This question paper contains 4 printed pages] May 2013

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : 1583

Unique Paper Code : 222203 C

Name of the Paper : PHHT-205 (Electricity & Magnetism)

Name of the Course : B.Sc. (Hons.) Physics

Semester : II

Maximum Marks : 75

Duration : 3 Hours

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all. Question No. 1 is compulsory.

All questions carry equal marks.

1. Attempt any *five* of the following :

(*a*) Show that the electrostatic field is conservative in nature.

(*b*) The electric potential in a given space is represented by $V = 3x + 5y - 6z$. Show that the electric field intensity is uniform everywhere in the given space.

(*c*) Prove that the electrostatic energy of a capacitor of capacitance C charged to a potential V is given by $(\frac{1}{2})CV^2$.

(*d*) What are the conditions for a moving coil galvanometer to be ballistic ?

P.T.O.

(e) What is Lenz's law ? Show that it is in accordance with the law of conservation of energy.

(f) What is the physical significance of solenoidal nature of magnetic field ?

(g) Why a parallel resonance circuit is called a rejecter circuit ? 5×3=15

2. (a) An alternating emf is applied to a circuit having an inductor, capacitor and resistor in series. Obtain the expression for impedance and instantaneous current in the circuit. Discuss graphically the variation of current with frequency for different values of resistance. What is the utility of such a circuit ? 10

(b) State and explain Thevenin's Theorem with the help of relevant circuit diagrams. 5

(a) State and prove Gauss's flux law in electrostatics. Obtain its differential form. 10

(b) A spherical charge distribution is given by $\rho(r) = \rho(0)\left(1 - \frac{r}{R}\right)$ for $r < R$ and $\rho(r) = 0$ for $r > R$. Here $\rho(r)$ is the volume charge density and $\rho(0)$ is constant. R is the radius of the sphere and r is the distance from the centre of the sphere. Obtain an expression for the electric field intensity E at a point inside the sphere. 5

4. (*a*) What is meant by polarization of a dielectric ? Explain with reference to the case when a dielectric slab is introduced between the plates of a parallel plate capacitor. 5

(*b*) Show that $q' = q\left(1 - \frac{1}{k}\right)$, where the symbols have their usual meaning. 5

(*c*) Define the terms electric susceptibility and relative permittivity. Obtain the relation between them. 5

5. (*a*) State and explain Biot-Savart's law. Obtain an expression for the magnetic flux density at a point due to an infinitely long straight current carrying conductor. 10

(*b*) An electron circulates around a nucleus in an orbit of radius 5.1×10^{-11}m at a frequency of 6.8×10^{15} revolutions per second. Calculate B at the centre of the orbit. 5

6. (*a*) Show that the Ampere's circuital law is modified in the presence of a material. Obtain the relation between **B**, **M** and **H** where the symbols have their usual meaning. 10

(*b*) A solenoid 2 m long with a mean diameter of 0.05 m has four layers of 1000 turns of wire each. Calculate the magnetic flux density at its centre when a current of 2.5 A flows through it. Also calculate the magnetic flux at centre. ($\mu = 4\pi \times 10^{-7}$ H/m). 5

7. (*a*) Show that the charge passing through a ballistic galvanometer is given by

$$Q = K\left(\frac{T}{2\pi}\right)\theta$$

where the symbols have their usual meaning. 1

(*b*) Find an expression for the self inductance of a solenoid. 2

This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : 6228

Unique Paper Code : 222203

D
(2013-2014)

Name of the Paper : Electricity and Magnetism—[PHHT-205]

Name of the Course : B.Sc. (Hons.) Physics

Semester : II

Duration : 3 Hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all.

Question No. **1** is compulsory.

All questions carry equal marks.

1. Attempt any *five* of the following : 5×3=15

(*a*) A resonant a.c. circuit has an inductance L = 0.1 mH and capacitance C = 1 μF. Find the frequency of oscillations.

(*b*) An equilateral triangle of side 1 m has three positive charges 1×10^{-9} C, 2×10^{-9} C and 3×10^{-9} C respectively, arranged at the corners. Find the potential at the centre of the triangle.

P.T.O

(c) If a dielectric completely fills the space between the plates of a parallel plate capacitor, show that the induced charge varies with the dielectric as :

$$q' = q\left(1 - \frac{1}{k}\right)$$

where the symbols have their usual meaning.

(d) Prove that the magnetic energy of an inductor of inductance L carrying a current I is given by :

$$\left(\frac{1}{2}\right)LI^2.$$

(e) Prove that the work done in moving a charge from one point to the other in an electrostatic field is path independent.

(f) What are the conditions for a moving coil galvanometer to be ballistic ?

(g) Define the coefficient of mutual induction. What is its unit ?

2. (a) State and prove Maximum Power Transfer Theorem for a two terminal linear network having complex impedance. 10

(b) A resistance R of 10 Ω is joined in series with an inductance L of 0.5 H. Find the value of the capacitance C required to be put in series with the combination to obtain maximum current when the circuit is connected to 200 V, 50 Hz mains. Also obtain the maximum current. 5

3. (*a*) Establish the relation between E and V. 5

(*b*) Show that the potential due to a uniformly charged circular disc falls off from the centre to the edge of the disc. Derive the necessary expressions. Also find the value of the electric field at the centre of the disc. 10

4. (*a*) Obtain an expression for the electrostatic potential energy for a system of *n* point charges. 6

(*b*) Obtain the generalized form of Gauss's law for a linear homogeneous isotropic dielectric medium. Define E, P and D and obtain the relation between them. 9

5. (*a*) Show that a current carrying loop placed in a uniform magnetic field is equivalent to a magnetic dipole. Obtain its magnetic dipole moment. Prove that the result is independent of the shape of the loop. 9

(*b*) Using Biot-Savart's law, prove that div B = 0. Explain its physical significance. 6

6. (*a*) Explain the terms hysteresis, retentivity and coercivity with reference to the B – H loop of a ferromagnetic material. 6

(*b*) Show that the area of a B-H loop denotes the energy dissipated per unit volume of the material during each cycle of magnetization. 9

7. (*a*) State and explain Faraday's laws of electromagnetic induction. Prove that : 9

$$\text{curl } E = -\frac{\partial B}{\partial t}.$$

(*b*) Define charge sensitivity and current sensitivity for a ballistic galvanometer and obtain the relation between them. 6

[This question paper contains 4+1 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : 6888

Unique Paper Code : 222463 D

Name of the Paper : Phys. IV [Elec., Magnetism & EMT] (PHPT-404)

Name of the Course : B.Sc. (Prog.)

Semester : IV

Duration : 3 Hours Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Question No. 1 is compulsory.

Use of non-programmable scientific calculator is allowed.

1. Attempt any *five* of the following : 5×3=15

(*a*) Show that electrostatic field vector is conservative.

(*b*) What is the charge density on the surface of a conducting sphere placed in free space, if the electric field near its surface is 1000 V/m ?

P.T.O.

(c) Show that the potential functions :

(i) $V = xyz$

(ii) $V = x^2 - y^2$;

satisfy Laplace's equation.

(d) Starting from Biot-Savart's law, prove that $\vec{B}$ is a solenoidal vector.

(e) Derive an expression for the torque acting on a rectangular loop carrying current placed in a uniform magnetic field.

(f) Establish the Reciprocity Relation in mutual inductance.

(g) For plane electromagnetic wave show that the intrinsic wave impedance of free space is 376.6 Ω.

(h) Obtain the boundary conditions satisfied by the electromagnetic field vectors $\vec{D}$ and $\vec{B}$ on the plane interface between two dielectric media.

2. (a) State and prove Gauss's theorem of electrostatics. 6

(b) Show that in absence of any charge, div $\vec{E} = 0$. 4

(c) Using Gauss's theorem, find an expression for electric field due to an infinite line of charge of linear density, 'λ' at a perpendicular distance 'a' from it. 5

3. (*a*) Define electric potential. Prove that the electrostatic field at any point can be expressed as the negative of the gradient of potential at that point. 6

(*b*) Derive expressions for electrostatic potential inside and outside of a uniformly charged spherical conductor shell. 9

4. (*a*) Using Biot-Savart's law calculate magnetic field near an infinitely long straight conductor carrying current. 6

(*b*) Calculate the magnetic field intensity at a perpendicular distance of 20 cm from a long straight conductor carrying a current of 20A. 4

(*c*) State Ampere's circuital law. Prove that : 5

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}.$$

5. (*a*) Describe the construction of a moving coil ballistic galvanometer. Discuss the conditions under which it behaves as :

(*i*) Oscillatory

(*ii*) Dead beat

(*iii*) Critically damped. 10

(*b*) Derive an expression for the quantity of charge passing through a ballistic galvanometer. 5

6. (*a*) Define self-inductance. Derive an expression for self-inductance of a long straight solenoid. 5

(*b*) Show that the coefficient of self-induction of a circuit is equal to twice the work done in establishing the magnetic flux associated with unit current in the circuit. 6

(*c*) What energy is stored in a magnetic field of a solenoid of self-inductance 5 mH, when a maximum current of 3A flows through it ? 4

7. (*a*) Why does Ampere's circuital law need modification in electrodynamic situations ? What is the Maxwell's correction to modify this law ? 5

(*b*) Starting from Maxwell's equations in free space, obtain wave equations for electric and magnetic field vectors. 6

(*c*) Assuming plane wave solutions, show that the electromagnetic waves are transverse in nature. 4

(a) Derive Fresnel's relations of reflection and transmission of a plane electromagnetic wave in which electric field vector is parallel to the plane of incidence (consider dielectric-dielectric interface). 12

(b) Define Brewster's angle. Why is it called polarizing angle ? 3

Physical Constants :

$\varepsilon_o = 8.854 \times 10^{-12}\ C^2/N\text{-}m^2$

$\mu_o = 4 \times 10^{-7}\ Wb/A\text{-}m$

$e = 1.6 \times 10^{-19}\ C.$

$c = 3 \times 10^8\ m/s$

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Your Roll No. .....

5080

D

B.Sc. Prog. / II

PH-201 – PHYSICS

(Electricity, Magnetism and Electromagnetic Theory)

Time : 3 Hours *Maximum Marks : 75*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt **five** *questions in all.*

Question No. **1** *is compulsory.*

All *questions carry equal marks.*

1. Attempt any **five** of the following :

(a) Show that the electrostatic field is conservative in nature.

(b) An equilateral triangle of side 1m has three positive charges 1×10^{-9} C, 2×10^{-9} C and 3×10^{-9} C respectively, arranged at the corners. Find the potential at the centre of the triangle.

(c) If a dielectric completely fills the space between the plates of a parallel plate capacitor, show that

P.T.O.

the induced charge varies with the dielectric constant as

$$q' = q\left(1 - \frac{1}{K}\right)$$

where the symbols have their usual meaning.

(d) Prove that the magnetic energy of an inductor of inductance L carrying a current I is given by $(\frac{1}{2})LI^2$.

(e) What is Lenz's law ? Show that it is in accordance with the law of conservation of energy.

(f) Distinguish between linearly and circularly polarized waves.

(g) Define numerical aperture, critical angle and acceptance angle in optical fibres. (3×5=15)

2. (a) State and prove Gauss Divergence Theorem of vector analysis. (10)

(b) Determine a unit vector perpendicular to the plane of $\mathbf{A} = 2\hat{i} - 6\hat{j} - 3\hat{k}$ and $\mathbf{B} = 4\hat{i} + 3\hat{j} - \hat{k}$. (5)

3. (a) Obtain an expression for electrostatic potential energy of a system of n charges. (10)

5020

(b) Using the above, obtain the expression for energy density in an electrostatic field. (5)

4. (a) Explain the phenomenon of polarization in a dielectric medium. (5)

(b) Define **E**, **P** and **D** and obtain relationship between them. (10)

5. (a) State and prove Ampere's circuital law. (10)

(b) Derive the expressions for the magnetic flux density due to a solenoid of N turns carrying current I at a point

(i) inside

(ii) outside

(5)

6. (a) Explain the construction and working principle of a moving coil ballistic galvanometer.

(b) Define charge sensitivity and current sensitivity of a moving coil ballistic galvanometer. Obtain the relation between them. (10,5)

7. (a) State and explain Maxwell's Equations. (10)

(b) Discuss their physical significance. (5)

P.T.O.

8. (a) State and explain Kirchoff's laws. (5)

(b) State and prove Maximum Power Transfer Theorem. (10)

This question paper contains 2 printed pages.

4

Your Roll No. .....

Sl. No. of Ques. Paper	: 6781	
Unique Paper Code	: 32225101	FC
Name of Paper	: Electricity and Magnetism	
Name of Course	: Other than B.Sc. (Hons.) Physics: CBCS Generic Elective Paper – I	
Semester	: I	
Duration :	: 3 hours	
Maximum Marks	: 75	

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(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt four questions in all including Question No. 1 which is compulsory.

1. Attempt any *six* questions: — 6×5=30

(a) Find $\bar{\nabla} \ln r$, where $\bar{r}=\sqrt{x^2+y^2+z^2}$.

(b) If $A=3xy\hat{i}-y^2\hat{j}$, evaluate $\int_C A\,dr$, where C is a curve in x, y plane, $y=2x^2$, from (0, 0) to (1, 2).

(c) Distinguish between (i) dia-, (ii) para- and (iii) ferromagnetic materials giving one for each.

(d) Derive the expression for the electric field intensity at any point inside and outside of a uniformly charged spherical shell of radius a.

(e) Write Gauss' theorem of electrostatics in integral and differential forms.

(f) What is electric displacement vector? Write down the relation between displacement vector, electric field and electric polarization vector.

(g) Show that two parallel conductors carrying currents in the same direction attract each other.

(h) Show that the ratio of the amplitude of the conduction current and displacement current density is $\sigma/\omega E$ for the applied field $E=E_0 \cos \omega t$.

(i) Distinguish between self and mutual inductance.

(j) If the current in an air core inductor having a self inductance 25×10^{-5} henry changes from zero to 1·0 A in 0·10 sec, what is the magnitude of the self induced emf?

6×5=30

P. T. O.

2. Evaluate $\iint_S A.n\,dS$, where $A=18xi-12j+3yk$ and S is that part of the plane $2x+3y=6z=12$, which is located in the first octant. 5

3. (a) Prove that the electrostatic field is a conservative field and hence show that it can be expressed as a gradient of some scalar potential. 6

(b) Electric field in a given region of space is $\vec{E}=5xi+6yj+3zk$. Find the volume charge density. 4

(c) The potential in a certain region is given as $V=x^4+4y^3+8z$. Find the electric field intensity at the point (1, −3, 4). 5

4. Obtain the general expression for the electric potential due to an electric dipole. Hence deduce the expression for the electric field at any point on equatorial plane. 6+9

5. (a) Using Biot-Savart's law, find the magnetic field at any point on the axis of a current carrying circular coil of radius a. 10

(b) A square loop of side 2 cm carries a current of 1·5 A, find the magnetic field at its centre. 5

6. (a) Show that the energy density stored in a magnetic field is given by $\mu_B=\frac{B^2}{2\mu_0}$ 10

(b) Write the differential and integral forms of Faraday's law of electromagnetic induction. 5

7. (a) Obtain the wave equations for the electric and magnetic field vectors in vacuum. 10

(b) Establish the transverse nature of EM waves. 5

Sr. No. of Question Paper: 2307

Unique Paper Code	:	2221202
Name of the paper	:	Physics IIB-Electricity & Magnetism
Name of Course	:	4YUP - Physics
Semester	:	II F-Y
Duration	:	3 Hours
Maximum Marks	:	75 Marks

Instructions for candidates

Attempt five question in all including Question No. 1 which is compulsory.
All question carry equal marks.

Q1. Attempt any five of the following: (5×3=15)

a) Convert integral from of Gauss Theorem of electrostatics in its differential form.
b) What is the charge density on the surface of a conducting sphere placed in free space if the electrostatic filed near its surface is $950\ V/m$?
c) Two protons in a nucleus of Uranium-238 are $6\ fermi$ apart, what is there mutual electric potential energy?
d) Show that $\vec{\nabla} \cdot \vec{B} = 0$.
e) Derive the relation $q' = q\left(1 - \frac{1}{k}\right)$ in case of a parallel plate capacitor with dielectric between its plates where q' is an induced charge and k is the dielectric constant.
f) Show that the energy required to build up a current I in a circuit of self-inductance L is $\frac{1}{2}Li^2$.
g) State Kirchoff's Laws for AC circuits.

Q2. a) Derive the expression for the electrostatic potential at an arbitrary point (r, θ) from the center of an electric dipole $\vec{p}$. Hence find the expression of the electrostatic field at that point. (10)
b) Determine the expression for torque on an electrostatic dipole placed in a uniform electric field. Hence find an expression for its electrostatic potential energy. (5)

Q3. a) Using Method of Images, find the expression for electrostatic potential and electrostatic field due to a point charge q placed near an earthed conducting sphere. (10)
b) A uniformly charged sphere of charge density ρ_0 and radius R is surrounded by a charged medium of volume charge density $\rho = \alpha/r$ where α is a positive constant and r is the distance from center of the sphere. Find the volume charge density ρ_0 of the sphere for which the electrostatic field outside the sphere becomes independent of r. (5)

Q4. a) Obtain the generalized form of Gauss' Law in dielectrics. Hence show that the (10)

displacement vector $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$.

b) A metal sphere of radius a carries a charge Q. It is surrounded out to radius b by a linear dielectric material of permittivity ϵ. Find the potential at the center of the sphere relative to infinity. (5)

Q5. a) State and prove Ampere's Circuital Law for an arbitrary closed path. Apply this law to obtain the magnetic induction $\vec{B}$ at a point inside an infinitely long solenoid. (10)

b) A wire is shaped to a regular hexagon of side $2cm$ and carries a current of $2A$. Find the magnitude of magnetic field at the center of the hexagon. (5)

Q6. a) Starting from Biot-Savart Law, show that the magnetic induction $\vec{B}$ can be represented as curl a of vector potential $\vec{A}$. (5)

b) A circular conducting loop of radius $40\ cm$ lies in the xy plane and has a resistance of $20\ \Omega$. If the magnetic flux density in the region is given as $\vec{B} = 0.2\cos(500t)\,\hat{\imath} + 0.75\sin(400t)\,\hat{\jmath} + 1.2\cos(314t)\,\hat{k}$ Tesla, determine the effective value of the induced current in the loop. (5)

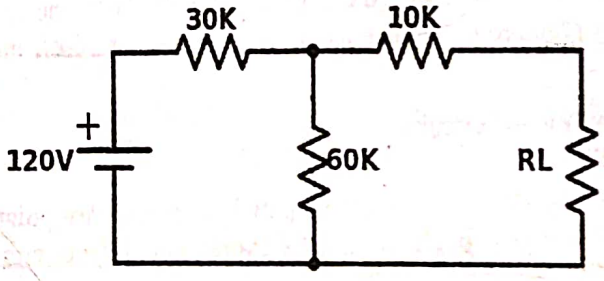
c) Show that the area enclosed by BH-loop represents the energy dissipated per unit volume per cycle of magnetization. (5)

Q7. a) Discuss the theory of moving coil ballistic galvanometer. Also discuss the condition under which it behaves as: (10)

(i) Dead Beat

(ii) Oscillatory

b) Using Thevenins' Theorem find out for what value of R_L maximum power is transmitted in the following circuit: (5)



What is the power dissipated in R_L when matched?

Values of Constants :

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

$\mu_0 = 4\pi \times 10^{-7}\ W/Am$

Charge on proton: 1.6×10^{-19}

This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : 937

Unique Paper Code : 222203 E

Name of the Paper : **Electricity and Magnetism (PHHT-205)**

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : **II**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all.

Question No. **1** is compulsory.

All questions carry equal marks.

Non-programmable calculators allowed.

1. Attempt any *five* of the following questions : 5×3=15

(*a*) Show that the line integral of electric field is independent of the path.

(*b*) Determine whether the electric field produced by the potential $V = 50x^2 - 75y$ in a given region of space is uniform or not.

(*c*) Define equipotential surfaces. Can two equipotential surfaces intersect ?

(*d*) The magnetic flux through a circular loop varies with time t as $0.033\ t^3$ Weber. Calculate the induced emf in the loop at $t = 1$ millisecond.

P.T.O.

(*e*) For a magnetic circuit, explain the terms magneto-motive force and reluctance.

(*f*) Draw hysteresis curve for materials suitable for use (*i*) in a transformer, (*ii*) as a permanent magnet.

(*g*) The successive deflections to the right and left of the mean position in the case of ballistic galvanometer and found to be 25.0, 24.9 and 24.8 cm respectively. Calculate the logarithmic decrement.

2. (*a*) Show that the capacitance of a spherical conductor of radius a enclosed by an earthed concentric spherical shell of radius b is given by :

$$C = 4\pi \epsilon_0 \frac{ab}{b-a}.$$

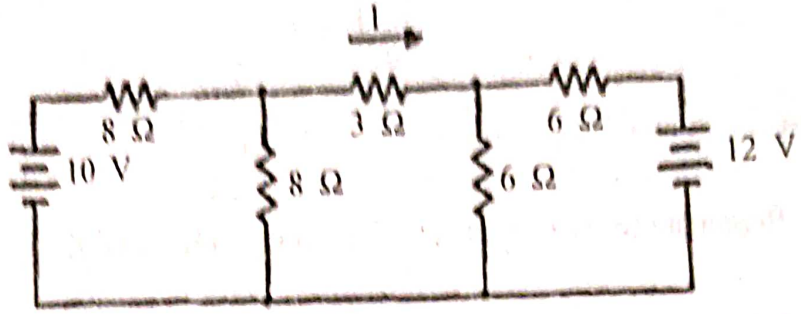
(*b*) A point charge q is placed in front of an earthed conducting shpere of radius R at a distance d from its center. Determine using the method of images, the electric potential at a point outside the sphere. 5,10

3. (*a*) State Gauss's law in electrostatics. Deduce its differential form.

(*b*) Derive an expression for potential and electric field at a point (r, θ) due to an electric dipole. 5,10

4. (*a*) State and prove Thevenin's theorem.

(*b*) Determine the current I in the given circuit using Thevenin's theorem.



(*c*) A capacitor of 250 pF is connected in parallel with a coil having inductance 0.16 mH and resistance 20Ω. Calculate the :

(*i*) resonance frequency and

(*ii*) circuit impedance at resonance. 7,4,4

5. (*a*) State Biot-Savart's law. Derive an expression for the magnetic field at a point due an infinitely long straight current carrying conductor using Biot-Savart's law.

(*b*) Define magnetic susceptibility and permeability. Establish a relation between them.

(*c*) A circular coil of 100 turns has an effective radius 50 cm and carries a current 0.10 amp. Calculate the amount of work required to turn the coil in an external uniform magnetic field 1.5 Weber/m^2 through an angle of 180°. 8,4,3

6. (*a*) Define magnetic vector potential. Derive an expression for the magnetic vector potential due to a current loop of an area *a* carrying uniform current I.

(*b*) Prove that the energy stored in a magnetic field is given by :

$$\frac{1}{2}\int \mathrm{H.B}\ d\tau$$

where volume integral is taken over all space. 7,8

7. (*a*) Differentiate between dead beat and ballistic galvanometer.

(*b*) A capacitor charged to 2 volts is discharged through a ballistic galvanometer. Calculate the capacitance if the corrected deflection is 9.6 cm and the time period is 12 sec. The current sensitivity of the B.G. is 4.54×10^2 mm/μA.

(*c*) Two inductances L_1 and L_2 are connected in parallel. If M is the mutual inductance between them, show that their effective inductance, L_{eff}, is given by : 3,5,7

$$L_{eff} = \frac{L_1L_2 - M^2}{L_1 + L_2 \pm 2M}.$$

This question paper contains 4 printed pages]

S. No. of Question Paper : 1531

Roll No. | | | | | | | | | | | |

Unique Paper Code : 222463

07 MAY 2016

E

Name of the Paper : Physics-IV : Electricity, Magnetism and Electromagnetic Theory (PHPT-404)

Name of the Course : B.Sc. (Physical Sciences)

Semester : IV

Duration : 3 Hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all.

Question No. 1 is compulsory. Attempt *four* questions from the rest of the paper.

Use of non-programmable scientific calculator is allowed.

1. Attempt any *five* of the following : 5×3=15

(*a*) Show that $\vec{E} = E\hat{i}$ is an irrotational vector.

(*b*) Draw and compare the electric field lines for :

(*i*) Equal and opposite charges separated by a distance '*d*' and

(*ii*) Equal positive charges separated by a distance '*d*'.

(*c*) Differentiate between circularly and elliptically polarised light.

(*d*) Prove that reciprocity theorem for coefficients of mutual inductance.

(*e*) A current of 2 A flowing through a coil is cut-off completely in 0.2 s. Calculate the e.m.f. induced in the coil if it has a self-inductance of 0.06 H.

P.T.O.

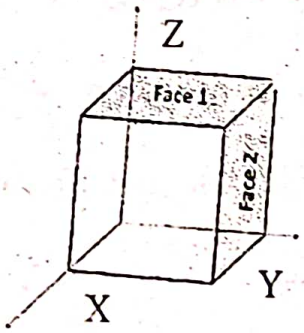
(*f*) Derive the continuity equation and discuss what it signifies.

(*g*) A light ray is incident from 'air' into 'paraffin'. Find the Brewster's angle. (Refractive index of paraffin is $\sqrt{3}$)

2. (*a*) Derive the differential form of Gauss's law. How would you interpret it to understand that electric charges act as sources and sinks of electric field lines when placed in some volume ? 6

(*b*) A long solid cylinder carries a charge density proportional to the distance from its axis as $\rho = kr$, for some constant k. Find the electrostatic field somewhere inside the cylinder. 5

(*c*) The electric field in a region is given by $\vec{E} = 3\hat{i} + 2\hat{j}$. Calculate the electric flux due to this field through the face 1 and face 2 for a cube of side 0.5 m : 4



3. (*a*) Write the expression for electric field at a point P lying inside and outside a uniformly charged sphere of radius R having a total charge Q at a distance r from its center. Calculate the electric potential at P (inside and outside) from it. 7

(*b*) Determine the electrostatic potential energy of a system of n-point charges. 5

(*c*) The electric potential at a point (x, y, z) is given by $V = 3xz - y^2$. Find the corresponding electric field $\vec{E}$. 3

(a) Using the Biot-Savart's law, find the force per unit length between two long parallel wires carrying current I_1 and I_2 in the same direction separated by a distance 'a'. 7

(b) A circular wire of radius $r = 3$ cm carries a current $I = 20$ A in clockwise direction. What magnetic field will be observed at a distance $d = 4$ cm along the axis from the center of the wire ? 4

(c) A charge q moving initially with velocity $3\hat{k}$ m/s enters a region with electric field, $\vec{E} = 10\alpha\,\hat{i}$ V/m and magnetic field, $\vec{B} = 20\,\hat{j} + 100\,\hat{k}$ T. What value of α will the Lorentz force on the charge be zero ? 4

(a) A Ballistic Galvanometer is given a current i for a short time duration Δt. Show that the deflection θ_0 is given by :

$$\theta_0 = \frac{NABQ}{\sqrt{cI}}$$

where N is the number of turns of the coil, A is area of the coil, B is the magnitude of the magnetic field, Q is the total charge delivered by the transient current, I is the moment of inertia of the BG coil and c is the Ballistic constant. Hence, define the charge sensitivity. 5

(b) A rectangular coil of length l and breadth b free to rotate about the x-axis is placed in a uniform magnetic field with direction along the y-axis. If a constant current i is now passed through the coil, find the total force and the total torque exerted on the coil by the magnetic field. 7

(c) A magnetic vector potential $\vec{A}$ is given by $3x^2\,\hat{j}$. Obtain $\vec{B}$, the magnetic field at a point (2, 3, 1) 3

6. (*a*) Prove that :

$$\text{curl } \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

What is the significance of Lenz's law ? 5

(*b*) Show that the energy density associated with each point in space where the magnetic field is $\vec{B}$ is given by :

$$U_m = \frac{1}{2\mu_0} B^2$$

where symbols have the usual meanings. 6

(*c*) Find the energy stored in the magnetic field of a section of length *l* of a long solenoid. 4

7. (*a*) Explain the inconsistency of Ampere's Circuital Law and explain how it can be removed. What is displacement current ? 6

(*b*) Using Maxwell's equations in dielectric medium obtain the wave equations for the electric and magnetic field vectors and find the expression for the velocity of EM wave in the medium. 6

(*c*) Prove that the electromagnetic waves are transverse in nature. 3

8. (*a*) Obtain the boundary conditions for $\vec{E}, \vec{D}, \vec{B}$ and $\vec{H}$ at the interface between two dielectrics. 8

(*b*) Derive Fresnel's relations for reflection and transmission of a plane electromagnetic wave incident normally at a plane interface separating the two dielectrics. 7

Physical Constants :

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

$\mu_0 = 4\pi \times 10^{-7}$ Wb/Am

$c = 3 \times 10^8$ m/s

$e = 1.6 \times 10^{-19}$ C

This question paper contains 2 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper	: 6781	
Unique Paper Code	: 32225101	FC
Name of Paper	: Electricity and Magnetism	
Name of Course	: Other than B.Sc. (Hons.) Physics: CBCS Generic Elective Paper – I	
Semester	: I	
Duration :	: 3 hours	
Maximum Marks	: 75	

01 DEC 2015

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt four questions in all including Question No. 1 which is compulsory.

1. Attempt any *six* questions: 6×5 = 30

(a) Find $\vec{\nabla} \ln r$, where $\vec{r} = \sqrt{x^2+y^2+z^2}$.

(b) If $\mathbf{A} = 3xy\mathbf{i} - y^2\mathbf{j}$, evaluate $\int_C \mathbf{A}\, d\mathbf{r}$, where C is a curve in x, y plane, $y = 2x^2$, from (0, 0) to (1, 2).

(c) Distinguish between (i) dia-, (ii) para- and (iii) ferromagnetic materials giving one for each.

(d) Derive the expression for the electric field intensity at any point inside and outside of a uniformly charged spherical shell of radius a.

(e) Write Gauss' theorem of electrostatics in integral and differential forms.

(f) What is electric displacement vector? Write down the relation between displacement vector, electric field and electric polarization vector.

(g) Show that two parallel conductors carrying currents in the same direction attract each other.

(h) Show that the ratio of the amplitude of the conduction current and displacement current density is $\sigma/\omega E$ for the applied field $E = E_0 \cos \omega t$.

(i) Distinguish between self and mutual inductance.

(j) If the current in an air core inductor having a self inductance 25×10^{-5} henry changes from zero to 1·0 A in 0·10 sec, what is the magnitude of the self induced emf?

6×5 = 30

P. T. O.

2. Evaluate $\iint_S A.n\,dS$, where $A=18zi-12j+3yk$ and S is that part of the plane $2x+3y=6z=12$, which is located in the first octant. 5

3. (a) Prove that the electrostatic field is a conservative field and hence show that it can be expressed as a gradient of some scalar potential. 6

(b) Electric field in a given region of space is $\vec{E}=5xi+6yj+3zk$. Find the volume charge density. 4

(c) The potential in a certain region is given as $V=x^4+4y^3+8z$. Find the electric field intensity at the point $(1, -3, 4)$. 5

4. Obtain the general expression for the electric potential due to an electric dipole. Hence deduce the expression for the electric field at any point on equatorial plane. 6+9

5. (a) Using Biot-Savart's law, find the magnetic field at any point on the axis of a current carrying circular coil of radius a. 10

(b) A square loop of side 2 cm carries a current of 1·5 A, find the magnetic field at its centre. 5

6. (a) Show that the energy density stored in a magnetic field is given by $\mu_B=\frac{B^2}{2\mu_0}$ 10

(b) Write the differential and integral forms of Faraday's law of electromagnetic induction. 5

7. (a) Obtain the wave equations for the electric and magnetic field vectors in vacuum. 10

(b) Establish the transverse nature of EM waves. 5

[This question paper contains 3 printed pages.]

18 MAY 2016

Sr. No. of Question Paper : 5778 F Your Roll No.....

Unique Paper Code : 222203

Name of the Paper : Electricity and Magnetism (PHHT-205)

Name of the Course : B.Sc. (Hons.) Physics

Semester : II

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Question No.1 is compulsory.
4. All questions carry equal marks.
5. Non programmable calculators allowed

1 Attempt any *five* of the following

a) Prove that $\vec{\nabla}.\vec{B} = 0$

b) State Superposition theorem and Norton's theorem.

c) The electric potential at a point (x, y, z) is given by $V = 2x(5y + 6x^2 - z)$. Find the corresponding electric field.

d) Establish a relation between $\vec{D}, \vec{E}$ and $\vec{P}$.

e) Calculate the coefficient of self-inductance of a coil of 1000 turnswhen a current of 2.5 Amperethrough it produces a magnetic flux equal to 0.5 micro-Weber.

P.T.O.

f) Explain the terms retentivity and coercivity.

g) Prove reciprocity theorem for mutual inductance.

(5×3=1

2

a) Derive an expression for the electrostatic energy of a uniformly charged sphere.

b) A cylinder of radius R is immersed in a uniform electric field $\vec{E}$ with its axis parallel the field.Calculate total flux through the cylinder.

(10,

3.

a) Find the capacitance per unit length of a cylindrical conductor of radius a place coaxially inside an earthed hollow conducting cylinder of radius b.

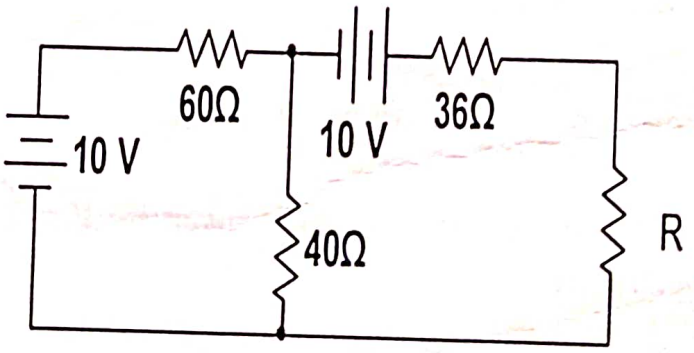
b) Use 'method of images' to calculate the potential and intensity of electric field at an point in space, when a point charge is placed in front of an earthed infinite conductin plane. Calculate the surface density of the induced charge on the conducting plane.

(5,10

4.

a) An *a.c.* source is connected to an inductance L, resistance R and capacitance C in series Derive an expression for resonant frequency and band width.Find the value of the qualit factor Qat resonance.

b) Determine the value of R for maximum power transfer. Also calculate the maximun power dissipated in the load R.



(10,5)

5.

a) Show that for a non-uniform magnetization $\overrightarrow{J_m} = \vec{\nabla} \times \vec{M}$ where $\overrightarrow{J_m}$ is bound current density and $\vec{M}$ is the magnetization.

b) Using Ampere's Circuital law, find the magnetic field due to long current carrying solenoid at a point inside it.

(10,5)

6.

a) What is hysteresis loop? Show that the area enclosed by the hysteresis loop represents the energy dissipated per unit volume per cycle of magnetization.

b) Derive Faraday law of electromagnetic induction in the differential form

$$\vec{\nabla}.\vec{E} = -\frac{d\vec{B}}{dt}$$

(10,5)

7.

a) Establish the equation of the motion of the coil in a moving coil galvanometer and discuss in detailthe conditions under which the motion is (i) dead beat (ii) ballistic and (iii) oscillatory.

b) Find the self-inductance of a toroid.

(10,5)

(300)

This question paper contains 4 printed pages]

12 MAY 2016

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : 6585

Unique Paper Code : 32221201 FC-2

Name of the Paper : Electricity and Magnetism

Name of the Course : B.Sc. (Hons.) Physics (CBCS)

Semester : II

Duration : Three Hours Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Question No. 1 is compulsory.

All questions carry equal marks.

Non-programmable calculator is allowed.

1. Attempt any *five* of the following :

(*a*) Show that the line integral of electric field $\vec{E}$ between two given points is independent of the path.

(*b*) A dielectric sphere of radius '*a*' has a polarization vector $\vec{P} = k\vec{r}$, where k is a constant. Calculate the surface charge density 'σ_p' and the volume charge density 'ρ_p' of the polarized dielectric.

(*c*) Draw a labelled diagram showing the 'coercive' field and the 'remanence' for an M-H cycle for a ferromagnetic material.

P.T.O.

(*d*) Show that the mutual inductance between two coils of self-inductances L_1 and I cannot exceed $\sqrt{L_1 L_2}$.

(*e*) Calculate the coefficient of self-inductance of a coil of 500 turns when a curren of 5 A produces a magnetic flux of 0.5 micro-webers.

(*f*) A coil of self-inductance of 2 mH and resistance 15Ω is connected in parallel wit a capacitance of 0.001 μF. Find the resonant frequency for the circuit.

(*g*) State the Superposition and the Norton's Theorem. 5×3=15

2. (*a*) Calculate the value of Electric Field Intensity at the center of a charged semicircular arc having linear charge density 'λ'.

(*b*) A sphere of radius R carries a charge density $\rho = kr$ (where k is a constant). Find the energy of the configuration.

(*c*) Derive an expression for potential at a point lying on the edge of a uniformly charged circular thin disc, having surface charge density 'σ'. 5,5,5

3. What is meant by 'Method of Images' ? A point charge '*q*' is placed in front of an earthed infinite conducting plane at a distance '*d*' from it. Using the 'Method of Images' determine the potential and intensity of electric field at any point in space. Also obtain the total induced charge on the conducting plane. 15

4. (*a*) Define electrical susceptibility and relative permittivity. Obtain the relation between them.

(*b*) A dielectric slab of thickness '*t*' and of dielectric constant '*k*' is inserted between

the two plates of a capacitor and parallel to them. Find the capacitance if the separation between the plates of the parallel plate capacitor is 'd', $(d > t)$.

(*c*) What is meant by polarization of a dielectric ? Obtain the generalized form of Gauss's law for a polarized dielectric both in integral and differential form. 4,5,6

(*a*) State Biot-Savart's law. Obtain an expression for the magnetic flux density at a point due to an infinitely long straight current carrying conductor.

(*b*) An electric dipole consists of two opposite charges of magnitude q = 2 μC separated by 2 cm. The dipole is placed in electric field 2×10^6 N/C. Calculate (*i*) the maximum torque on the dipole (*ii*) the work done to turn the dipole through 180° starting from a position $\theta = 0°$.

(*c*) State the Ampere's circuital law. Apply the law to obtain magnetic induction vector $\vec{B}$ inside and outside a toroid. 6,4,5

(*a*) Show that the energy required to establish a current 'I' in a coil of self-inductance 'L' is $\frac{1}{2}LI^2$.

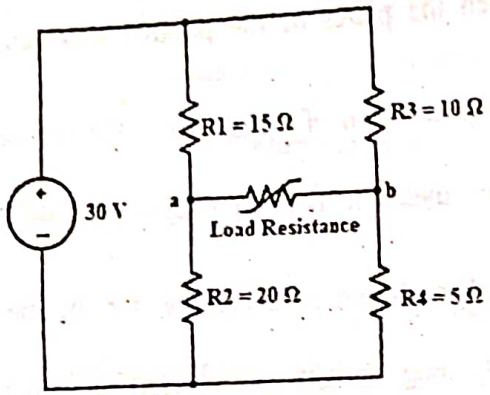
(*b*) Derive the relation $\vec{\nabla} \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$; where the symbols have the usual meaning.

(*c*) A rod of magnetic material 0.5 m in length has a coil of 200 turns wound over it uniformly. If a current of 2A is sent through it, calculate $\vec{H}, \vec{M}, \vec{B}$ and μ_r. (Given $\chi_m = 6 \times 10^{-3}$) 4,6,5

7. (a) State and prove Thevenin's theorem.

(b) Determine the power factor for a circuit containing L, C and R in series.

(c) Find the value of the load resistance for maximum power transfer from the voltage source and also determine the maximum power for the given circuit.



[This question paper contains 4 printed pages.]

Sr. No. of Question Paper : 6637 FC-2 Your Roll No.....

Unique Paper Code : 42221201

Name of the Paper : Electricity, Magnetism and EMT

Name of the Course : B.Sc. Program (Physics) CBCS

Semester : II

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any Five questions in all, including Q. No. 1 which is compulsory.

1. Attempt any five of the following : (5×3=15)

(a) A test charge of 3×10^{-9} C is moving with a velocity $\vec{V} = 2\hat{i} + 3\hat{j}\ ms^{-1}$ in a magnetic field $\vec{B} = 2\hat{j} + 3\hat{k}$ *Tesla*. Find the magnitude and direction of Lorentz force acting on the test charge.

(b) What is the physical significance of the equation, $\vec{\nabla}.\vec{B} = 0$?

(c) Find a unit vector normal to the surface $x^2 - 2x^2 + z^2 = 3$ at the point (2,1,1).

(d) Using the Ampere's circuital law, determine the magnetic field due to infinite straight conductor carrying a current 'I'.

(e) What is the fundamental difference between the electric field induced due to a changing magnetic flux and the electric field due to static charge ?

P.T.O.

(f) Write the equation of continuity and explain its physical significance.

(g) Distinguish between self and mutual inductance.

(h) What is the relation between $\vec{B}$, $\vec{M}$ and $\vec{H}$ where the symbols have their usual meaning ?

2. (a) Give the physical significance of the curl of vector field. (3)

(b) Find, (i) $\vec{\nabla}(r^n)$ (ii) $\vec{\nabla}.\left(\frac{\vec{r}}{r^3}\right)$ (4,4)

(c) Evaluate the line integral $\int_C \vec{F}.d\vec{r}$, where $\vec{F} = 3xy\,\hat{i} - y^2\,\hat{j}$ and C is the curve in x-y plane $y = 2x^2$ from (0, 0) to (1, 2). (4)

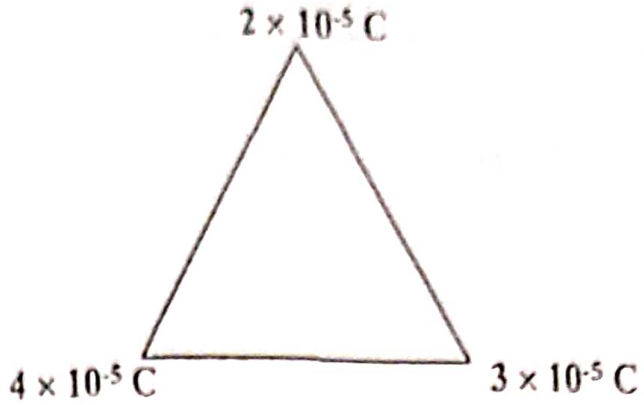
3. (a) Prove that the electrostatic field, due to a point charge, is a conservative field and hence show that it can be expressed as a gradient of some scalar potential. (6)

(b) Find the electric field at a distance z above the midpoint of a straight line segment of length 2L, which carries uniform line charge 'λ'. (4)

(c) Using Gauss's theorem in electrostatics, determine the electric field near an infinite plane charged conductor, having uniform surface charge density σ. (5)

4. (a) Compute the work to be done in assembling three charges at the vertices of an equilateral triangle of side 10 cm as shown :

6637



(5)

(b) A dielectric completely fills the space between the plates of a parallel plate capacitor. Show that the induced charge varies with the dielectric as :

$$q' = q\left[1 - \frac{1}{K}\right]$$ (4)

(c) Derive the expression for the electric field intensity at any point inside and outside of a uniformly charged non-conducting sphere of radius 'R'. (6)

5. (a) State Biot-Savart's law. Find an expression for the magnetic field $(\overline{B})$ at a point inside a solenoid, on its axis, having current 'I', number of turns per unit length 'n' and radius 'a'. (6)

(b) Two long parallel wires are separated by 10 cm and each carries 10A current in the same direction. Calculate the force between the wires per unit length. (3)

(c) Give the brief introduction of diamagnetic, paramagnetic and ferromagnetic materials. (6)

6. (a) Derive an expression for self-inductance of a long straight solenoid. (5)

(b) Starting from integral forms, prove that :

(i) Curl $\vec{E} = -\partial\vec{B}/\partial t$

(ii) $\vec{\nabla}.\vec{E} = \frac{\rho}{\varepsilon_0}$ (4,4)

(c) What is Lenz's law ? (2)

7. (a) What was the inconsistency in Ampere's Circuital Law for time dependent field. How did Maxwell remove it ? (5)

(b) Write the Maxwell's equations for a linear, homogeneous and isotropic dielectric medium. Derive electromagnetic equations and find the velocity of these waves in the medium. (10)

[This question paper contains 2 printed pages]

Sl. No. : 2259 GC-3 Roll No.....

Unique Paper Code : 32225101

Name of the Paper : Electricity and Magnetism

Name of the Course : Generic Elective -Physics: CBCS

Semester : II

Duration :3 hours Maximum Marks : 75

Attempt *five* questions in all.

Question No. 1 is compulsory.

All questions carry equal marks.

(5x3=15)

Q1. Attempt any five of the following:

(a) Verify that electrostatic field is irrotational.

(b) What is the fundamental difference between the electric field produced due changing magnetic flux and the electric field due to static charges?

(c) Show that the potential function $\phi = \frac{A}{r} + B$, where A and B are constants, satisfies Laplace's equation.

(d) Starting from Biot-Savart's law, verify that $\vec{B}$ is a solenoidal vector.

(e) What is Lenz's law?

(f) Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.

(g) The electric field of a plane electromagnetic wave propagating through a certain isotropic dielectric, non-magnetic medium is given by:

$$\vec{E} = 4sin(2\pi \times 10^7 t - 0.8x)\hat{k}\, V/m$$

What are the direction of wave propagation and velocity of the wave in the medium?

Q2. (a) Derive the expression for $div\vec{A}$ in Curvilinear coordinates. (7)

(b) Find (i) grad (r^n) (ii) div $(\frac{\vec{r}}{r^3})$ (8)

Q3. (a) State Gauss theorem of electrostatics. Verify this theorem for an irregularly shaped closed surface. Express it in its differential and integral form. (10)

(b) Using Gauss theorem, find an expression for the mechanical force per unit area on the surface of a charged conductor. (5)

P.T.O.

Q4. (a) Find the expression for electrostatic potential due to a uniformly charged solid sphere at points outside and inside the sphere. Verify that for an outside point, total charge on the sphere can be assumed to be concentrated at its centre. Also from the expressions of potential, find the expressions for electric field at points outside and inside the sphere.

(b) A charge of 2μC is distributed uniformly on a solid sphere of radius 10 cm. Calculate the electric potential at a point:

(i) 5 cm from the centre

(ii) 20 cm from the centre of the sphere.

Q5. (a) Explain polarization of a dielectric considering the case when a dielectric slab is introduced between the plates of a parallel plate capacitor

(b) Derive an expression for the capacitance of a parallel plate capacitor filled with air. Show that the capacitance increases when a dielectric is inserted between the plates. By what amount does it increase when the dielectric completely fills the space between the plates?

(c) Verify that the electrostatic energy of a capacitor of capacitance C charged to a potential V is given by $\frac{1}{2}CV^2$.

Q6. (a) Starting from Biot-Savart's law, deduce the expressions for the magnetic field due to a long straight current carrying wire. Obtain its limiting form when the wire is assumed to be infinitely long.

(b) State Ampere's circuital law. Obtain its differential form.

(c) Using Ampere's circuital law, derive the expression for magnetic field at a point inside an infinitely long solenoid carrying current.

Q7. (a) Explain the phenomenon of self induction. Define self inductance in terms of magnetic flux and induced e.m.f.

(b) Obtain an expression for the work to be done to establish a current I in a coil of self inductance L. Hence define self inductance in terms of this work done.

(c) The current passing through an inductance decreases from 5Amp to 1Amp in 0.2 sec. If the e.m.f induced in the coil is 0.4 V, calculate the self inductance of the coil.

Q8. (a) Write the differential and integral forms of all the Maxwell's Equations. Also explain their physical significance.

(b) For a plane electromagnetic wave propagating through free space, derive the wave equations for electric and magnetic field vectors.

Values of Constants:

$\mu_o = 4\pi \times 10^{-7}$ H/m

$\varepsilon_o = 8.85 \times 10^{-12}$ F/m

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **1827** **GC-4**

Unique Paper Code : 32221201

Name of the Course : **B.Sc.(Hons.) Physics**

Name of the Paper : Electricity and Magnetism

Semester : II

Time : 3 Hours ***Maximum Marks : 75***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Attempt any **FIVE** questions in **all**. Question **NO.1** is compulsory.

(c) **All** questions carry equal marks.

(d) Non-programmable calculators allowed.

1. Attempt any **five** of the following : 3×5=15

(a) Can the following be a possible electrostatic field ?

$$\vec{E} = K\left[y^2\hat{x} + \left(2xy + z^2\right)\hat{y} + 2yz\hat{z}\right]$$

(b) Explain the principle of 'Method of Electrical Images'. With reference to a earthed conducting plane.

(c) Calculate the potential difference between two points which are situated at a distance 1m and 2m from the source of electric field whose strength as a function of distance 'x', from the source is $\vec{E} = 3/x^2$ NC^{-1} along positive x-axis.

(d) Prove that $\vec{\nabla}.\vec{B} = 0$ and explain its significance.

(e) Define magnetic susceptibility and relative permeability. Obtain the relation between them.

(f) Find the frequency of resonance of a parallel resonant circuit.

(g) Define the terms hysteresis, retentivity and coercivity.

2. (a) State and prove Gauss's flux theorem in electrostatics. Show that div. $E = \frac{\rho}{\varepsilon_0}$.

(b) A long cylinder carries a charge density that is proportional to the distance from the axis : $\rho = KS$, for some constant K. Find the electric field inside the cylinder.

(c) Find the total energy stored in the surrounding of a conducting sphere of radius R carrying charge 'q'. 5×3=15

3. (a) A cylindrical capacitor is made by placing coaxially a metallic cylinder of radius 'a' inside an earthed hollow metallic cylinder of larger radius 'b'. If 'l' is the length of the cylindrical capacitor determine the capacitance of the capacitor.

(b) Derive an expressions for potential and electric field at a point (r, θ) due to an electric dipole. 5+10=15

4. (a) What is a dielectric ? Define $\vec{D}, \vec{E}$ and $\vec{P}$. Establish the relation $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$.

(b) If a dielectric is introduced between the plates of a parallel plate capacitor, show that the induced charge varies with the dielectric as: q'= q (1-1/k), where k is the dielectric constant.

(c) Show that polarization of a dielectric medium gives rise to a volume charge density ρ_p and surface charge density σ_p.

5×3=15

5. (a) Starting from Biot-Savart's law, show that curl $\vec{B} = \mu_0 \vec{J}$ and hence show that 6

$$\oint \vec{B}.\,\overrightarrow{dl} = \mu_0 i$$

(b) Find an expression for the magnetic field at the centre of a circular current loop.

4

(c) Using Ampere circuital law find the magnetic induction due to a long current carrying solenoid at a point inside and outside it. 5

6. (a) Show that the area of B-H curve denotes the energy dissipated per unit volume during each magnetizing cycle.

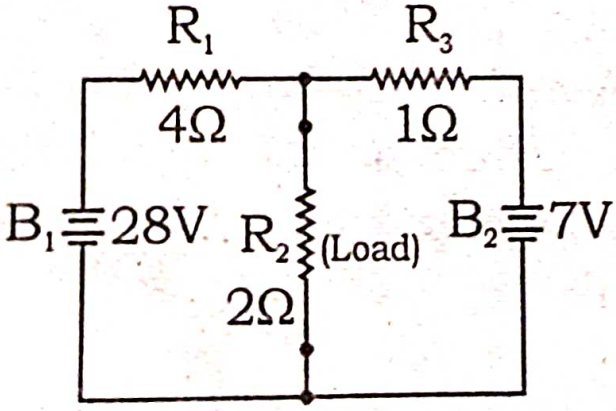
(b) State and prove the 'reciprocity theorem' in case of mutual inductance between two coils.

(c) State the Faraday's laws of electromagnetic induction. Derive the differential and integral forms of the Faraday's law. 5×3=15

7. (a) Derive an expression for quality factor in terms of band width for a series LCR circuit. 5

(b) State and prove Maximum power theorem for a DC network. 6

(c) Determine Thevenin's and Norton equivalent circuits of the circuit given below. 4



his question paper contains 4 printed pages.]

Your Roll No.....

No. of Question Paper : 1888 GC-4

ique Paper Code : 42221201

me of the Paper : Electricity, Magnetism and EMT

me of the Course : **B.Sc. Program**

mester : II

ration : 3 Hours Maximum Marks : 75

structions for Candidates:

Write your Roll No. on the top immediately on receipt of this question paper.

Attempt any **five** questions in all, including **Q. No. 1** which is compulsory.

Attempt any **five** of the following: (5x3=15)

(a) A charge 'q' moving initially with velocity 3 $\hat{k}$ m/s enters a region with electric field, $\vec{E} = 10\ \alpha\,\hat{i}$ V/m and magnetic field, $\vec{B} = 20\,\vec{j} + 100\ \hat{k}$ Tesla. For what value of α will the Lorentz force on the charge be zero.

P.T.O.

(b) What is the physical significance of divergence vector field?

(c) Five thousand lines of a electric force enter in a ce region and three thousand lines emerge from it. the total charge in coulomb within the region.

(d) A conductor of circular cross section of radius carries a current of uniform current density "j". the magnetic field at distance r > a., from the ce of the conductor.

(e) Is the electric field induced due to a changing magn flux a conservative field or not? Explain.

(f) Write the equation of continuity and explain physical significance.

(g) Distinguish between self and mutual inductance.

(h) What is the relation between $\vec{E}$, $\vec{P}$ and $\vec{D}$ where symbols have their usual meaning.

2. (a) Find a unit vector normal to the surface $xz^2 + x$ z – 1, at the point (1, -3, 2).

(b) Find $\vec{\nabla}$ (In r)

(c) Evaluate the surface integral, $\oiint_S \vec{r}.\hat{n}\, dS$ for a sphe surface S of radius 'a' having its centre at the or

(a) Prove that the energy stored per unit volume of the electric field is $\frac{1}{2}\epsilon_0 E^2$. (5)

(b) Eight identical charges of 'q' coulomb each are placed at corners of a cube of side length 'a'. Find the electric potential energy of this system of charges. (5)

(c) State and prove the Gauss's theorem in electrostatics for spherical surface (2,3)

(a) Find the electric potential, inside and outside a spherical shell of radius R, which carries a uniform charge Q. Set the reference point at infinity. (5)

(b) A dielectric completely fills the space between the plates of a parallel plate capacitor. Show that the induced charge varies with the dielectric as:

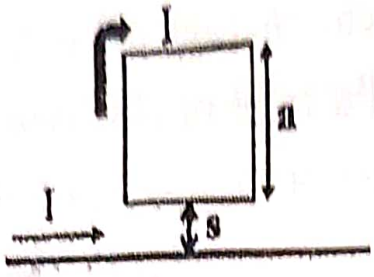
$$q' = q\left[1 - \frac{1}{k}\right]$$ (5)

(c) Find out the capacitance of a cylindrical capacitor of two coaxial, cylindrical metallic shells A and B of radii 'a' and 'b' respectively and length 'l'. Assume 'q' is the charge on the inner cylinder A and outer cylinder B is grounded. (5)

(a) State Biot-Savart's law and find an expression for the magnetic field (B) at the centre of a square of side 'a', carrying a steady current 'I'. (2,4)

P.T.O.

(b) Find out the force on a square loop placed as sl in Figure, near an infinite straight wire. Both the and wire carry a steady current 'I'.



(c) Distinguish between diamagnetic, paramagnetic ferromagnetic materials.

6. (a) Show that for two interacting coils, M $\leq$ $M \leq \sqrt{L}$ where the symbols have their usual meaning.

(b) State Ampere's circuital law in magnetostatics, obtain its differential form.

(c) Prove that: Curl $\vec{B} = \vec{J} + \vec{J}_d$

7. (a) What is Poynting vector? Sunlight strikes the outside its atmosphere with intensity of 2.0 cal/ min. Find the peak value of **E** and **B** for sunlight a earth.

(b) Write the Maxwell's equations for vacuum. De electromagnetic equations and find the velocity of t waves in free space.

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 122 G

Unique Paper Code : 222463

Name of the Paper : Physics – IV : Electricity, Magnetism and Electromagnetic Theory (PHPT-404)

Name of the Course : **B.Sc. (Physical Science)**

Semester : IV

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Five** questions in all.
3. Question No. **1** is compulsory. Attempt **four** questions from the rest of the paper.
4. Use of non-programmable scientific calculator is allowed.

1. Attempt any **five** of the following : (5×3=15)

(a) What is Lenz's law ?

P.T.O.

(b) When does magnetic forces do no work on a movi point charge ?

(c) How Maxwell modified Ampere's Law ?

(d) What is the difference between circular and ellipti polarisation ?

(e) Why do the electric field lines never cross ? Explai

(f) For the electrostatic potential $V = \frac{1}{r} + 2$ determ whether $\vec{E}$ is rotational or irrotational.

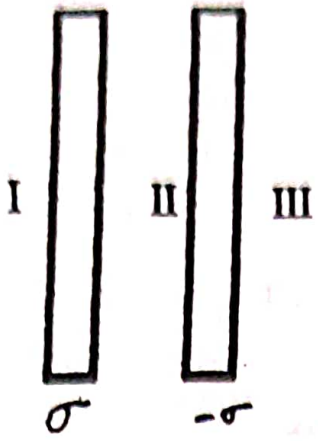
(g) What is the critical damping resistance in a balli Galvanometer ?

(h) A magnetic vector potential $\vec{A}$ is given by $3x^3\hat{i} + y$ Obtain $\vec{B}$, the magnetic field at the point (1,3,5,).

2. (a) State and prove Gauss's theorem of electrostatics fo spherical surface.

(b) Find the electric field inside a sphere which carrie charge density proportional to the distance from the ori given by $\rho = k\, r$, for some constant k.

(c) Two infinite parallel planes carry equal but opposite uniform charge densities $\pm \sigma$. Find the electric field in the three regions shown. (4)



(a) A thin spherical shell of radius R carries a uniform charge density. Find the expression of electric field at a point lying inside and outside this spherical shell. Use these values to calculate the electric potential at an arbitrary point inside and outside the shell. (7+3)

(b) Find the electric-energy associated with an electric field for a uniformly charged solid sphere of total charge Q and radius R. (5)

(a) State the Biot Savart Law. Using the Biot Savart Law find the magnetic field at a distance a due to long straight wire carrying a current I along the positive y-axis. (7)

(b) A circular loop of radius r = 2 cm carries a stea current, I = 16 A in anti-clockwise direction. Wh magnetic field will be observed at the center of th loop.

(c) The magnetic field in a region is given by $\vec{B} = 3\hat{i} + 4$ Tesla. Calculate the magnetic flux across the surfac each of area $2m^2$ in

(i) x – y plane

(ii) y – z plane

(iii) z – x plane.

5. (a) List the various torques that act on the coil of a movi coil galvanometer. Using them write the equation motion of the coil. Under what conditions does it sh 'ballistic' behaviour. (2+2+3 =

(b) Using Ampere's Circuital Law find the magnetic fi (i) inside and (ii) outside a very long solenoid, consisti of n closely wound turns per unit length on a cylinder radius R and carrying a current i.

(c) The first and the eleventh throw of a ballis galvanometer are 20 cm and 16 cm respective Calculate the value of the logarithmic decrement.

(a) Define self inductance. Does it have dependence on the geometry of the circuit ? Find the self inductance of a solenoid of radius R and n number of turns per unit length. (7)

(b) Prove that curl $\vec{E} = -\frac{\overrightarrow{\partial B}}{\partial t}$. (5)

(c) A 50 mH coil carries a current of 2A. Find the energy stored in the magnetic field. (3)

(a) Obtain the wave equation for electric and magnetic field vectors in free space and show that electromagnetic waves are transverse in nature. (7)

(b) Write Maxwell's equations for electromagnetic field in integral form and explain their physical meaning. (8)

(a) Derive the boundary conditions for the $\vec{D}$, $\vec{B}$, $\vec{E}$ and $\vec{H}$ fields using Maxwell's equations at the interface between two dielectrics. (8)

(b) Deduce Brewster's law on the basis of Fresnel's equations and explain the concept of polarisation by reflection. (7)

P.T.O.

6

Physical Constants

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

$$\mu_0 = 4\pi \times 10^{-7}\ Wb/Am$$

$$c = 3 \times 10^8\ m/s$$

$$e = 1.6 \times 10^{-19}\ C$$

2017

This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7340 HC

Unique Paper Code : 32225101

Name of the Paper : Electricity and Magnetism

Name of the Course : **Physics : Generic Elective**

Semester : I

Duration : 3 hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **Five** questions.
3. Question No. **1** is compulsory.
4. **All** questions carry equal marks.

1. Attempt any **five** of the following : (3×5)

(a) Show that $W = \frac{1}{2} LI^2$ is the work done to establish a current I in a coil of self-inductance L.

(b) If $\varphi = x^2yz^3$ and $A = xzi - y^2j + 2x^2yk$, find the value

P.T.O.

of $\nabla . (A\varphi)$ at (1, 1, 1).

(c) State Poynting Theorem. Write its mathematical fo

(d) Using Gauss's law find the electric field for uniform charged wire having λ as charge per unit length.

(e) State and write Gauss-Divergence theorem.

(f) Find the capacitance of two concentric spherical me shells, with radii a and b.

(g) Show that $V = (x + 3y)i + (y - 2z)j + (x + az)k$, solenoidal in nature if $a = -2$.

2. (a) Show that $\nabla^2\left(\frac{r}{r}\right) = 0$, where r position vector. (3×

(b) Show that volume enclosed by a surface S

$$V = \frac{1}{6} * \int \nabla r^2 . ds .$$

(c) Evaluate $\int r . ds$ where s is a closed surface and r is position vector.

3. (a) State and prove of Gauss law of electrostatics. Writ down its differential form. (10

(b) Using the Gauss's law, find electric field and potential of uniformed charge sphere. (5)

Find the potential of a spherical shell of radius R at a point r where

(a) $r > R$ (b) $r = R$ (c) $r < R$

The shell has a uniform surface charge. Set the reference point at infinity. (7,4,4)

Derive an expression for electric field and potential due to a dipole. (15)

(a) Calculate the speed of the electromagnetic wave propagating through in dielectric medium. (8)

(b) Show that magnetic energy density is given by $\frac{1}{2\mu}B^2$. (7)

(a) Write down the integral form of Maxwell's equations and give physical interpretation of each equation. (6)

(b) Derive the equation of continuity. (3)

(c) Explain the need to modify the Ampere's Circuital Law. (3)

P.T.O.

(d) Derive the expression for modified form of Ampe
Circuital Law.

8. (a) Obtain an expression for magnetic field due to infi
straight current carrying conductor.

(b) State and prove Reciprocity theorem.

(14)

his question paper contains 4 printed pages.]

Your Roll No.....

. No. of Question Paper : 902 I

iique Paper Code : 32225101

ime of the Paper : Electricity and Magnetism

ime of the Course : **Physics : G.E. for Honours**

mester : I

iration : 3 Hours Maximum Marks : 75

structions for Candidates

Write your Roll No. on the top immediately on receipt of this question paper.

Attempt any **Five** questions.

Question No. **1** is compulsory.

All questions carry equal marks.

Attempt any **five** of the following : (3×5)

(a) State and write Stoke's theorem.

(b) Show that the vector $A = i(2xy + yz^2) + j(x^2 + xz^2) + k(2xyz)$ is irrational.

(c) Distinguish between diamagnetic, paramagnetic and ferromagnetic materials.

P.T.O.

(d) Show that energy associated with a capacitor C carrying charge Q is given by $\frac{1}{2}CV^2$.

(e) Prove the conservative nature of electrostatic field.

(f) Find the magnetic force between two parallel conductors carrying current i.

(g) Show that $\nabla.(\nabla \times A) = 0$.

2. (a) Evaluate ∇r^n where r is position vector and n is a positice integer. (3×5)

(b) If $A = (3x^2 - 6yz)i + (2y + 3xz)j + (1 - 4xyz^2)k$, evaluate $\int A.\,dr$ from the (0,0,0) to (1,1,1) along the following $x = t,\ y = t^2,\ z = t^3$.

(c) If A and B are irrotational vectors, then prove that A × B is solenoidal.

3. (a) Using Gauss law, establish the relationship $D = \in.E + P$, where the symbols have their usual meaning. (8)

(b) Explain the effect of dielectric on the capacitance of a parallel plate capacitor. (7)

4. (a) Using the Biot-Savart's law, show that $\nabla.B = 0$. Explain its physical significance. (8,2)

(b) Calculate the self-inductance of a solenoid having 100 turns wound uniformly on a cylindrical paper tube of length 10 cm having a diameter of 2 cm in diameter. The medium is assumed to be air. (5)

5. (a) Derive an expression for the capacitance of cylindrical capacitor. (5)

(b) Obtain an expression for electrical field due to uniformly charged plane sheet having a uniform charge density σ. (5)

(c) The potential is give by $V(r) = -k \ln\left(\frac{r}{a}\right)$, where k and a are constants. Calculate electric field. (5)

6. (a) Write down the differential form of Maxwell's equations. Explain the physical significance of each equation. (4,4)

(b) Obtain the expression for the self-inductance L of a solenoid having N turns. (7)

7. (a) Show that $\nabla \times B = \mu . J$. (10)

P.T.O.

(b) Obtain an expression for magnetic field at a distan
s from a long straight wire carrying a steady curre
i. (

8. (a) Using Maxwell's equations obtain the expression f
speed of EM wave travelling in vacuum. (1(

(b) Prove the transverse nature of EM wave. (5

(14)

This question paper contains 4 printed pages.

Your Roll No. .....

S. No. of Paper : 6680 HC

Unique paper code : 32221201

16 MAY 2018

Name of the paper : **Electricity and Magnetism**

Name of course : **B.Sc. (Hons.) Physics**

Semester : **II**

Duration : **3 hours**

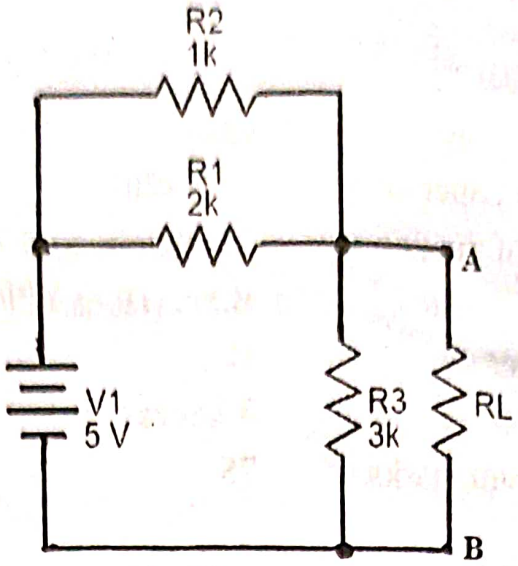
Maximum marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt five questions in all.
Question No.1 is compulsory.
All questions carry equal marks.
Non-programmable calculators are allowed.

1. Attempt any *five* of the following:
   a) Show that $\vec{P} = \varepsilon_0(\varepsilon_r - 1)\vec{E}$.
   b) The electrostatic potential at any point in a plane is given by
   $$V(r,\theta) = \frac{a\cos\theta}{r^2} + \frac{b}{r^2}$$
   Find the components E_r and E_θ of the electric field at any point.
   c) Prove that $\vec{\nabla}.\vec{B} = 0$ and explain its physical significance.
   d) State and prove the first Uniqueness theorem.
   e) Find the Thevenin's equivalent of the given circuit across RL.

P. T. O.



f) A capacitor of 250 pF is connected in parallel with a coil having inductance of 1.16 mH and effective resistance 20 Ω. Calculate the circuit impedance at resonance.

g) Prove reciprocity theorem for mutual inductance (*i.e.*, $M_{12}=M_{21}$). **(5x3=15)**

2. a) State and prove Gauss's theorem in electrostatics. Show that $\vec{\nabla}.\vec{E} = \frac{\rho}{\varepsilon_o}$.

b) A thick spherical shell carries a charge density $\rho = \frac{k}{r^2}$. The inner and outer radii of the spherical shell are a and b respectively. Find the electric field in the regions (i) $r < a$, (ii) $a < r < b$, and (iii) $r > b$. **(7,8)**

3. a) Derive an expression for potential and electric field at a point (r, θ) due to an electric dipole.

b) Using the method of images, determine the position and magnitude of the image charge of a point charge q placed in front of an earthed conducting sphere of radius R at a distance d from its centre. **(8,7)**

4. a) Find the capacitance per unit length of a cylindrical conductor of radius a placed coaxially inside an earthed hollow conducting cylinder of radius b.

b) Two dielectrics of thickness d_1 and d_2 having dielectric constant k_1 and k_2 are placed between a pair of oppositely charged parallel plates. If E_1 and E_2 are electric field intensities in the two dielectrics, show that :

$$\frac{E_1}{E_2} = \frac{k_2}{k_1}$$ (8,7)

5. a) State Biot-Savart's law. Derive an expression for the magnetic field at a point due to an infinitely long straight current carrying conductor using Biot-Savart's law.

b) Using Ampere's circuital law, find the magnetic field due to a long current carrying solenoid at a point inside it. (9,6)

6. a) Explain how and under what conditions the Ampere's circuital law fails. How did Maxwell modify it to make it consistent with continuity equation?

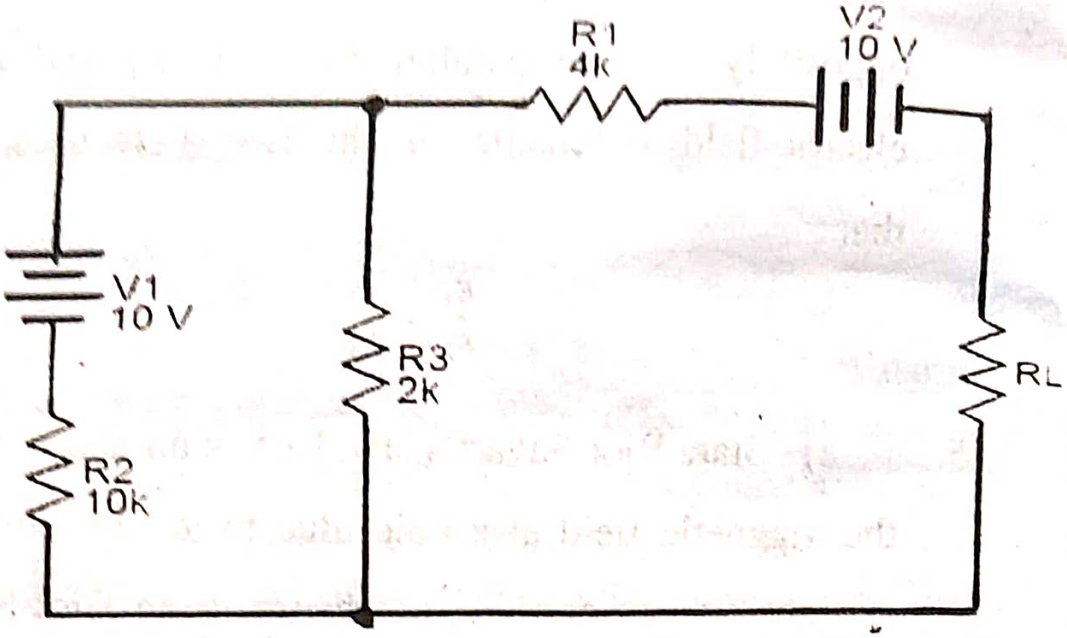
b) Two inductances L_1 and L_2 are connected in parallel. If M is the mutual inductance between them, show that their effective inductance, L_{eff}, is given by

$$L_{eff} = \frac{L_1 L_2 - M^2}{L_1 + L_2 \pm 2M}$$ (7,8)

P. T. O.

7. a) An a.c. source is applied across an inductor, resistor and capacitor connected in series. Derive relation for its resonant frequency.

b) Determine the value of RL for maximum power transfer and power dissipated across it. **(9,6)**



This question paper contains 4+1 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : 6913

16 MAY 2018

Unique Paper Code : 42221201 HC

Name of the Paper : Electricity, Magnetism and EMT

Name of the Course : B.Sc. (Prog.)

Semester : II

Duration : 3 Hours Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Q. No. 1 is compulsory. Attempt *four* questions from the rest of paper.

Use of non-programmable scientific calculator is allowed.

1. Attempt any *five* of the following : 5×3=15

(*a*) Show that :

$$\nabla r^n = nr^{n-2}\vec{r}.$$

(*a*) If $\vec{r}$ is the position vector, show that $\iint_S \vec{r} \cdot \hat{n}\, dS = 3V$, where V is the volume enclosed by the surface S.

P.T.O.

(c) Show that the work done in moving an electric charge in an electric field is path independent.

(d) What is the magnitude of a point charge so that the electric field 50 cm away has a magnitude 2.0 N/C ?

(e) Explain the term potential gradient and establish the relation $\vec{E} = -\vec{\nabla} V$.

(f) A magnetic vector potential $\vec{A}$ is given by $3x^3\hat{i} + yz\hat{j}$. Obtain $\vec{B}$, the magnetic field at the point (1, 3, 5).

(g) What is the significance of Lenz's law ?

2. (a) Express Gauss Divergence theorem in words and write it in differential form. 3

(b) A vector field is given by $\vec{A} = (x^2 - y^2 + x)\hat{i} - (2xy + y)\hat{j}$. Is this field irrotational ? If so, find its scalar potential. 5

(c) Evaluate $\iiint_R (x^2 + y^2 + z^2)dx\,dy\,dz$, where R denotes the region bounded by $x = 0$, $y = 0$, $z = 0$ and $x + y + z = a$, $(a > 0)$. 7

3. (*a*) State and prove Gauss's theorem of electrostatics. 5

(*b*) Use Gauss's law to find the electric field due to an infinite length of wire of linear charge density λ. 6

(*c*) Three charges, each equal to q, are placed at the three corners of a square of side a. Find the electric field at the fourth corner. 4

4. (*a*) What is dipole moment ? Obtain an expression for the potential and field due to an electric dipole. 6

(*b*) Prove that the energy stored in an electric field is given by : 5

$$\frac{1}{2}\varepsilon_0 \iiint_{\text{all space}} E^2 \cdot d\tau.$$

(*c*) A potential of 50 V is applied between two parallel plates of a capacitor which are 4 cm apart. Obtain the force acting on charge of 4.3×10^{-7} C placed between the plates. 4

5. (*a*) State the Biot-Savart Law. Using the Biot-Savart Law, find the magnetic field along the axis of a circular current loop of radius '*a*' carrying current I. 7

(*b*) The magnetic field $\vec{B}$ due to a current carrying circular loop of radius 12 cm at its centre is 0.5×10^{-4} T. Find the magnetic field due to this loop at a point on the axis at a distance of 5.0 cm from the centre. 3

(*c*) Find the capacitance of two concentric spherical shells, with radii a and b ($> a$). 5

6. (*a*) Define self inductance. Does it depend on the geometry of the circuit ? Find the self inductance of a solenoid of radius R and n number of turns per unit length. 7

(*b*) Derive the expression for mutual inductance of concentric solenoids. 5

(*c*) Derive the expression for the energy stored in the magnetic field of an inductor. Find the energy stored in the magnetic field for a 60 mH coil carrying a current of 3A. 3

7. (*a*) Obtain the wave equation for electric and magnetic field vectors in free space and show that electromagnetic waves are transverse in nature. 7

(*b*) Write Maxwell's equations for electromagnetic field in integral form and explain their physical meaning. 5

(*c*) Show that equation of continuity is a consequence of Maxwell's equation. 3

Physical Constants :

$\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2/N\text{-}m^2$

$\mu_0 = 4\pi \times 10^{-7}$ Wb/A-m

$e = 1.6 \times 10^{-19}$ C

$c = 3 \times 10^8$ m/s.

(14)

[This question paper contains 10 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 2262A **IC**

Unique Paper Code : 32221201

10 MAY 2019

Name of the Paper : Electricity and Magnetism

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

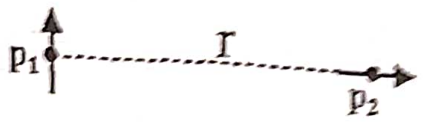
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. **1** with all its parts is compulsory.
3. Attempt any **four** questions from the remaining questions.
4. Each of the question nos. **2** to **7**, carries **14** marks.
5. Out of the **three** parts of question Nos. **2–7**, attempt any **two** parts.

1. (a) A constant electric field $\vec{E}$ passes through the surface of an open hemisphere, perpendicular to its base. Calculate the flux through the curved surface. (3)

P.T.O.

(b) Find the force per unit area on the surface of a charged conductor. (3)

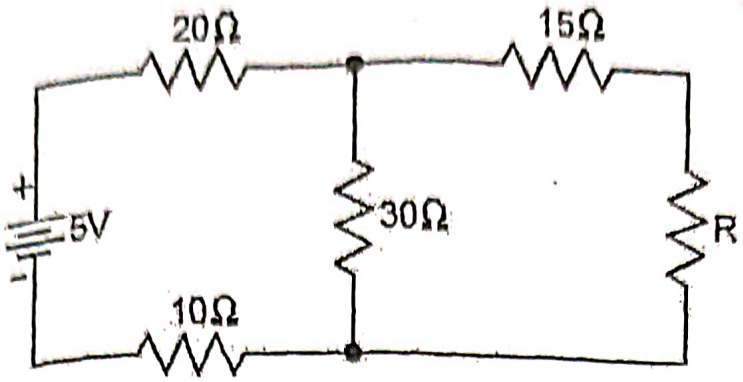
(c) Consider $\vec{p}_1$ and $\vec{p}_2$ are perfect dipoles a distance r apart as shown in figure given below. What is the torque on $\vec{p}_1$ due to $\vec{p}_2$? (3)



(d) A sphere of radius R carries a polarization $\vec{P}=k\vec{r}$ where k is a constant and $\vec{r}$ is the radial vector from the center. Find bound charge densities σ_b and ρ_b. (3)

(e) Suppose a uniform magnetic field in some region has the form $\vec{B}=B\hat{i}$. Find the force on a circular loop of radius a, lying in the yz plane, centered at the origin, which carries a current I in clockwise direction, when you look down the x-axis. (3)

(f) Determine Thevenin's equivalent circuit for the given network external to load resistance R. (3)



(g) What is displacement current? (1)

2. (a) State and prove first uniqueness theorem. Also derive Poisson's equation. (7)

(b) The electric field in a cubical region ($0 \le x, y, z \le a$) of space is given by the following expression:

$$\vec{E} = k\left[y^2\hat{i} + \left(2xy + z^2\right)\hat{j} + 2yz\hat{k}\right]$$

(i) Verify that this expression represents an electrostatic field or not.

(ii) Find charge density and

(iii) Total charge that gives rise to this electric field. (7)

(c) A hollow spherical shell inner radius a and outer radius b carries charge density $\rho = \frac{k}{r^2}$ in the region

$a \leq r \leq b$. Find the electric field in the three regions :

(i) $r < a$

(ii) $a < r < b$

(iii) $r > b$

(7)

3. (a) Evaluate the electrostatic energy of sphere of radius R and having uniform distribution of total charge Q for the following configuration

(i) Non-conducting sphere

(ii) Conducting sphere

Show that their ratio is 6/5. (7)

(b) There are two cavities of spherical shapes inside spherical conductor of radius R. The charges q_1 and q_2 are placed inside at the centers of each cavity. Then

(i) Find the surface charge densities σ_1, σ_2 and σ_R.

(ii) Find the electric field in each cavity.

(iii) What is the force on q_1 and q_2? (7)

(c) A point charge q is placed at a distance d from the centre of a grounded conducting sphere of radius a. Using the method of images, find

(i) The potential outside the sphere.

(ii) The magnitude and direction of the force acting on q.

(7)

4. (a) Show that the potential due to a polarized dielectric material is given by

$$V = \frac{1}{4\pi\varepsilon_0}\left(\oiint_S \frac{\sigma_b}{r} dS + \iiint_\tau \frac{\rho_b}{r} d\tau\right)$$

where σ_b and ρ_b are bound surface charge density and bound volume charge density respectively. Also, show that the net charge in a polarized dielectric material is zero.

(7)

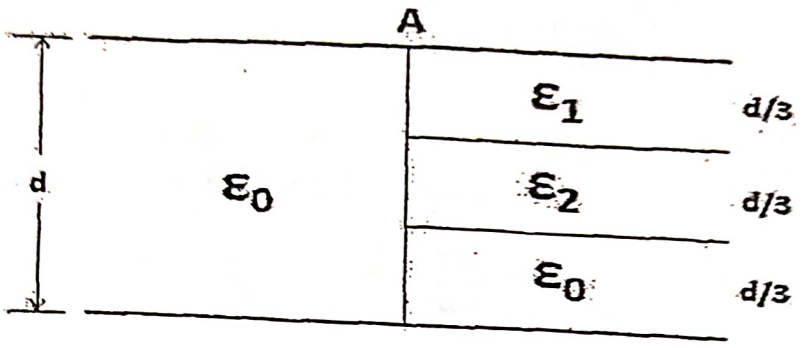
(b) A spherical conductor of radius a carries a charge Q and it is surrounded, out to radius b, by linear dielectric material of permittivity ε. Find the potential at the center (relative to infinity) and polarization vector $\vec{P}$.

(7)

(c) Calculate the capacitance for the configuration given below, where A is the cross-sectional area

of the square metallic parallel plates separated by total distance d. One half of the volume within the plates is free space with permittivity ε_0, while the other half is filled with equal slabs of different dielectrics with permittivities ε_1, ε_2, and ε_0.

(7)



5. (a) Starting from Biot-Savart law, show that $\vec{\nabla}.\vec{B}=0$ and explain its physical significance. Hence prove that the magnetic flux through any closed surface is zero.

(7)

(b) Two long coaxial solenoids each carrying current I in the same direction having number of turns per unit length n_1 (inner solenoid) and n_2 (outer solenoid). The radii of the inner and outer solenoids are a and b respectively. Find the magnetic field in the following regions with r being the radial distance from the axis :

(i) $r < a$

(ii) $a < r < b$

(iii) $r > b$

(7)

(c) Determine the magnetic field due to a long current carrying straight wire at a distance r from it. Consider two long parallel conducting wires 1 and 2 carrying currents I in same direction. One wire is placed at $x = +a$ and another at $x = -a$. Determine the magnetic field for the point $x > a$ on positive x-axis.

(7)

6. (a) Show that for a system of two coils C_1 and C_2, the mutual inductance is given by

$$M = \frac{\mu_0}{4\pi} \oint_{C_1} \oint_{C_2} \frac{\overrightarrow{dl_1} . \overrightarrow{dl_2}}{r}$$

where $\overrightarrow{dl_1}$ and $\overrightarrow{dl_2}$ are the elements of coils C_1 and C_2 respectively and r is the distance between them.

(7)

(b) Let the internal dimensions of a coaxial cylindrical capacitor be a = 1.2 cm, b = 4 cm, and L = 40 cm.

The homogeneous material inside the capacitor has the parameters $\epsilon = 10^{-11}$ F/m and $\sigma = 10^{-5}$ S/m. If this capacitor is connected to the source $V_S = V_0 \sin(\omega t)$ and the electric field inside this capacitor is

$$\vec{E}(r) = \frac{V_S \hat{r}}{r \ln(b/a)}$$

find

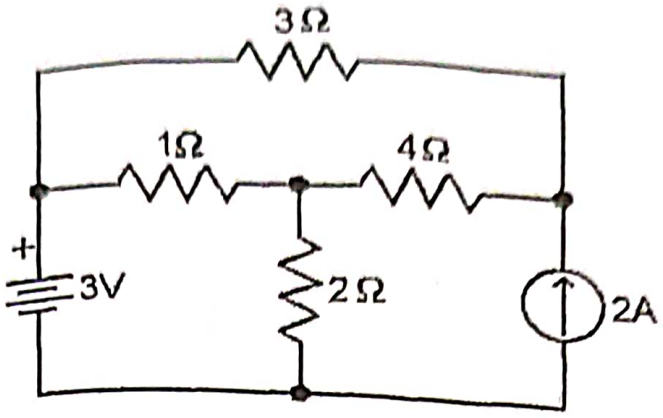
(i) The displacement current density, $\vec{J}_D$ and displacement current I_D

(ii) the conduction current density, $\vec{J}_C$ and conduction current I_c

$$\left[C = \frac{2\pi \epsilon L}{\ln(b/a)} \text{ Farad} \right] \quad (7)$$

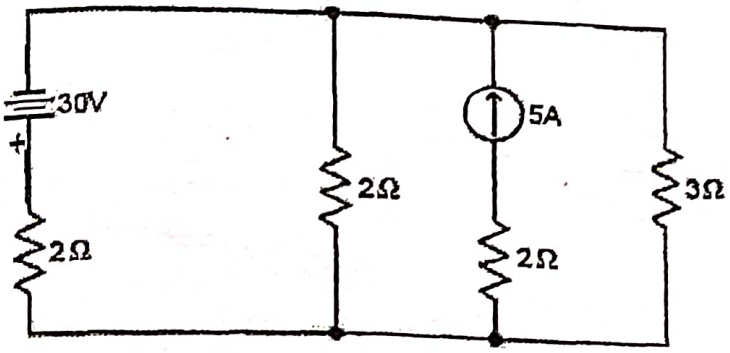
(c) Given $\vec{E} = E_o \sin(\omega t - kz)\hat{y}$ V/m in free space. Find $\vec{D}$, $\vec{B}$ and $\vec{H}$. (7)

7. (a) Use Mesh-Analysis to find the voltage across 1Ω resistance



(7)

(b) Obtain Norton equivalent circuit for the network external to the 3Ω resistance for the given network. Further determine the current through 3Ω resistor.



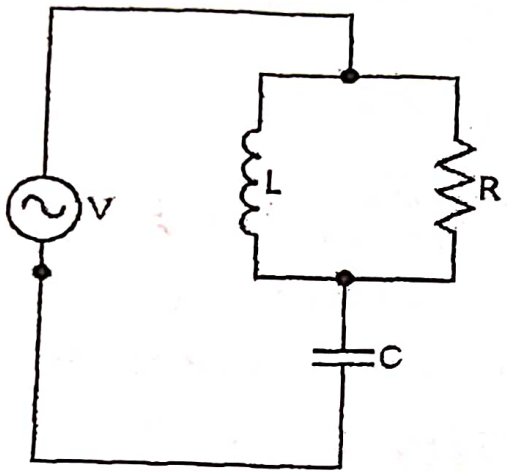
(7)

(c) A resistor 50Ω which is connected in parallel with an inductor of 30 mH, is connected in series with a capacitor C. An ac voltage of 220 V, with frequency 50 Hz is applied to the circuit. Find

(i) The value of C to give unity power factor

(ii) Total current in the circuit

(iii) The current in the inductor



(7)

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 2333 **IC**

Unique Paper Code : 42221201

Name of the Paper : Electricity, Magnetism and EMT

Name of the Course : **B.Sc. (Prog.)**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Five** questions in all.
3. Question No. **1** is compulsory. Attempt **four** questions from the rest of the paper.
4. Use of non-programmable scientific calculator is allowed.

1. Attempt any **five** of the following :

(a) If $\varphi(x,y,z) = 3x^2y - y^3x^2 + z^2$, calculate gradient of φ at the point $(1, -2, -1)$.

(b) Can the following be a possible electrostatic field?

$$\vec{E} = xy\hat{i} + 2yz\hat{j} + 3xz\hat{k}$$

P.T.O.

(c) State Poynting theorem and explain what do you understand by the Poynting vector.

(d) If $\vec{A}$ and $\vec{B}$ are irrotational, prove that $\vec{A}\times\vec{B}$ is solenoidal.

(e) Prove that $\vec{\nabla}.\vec{B}=0$ and explain its physical significance.

(f) Distinguish between dia-, para- and ferro-magnetic materials.

(g) Discuss the difference between induced electric field and electric field due to static charges.

(5×3=15)

2. (a) Find the work done in moving a particle in the force field

$$\vec{F}=\left(2x+y^2\right)\hat{i}+\left(3y-4x\right)\hat{j}$$

along the straight lines from (0,0) to (2,0), then to (2,1), then to (0,0).

(b) Show that the following function is a sink field

$$\vec{V}=\frac{-x\hat{i}-y\hat{j}}{\sqrt{x^2+y^2}}$$

(c) Prove that $\vec{\nabla}.\left(\vec{\nabla}\times\vec{A}\right)=0$. (6,6,3)

3. (a) Use Gauss's law to find the electric field inside, outside and on the surface of a uniformly charged solid sphere having charge density ρ.

(b) Derive an expression for an electrostatic potential due to a uniformly charged spherical shell at a point inside and outside the shell.

(c) The electric potential at any point (x,y,z) is given by $V = x(3y^2 - x^2 + z)$. Find the electric field at that point. (6,6,3)

4. (a) Derive $Q_p = Q\left(1-\frac{1}{k}\right)$ for a capacitor with dielectric between the parallel plates, where Q_p is the induced charge and k is dielectric constant. Calculate the capacitance of a parallel plate capacitor of plate area 5 cm^2 and separated by dielectric of dielectric constant 4 and thickness 1 cm.

(b) What is meant by polarization of a dielectric? Obtain generalized form of Gauss's law for a polarized dielectric.

(c) The magnetic field $\vec{B}$ due to a current carrying circular loop of radius 10 cm at its centre is 0.2×10^{-4} T. Find the magnetic field due to this loop at a point on the axis at a distance of 6 cm from the centre. (6,6,3)

5. (a) State and explain Biot-Savart's law. Derive an expression for the magnetic field at a point due an infinitely long straight current carrying conductor using Biot-Savart's law.

(b) State and prove Ampere's Circuital law. Starting from Ampere's circuital law, establish the relation

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}.$$

(c) Define $\vec{B}, \vec{M}$ and $\vec{H}$. Establish the relation

$$\vec{B} = \mu_0 \left(\vec{H} + \vec{M} \right).$$ (6,6,3)

6. (a) State the Faraday's law of electromagnetic induction. Show that

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

(b) Show that if the two coils having coefficient of self inductance L_1 and L_2 are mutually coupled together so that the whole of the flux from one coil links with the other, then the mutual inductance between the two coils is given by

$M = \sqrt{L_1 L_2}$.

(c) Derive the expression for the energy stored in the magnetic field of an inductor. Find the energy stored in the magnetic field of a 50 mH coil carrying a current of 2 A. (6,6,3)

7. (a) The magnetic field in a region is given by $\vec{B} = 3\hat{i} + 4\hat{k}$ tesla. Calculate the magnetic flux across the surfaces each of area 2 m^2 in

(i) $x-y$ plane (ii) $y-z$ plane (iii) $z-x$ plane.

(b) Write the four Maxwell's equations in an isotropic dielectric medium.

(c) Derive the wave equation for electric field and magnetic field vectors in an isotropic dielectric medium and hence obtain the velocity of electromagnetic wave in this medium.

(6,3,6)

P.T.O.

Physical Constants:

$\varepsilon_0 = 8.854 \times 10^{-12}\ C^2/N\text{-}m^2$

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

$e = 1.6 \times 10^{-19}\ C$

$c = 3 \times 10^8\ m/s$