(1)

This question paper contains 4 printed pages.

Your Roll No. 16/5/18

S. No. of Paper	: **6680**	**HC**
Unique paper code	: **32221201**	
Name of the paper	: **Electricity and Magnetism**	
Name of course	: **B.Sc. (Hons.) Physics**	
Semester	: **II**	
Duration	: **3 hours**	
Maximum marks	: **75**	

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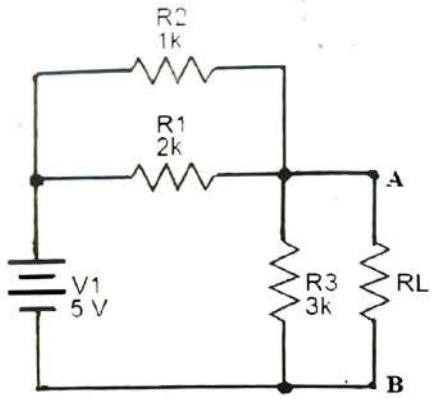
on receipt of this question paper.)

*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 $\vec{P} = \varepsilon_o(\varepsilon_r - 1)\vec{E}$.
   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 :

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

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?

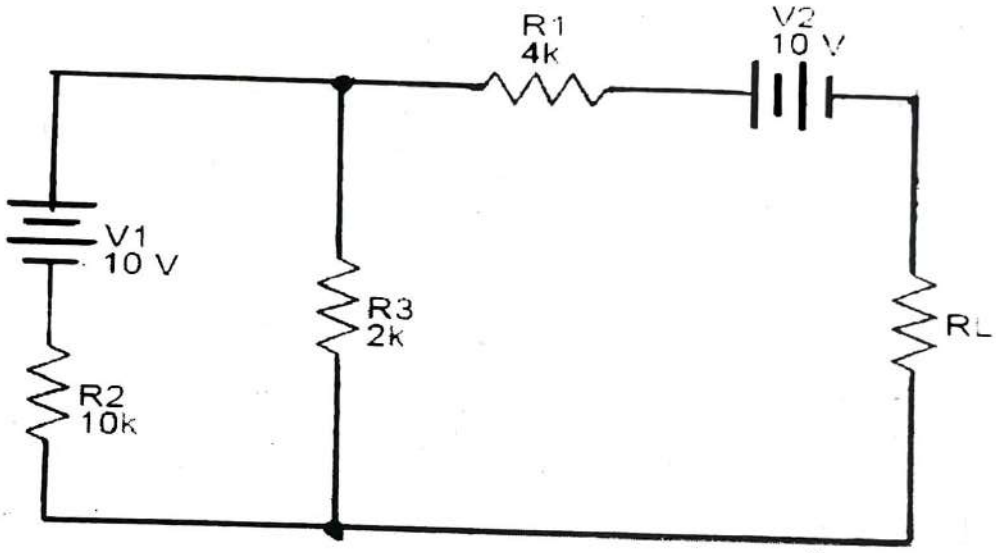
b) Two inductances L_1 and L_2 are connected in parallel. If M is the mutual inductance between them, show that their effective inductance, L_{eff}, is given by

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

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)**



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Your Roll No. 22/5/18

HC

Sl. No. of Ques. Paper : **6681**
Unique Paper Code : **32221202**
Name of Paper : **Waves and Optics**
Name of Course : **B.Sc. (Hons.) Physics**
Semester : **II**
Duration : **3 hours**
Maximum Marks : **75**

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Attempt five questions in all.
Question No. 1 is compulsory.
All questions carry equal marks.

1. Attempt any *five* of the following:

   (a) Obtain an expression for the amplitude of the combined motion:

   $$\sqrt{2}\sin 8\pi t + 2\sqrt{2}\cos 10\pi t$$

   (b) Obtain a relation between particle velocity and wave velocity for a simple harmonic wave.

   (c) Using the principle of reversibility, derive Stokes' relations.

   (d) State the essential conditions for obtaining a sustained interference pattern.

   (e) Give differences between Fresnel's biprism and Lloyd's mirror fringes.

P. T. O.

(f) Distinguish between Fraunhofer and Fresnel diffraction.

(g) A convex lens of focal length 20 cm is placed after a slit of width 0·6 mm. A plane wave of $\lambda=6000$ Å falls normally on the slit. Calculate the separation between the second minima on either side of the principal maxima. $5\times3=15$

2. (a) Using the rotating vector representation obtain the resultant motion of a particle subjected simultaneously to two simple harmonic motions in the same direction having equal amplitudes and equal frequencies. 8

(b) A particle is subjected simultaneously to N simple harmonic motions of the same frequency. If the amplitude of each oscillation is A_0 and ϕ is the phase difference between successive oscillations, show that amplitude A and phase δ of the resultant oscillation are given by:

$$A=A_0\frac{\sin(N\phi/2)}{\sin(\phi/2)} \text{ and } \delta=(N-1)\phi/2$$ 7

3. (a) Two vibrations, at right angles to each other, are described by the equations:

$$x=5\cos 3\pi t$$

$$y=3\cos(3\pi t+\pi)$$

where x and y are expressed in centimeters and t in seconds. Construct the Lissajous figure of the combined motion. 5

(b) Obtain an expression for the total energy transport in a string when transverse waves travel in it. 10

4. (a) Explain using diagrams the formation of Heidinger fringes in thin films. How are they different from Fizeau fringes? 7

(b) Derive an expression for fringe width in Young's double slit experiment. Explain graphically the intensity distribution in the fringe system. 8

5. (a) Derive the formula for the intensity of the fringe system formed in a Fabry-Perot interferometer in transmitted light. 9

(b) Draw the graph of intensity transmitted as a function of phase difference in Fabry-Perot interferometer and hence explain why interference fringes obtained in Fabry-Perot interferometer are sharper than that of Michelson's interferometer. 6

6. (a) Discuss Fraunhofer diffraction due to double slit. Draw the curve indicating distribution of intensity in the diffraction pattern. Find the positions of the maxima and minima. 12

(b) Calculate the aperture of the objective of a telescope which may be used to resolve stars separated by $4\cdot88\times10^{-6}$ radian for light of wavelength 6000 Å. 3

P. T. O.

7. (a) Derive Fresnel's integrals. 8

(b) Discuss Fresnel diffraction pattern due to a straight edge. 7