

KATHMANDU UNIVERSITY
End Semester Examination
August, 2019

Marks Scored:

Level : B.E./B.Sc./B.Pharm./B.Tech.
Year : I

Course : PHYS 102
Semester : II

Exam. Roll No.:

Time : 30 mins.

F.M. : 15

Registration No.:

Date **AUG 09 2019**

SECTION "A"
[15Q × 1 = 15 marks]

I. Choose and tick/circle the most appropriate answers. The symbols, unless mentioned otherwise, have their usual meanings.

1. Which one of the following vector identities is NOT correct?

[a] $\nabla \times (f\vec{A}) = f\nabla \times \vec{A} - \vec{A} \times \nabla f$

[b] $\nabla \times (\nabla \times \vec{A}) = \nabla(\nabla \cdot \vec{A}) - \nabla^2 \vec{A}$

[c] $\nabla \times (\vec{A} \times \vec{B}) = \vec{B} \times (\nabla \times \vec{A}) - \vec{A} \times (\nabla \times \vec{B})$

[d] $\nabla \cdot (\vec{A} \times \vec{B}) = \vec{B} \cdot (\nabla \times \vec{A}) - \vec{A} \cdot (\nabla \times \vec{B})$

2. A point charge Q_1 lies at a point inside a sphere S_1 of radius R_1 . Another point charge Q_2 lies at a point outside the sphere S_1 and inside the concentric sphere S_2 of radius R_2 . If ϕ_1 and ϕ_2 are the total fluxes crossing the spheres S_1 and S_2 respectively, then

[a] $\frac{\phi_1}{\phi_2} = \frac{Q_1}{Q_2}$

[b] $\frac{\phi_1}{\phi_2} = \frac{Q_1}{Q_1 + Q_2}$

[c] $\frac{\phi_1}{\phi_2} = \frac{Q_1 + Q_2}{Q_2}$

[d] $\frac{\phi_1}{\phi_2} = \frac{Q_1 R_1^2}{Q_2 R_2^2}$

3. Let V and \vec{E} are the electrostatic potential and field respectively inside a spherical shell which carries a uniformly distributed total charge q . Which one of the following circumstances is correct everywhere inside the shell?

[a] $V = 0$ and $\vec{E} \neq 0$.

[b] $V \neq 0$ and $\vec{E} \neq 0$.

[c] $V = 0$ and $\vec{E} = 0$.

[d] $V \neq 0$ and $\vec{E} = 0$.

4. The electric susceptibility of a linear dielectric material

[a] measures the strength of polarization of the material.

[b] is directly proportional to the polarization of the material.

[c] is inversely proportional to the electric field in the material.

[d] is directly proportional to the amount of free charges present in the material.

5. A charge particle of mass m and charge Q moving with velocity \vec{v} enters in a magnetic field \vec{B} . Which one of the following statements is NOT correct?

[a] The particle follows the cycloid path, if $\vec{v} \cdot \vec{B} \neq 0$ and $\vec{v} \times \vec{B} \neq 0$.

[b] The particle follows the circular path with frequency $\frac{QB}{2\pi m}$, if $\vec{v} \cdot \vec{B} = 0$.

[c] The particle follows the straight path along the direction of \vec{B} , if $\vec{v} \times \vec{B} = 0$.

[d] The particle follows the helical path with frequency $\frac{QB}{2\pi m}$, if $\vec{v} \cdot \vec{B} \neq 0$ and $\vec{v} \times \vec{B} \neq 0$.

6. The integral form of Ampere's law can be used to find the magnetic field around the current carrying wires. The Amperian loop must be constructed in such a way that the line integral along the entire loop is not zero as well as
- [a] the magnetic field is tangential and varies uniformly along the loop.
 - [b] the magnetic field is tangential and constant at every point on the loop.
 - [c] the magnetic field is perpendicular and varies uniformly along the loop.
 - [d] the magnetic field is perpendicular and constant at every point on the loop.
7. A material contains tiny magnetic dipoles called atomic/molecular magnetic dipoles. They are in random orientation in the absence of external magnetic field and the net dipole moment of the material is zero. These dipoles arise due to spinning motion of electrons on their axes. In general, the atoms or molecules containing odd number of electrons can exhibit such nature. The material is called
- [a] diamagnetic material.
 - [b] ferromagnetic material.
 - [c] paramagnetic material.
 - [d] anti-ferromagnetic material.
8. The self-inductance per unit length of a long solenoid of radius R and n turns per unit length carrying a current I is
- [a] $\mu_0 \pi n R^2$
 - [b] $\mu_0 \pi n I R^2$
 - [c] $\frac{3}{4} \mu_0 \pi n^2 R^3$
 - [d] $\mu_0 \pi n^2 R^2$
9. Which one of the following statements is equivalent to Ampere's law after corrected by Maxwell?
- [a] Time varying electric field induces a magnetic field.
 - [b] Time varying magnetic field induces an electric field.
 - [c] Magnetic flux in a current loop is directly proportional to the current.
 - [d] The direction of induced current is such that it opposes the effect producing it.
10. In Raman spectra,
- [a] stokes lines have shorter wavelengths and are less intense than anti-stokes lines.
 - [b] stokes lines have longer wavelengths and are more intense than anti-stokes lines.
 - [c] stokes lines have longer wavelengths and are less intense than anti-stokes lines
 - [d] stokes lines have shorter wavelengths and are more intense than anti-stokes lines.

II. Fill the following blanks with appropriate answers.

11. The divergence of the position vector $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ at a point with coordinate $(3, 2, -4)$ is
12. The potential difference between the center and a point on the surface of a solid sphere of radius R carrying a uniform volume charge density ρ is
13. Let V and \vec{A} are the electric potential and magnetic vector potential respectively at a point in space. If \vec{A} varies with time, the net electric field at the point is
14. The SI unit of polarization is
15. The vibrational spectra of a molecule fall on the far infra-red region while the rotational spectra fall on theregion.

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Course : PHYS 102
Semester : II
F.M. : 40

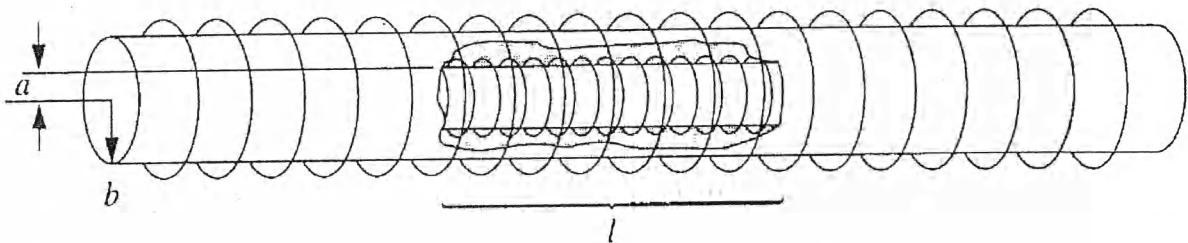
SECTION "B"
[5Q × 3 = 15 marks]

1. What are perfect conductors? Explain, why the electric field inside a perfect conductor is always zero.

OR

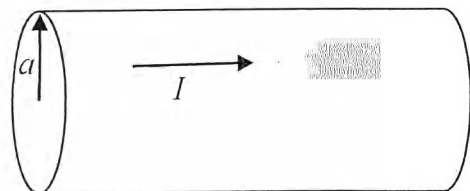
Define polarization. Show that the polarization \vec{P} establishes the volume bound charge density $\rho_b = -\nabla \cdot \vec{P}$ inside of the polarized material.

2. Define curl and divergence of a vector. Show that divergence of curl of a vector is always zero.
3. A short solenoid (length l and radius a , with n_1 turns per unit length) lies on the axis of a very long solenoid (radius b , n_2 turns per unit length) as shown in figure below. Current I flows in the short solenoid. What is the flux through the long solenoid? What is the mutual inductance of the system?



OR

A steady current I flows down a long cylindrical wire of radius a as shown in figure. Find the magnetic field, both inside and outside the wire, if the current is distributed in such a way that J is proportional to r , the distance from the axis.



4. What do you mean by superconductivity? What happens, when the magnetic flux is introduced into a superconducting ring? Explain the Meissner Effect of superconductivity.
5. Explain, how the hysteresis loop can be obtained in a ferromagnetic material. Show that hysteresis loss in a ferromagnetic substance is equal to the B-H curve.

OR

Obtain the Maxwell's equations in matter.

SECTION "C"
[5Q × 5 = 25 marks]

6. Find the electric field a distance z above one end of a straight line segment of length L , which carries a uniform line charge λ . Check that your formula is consistent with what you would expect for the case $z \gg L$.

OR

If \vec{B} is uniform, show that $\vec{A}(\vec{r}) = -\frac{1}{2}(\vec{r} \times \vec{B})$. Check that $\nabla \cdot \vec{A} = 0$ and $\nabla \times \vec{A} = \vec{B}$.

7. Show that the power delivered by the electromagnetic fields on a system of charge is $\frac{dW}{dt} = \int (\vec{E} \cdot \vec{J}) d\tau$ and proceed further to obtain the Poynting's theorem. Finally, show that Poynting vector \vec{S} satisfies the continuity equation, $\nabla \cdot \vec{S} = -\frac{\partial}{\partial t}(U_{em} + U_{mech})$, where U_{em} and U_{mech} are the electromagnetic and mechanical energy densities respectively.

8. Derive an expression for work done to assemble the first four point charges by bringing them from infinity. Enhance your derivation to assemble n point charges and hence for continuous charges. Using the result, show that the energy stored in an electric field \vec{E} is

$$W = \frac{\epsilon_0}{2} \int_{\text{all space}} E^2 d\tau.$$

OR

A cavity sphere is made inside a polarized material with polarization \vec{P} . Show that the electric field at the center of the cavity sphere due to the bound charges on the cavity surface is $\frac{\vec{P}}{3\epsilon_0}$.

Obtain the Clausius-Mossotti formula using the result.

9. With schematic diagram, explain experimental setup to observe the Raman Effect. Give the quantum mechanical explanation of it.
10. What is magnetic dipole? Derive the expressions of torque and energy stored in a magnetic dipole of dipole moment \vec{m} placed in a uniform magnetic field \vec{B} . At what conditions the energy is maximum and minimum?

OR

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). Find the magnetic energy stored in a section of length l . Also find the self inductance of the system from the result you have obtained.