 40 A.m. (3)

BITS, PILANI – DUBAI

II Year, FIRST SEMESTER:2012 – 2013

TEST- 1 (Closed Book)

Course Code:	**EEE/ECE/INSTR F212**	Date:	**21.10.12**
Course Title:	**Electromagnetic Theory**	Maximum Marks:	**50**
Duration:	**50 minutes**	Weightage:	**25%**

Divergence formula

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

Q1. A charge of **4 x 10^{-8} C** is distributed uniformly on the surface of a sphere of radius **1cm**. It is covered by a concentric, hollow conducting sphere of radius **5cm**.

a) Find the electric field at a point **2cm** away from the centre.

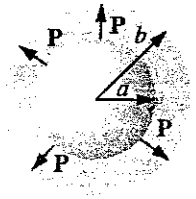
b) A charge of **6 x 10^{-8}C** is placed on the hollow sphere. Find the surface charge density on the outer surface of the hollow sphere. **[8 M]**

Q2. Find the electric field inside a sphere which carries a charge density proportional to the distance from the origin $\rho = kr$ for some constant k. **[8 M]**

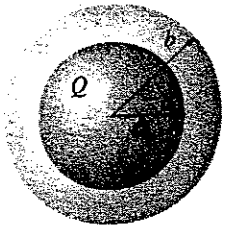
Q3. Find the energy required to assemble a uniform sphere of charge of radius b and volume charge density ρ. **[8 M]**

Q4. Show that any polarized object having polarization $\vec{P}$ is equivalent to an object having surface and volume bound charge density. **[9 M]**

Q5. A thick spherical shell (inner radius a, outer radius b) is made of dielectric material with polarization $P(r) = k/r\ \hat{r}$ where k is a constant and $\hat{r}$ the distance from the center. Calculate all the bound charges and find the electric field in all the three regions **[8 M]**



Q6. A spherical conductor 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. **[9 M]**



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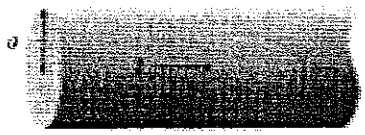
II-Year I -Semester 2012-13
Quiz II

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

Date: 27-11-12; **Weightage:** 7%;
Duration.: 25 minutes; **Max Marks:** 14

Each question carries 2marks

1. A current I is uniformly distributed over a wire of circular cross section, with radius a. Find the volume current density J.



2. A long straight wire carrying current produces a magnetic induction of 4×10^{-6} **T** at a point, **15cm** from the wire. Calculate the current through the wire.

3. A stream of deutrons is projected with a velocity of $\mathbf{10^4 ms^{-1}}$ in XY- plane. A uniform magnetic field of induction $\mathbf{10^{-3}T}$ acts along the z - axis. Find the radius of the circular path of the particle. (Mass of deuteron is $\mathbf{3.32 \times 10^{-27}}$ **kg** and charge of deuteron is $\mathbf{1.6 \times 10^{-19}C}$)

4. An α particle moves with a speed of $\mathbf{5x10^5\ ms^{-1}}$ at an angle **30°** with respect to a magnetic field of induction $\mathbf{10^{-4}T}$. Find the force on the particle (α particle has a +ve charge of 2e)

5. A uniform magnetic field of induction **0.5T** acts perpendicular to the plane of dees of a cyclotron. Calculate the frequency of the oscillator to accelerate the protons. (Mass of proton is $\mathbf{1.67 \times 10^{-27}}$ **kg** and charges is $\mathbf{1.6 \times 10^{-19}C}$)

6. A circular coil of **200 turns** and of radius **20cm** carries a current of **5A**. Calculate the magnetic induction at a point along its axis, at a distance three times the radius of the coil from its centre.

7. Two parallel wires each of length **5m** are placed at a distance of **10cm** apart in air. They carry equal currents along the same direction and experience a mutually attractive force of **3.6 x 10^{-4}N**. Find the current through the conductors.

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II-Year I -Semester 2012-13
Quiz I

Course Name: Electromagnetic Theory
Course No: EEE/INSTR/ECE F 111
Date: 02-10-12;
Weightage: 8%;
Duration.: 20 minutes;
Max Marks: 16

1. Find the gradient of $r = \sqrt{x^2+y^2+z^2}$ (2)

2. Calculate the divergence of a vector function $v = xy\ \hat{x} + 2yz\ \hat{y} + 3zx\ \hat{z}$ (2)

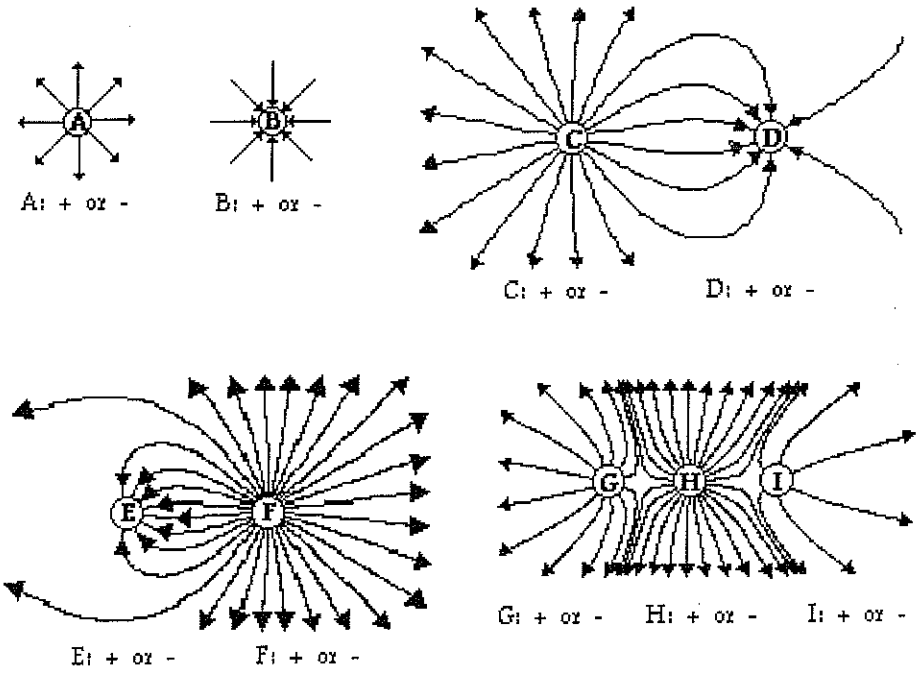
3. Calculate the curl of a vector function $v = x^2\ \hat{x} + 3xz^2\ \hat{y} - 2xz\ \hat{z}$ (2)

4. Calculate the line integral of the function $v = x^2\,\hat{x} + 2yz\,\hat{y} + y^2\,\hat{z}$ from the origin to the point (1,1,1) by three different routes $(0,0,0) \rightarrow (1,0,0) \rightarrow (1,1,0) \rightarrow (1,1,1)$ (2)

5. Find the electric field a distance z above the center of a circular loop of radius r which carries a uniform line of charge λ (2)

6. Use Gauss law to find the electric field outside a spherical shell of radius R which carries a uniform surface charge density σ. (2)

7. Use your understanding of electric field lines to identify the charges on the objects in the following configurations. (2)



8. A cylinder of length L and radius b has its axis coincident with the x axis. The electric field in this region is E = 200i . Calculate the electric flux through the left and right end. (2)