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Name of Course	:	**B.Sc. Hons.–(Physics)_NEP: UGCF-2022**
Semester	:	**II- Semester (GE Paper)**
Name of the Paper:	:	**Electricity and Magnetism**
Unique Paper Code	:	**2224001201**
Total Marks	:	**90** Total time : **3 hours**

Instructions:

Question 1 is compulsory.

Four questions to be attempted from Q. No. 2 to 6

Q. 1: Attempt any **six** questions:

a) State and prove the Maximum Power Transfer Theorem for AC circuits involving complex impedances.

b) Define conservative vector fields. Show with an example how curl helps identify them.

c) Distinguish between free and bound charge densities in a dielectric.

d) Derive the condition under which electric field can be expressed as the negative gradient of a scalar potential.

e) Why is vector potential not uniquely defined? How does gauge transformation resolve this ambiguity?

f) Derive the continuity equation from Maxwell's equations and explain its significance in electromagnetic theory.

g) Derive boundary conditions at the interface of two dielectrics for both **E** and **D** fields.

(6x3 =18)

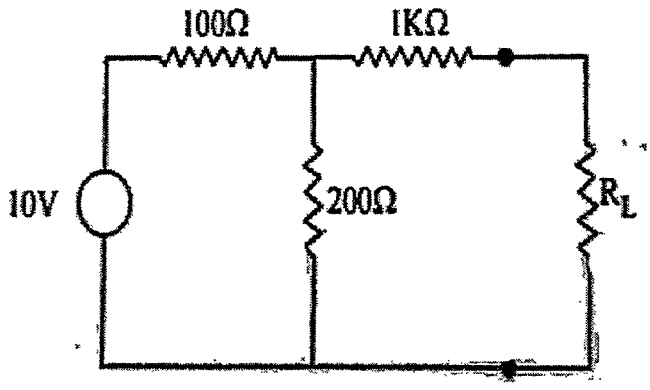
Q.2.

a) Show that the potential due to a Uniformly charged circular disc falls off from the Centre to the edge of the disc, derive necessary expressions. Also find the Electric field at the Centre of the disc.

b) Analyze the limitations of Superposition Theorem when applied to non-linear or time-varying

networks.

c) Determine the Thevenin equivalent circuit of the network shown in fig.



(10+4+4)

Q.3.

a) What do you mean by dielectric polarization? What is uniform and non-uniform polarization? Show that for non-uniform polarization, volume bound charge density $\rho_b = -\nabla.\mathbf{P}$

b) Derive Laplace's equation from electrostatic potential and discuss its uniqueness theorem.

c) Given a scalar field $\phi(x, y, z) = x^2 + y^2 - 2z^2$, calculate grad($\phi$) and div(grad($\phi$)).

(8+6+4)

Q.4.

a) Derive the expression for electric field due to an infinite uniformly charged plane using Gauss's law and discuss field uniformity.

b) Define D, E and P. Establish the relation $\mathbf{D} = \varepsilon_0\mathbf{E} + \mathbf{P}$

c) A dielectric slab with relative permittivity $\varepsilon_r = 4$ is placed between two plates of a capacitor charged to 300 V. Find the electric field in the dielectric and bound surface charge density.

(8+6+4)

Q.5.

a) Starting from Biot-Savart Law, derive the expression for magnetic field along the axis of a circular current loop and discuss its limit at center and infinity.

b) Explain the concept of magnetic susceptibility and permeability. How do they differ in diamagnetic and ferromagnetic materials?

c) A toroidal core has N = 500 turns, mean radius = 0.1 m, and relative permeability = 1000. If current I = 2 A, find the magnetic field inside the core.

(8+6+4)

Q.6.

a) State and explain Faraday's laws of electromagnetic induction.

b) Write the four Maxwell Equations in matter. Calculate the self -inductance of a solenoid of length L.

c) A rod of length 0.1m and cross-sectional area 0.005 m^2 is placed at a magnetized field (H) of 5000 Amp/m. Find the Intensity of Magnetic Field (B) and Magnetization (M) if permeability of matter is 2.5×10^{-4} Web/Amp-m.

(3+9+6)