[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.

P.T.O.

(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. $\vec{E} = \frac{\rho}{\varepsilon_0}$.

(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

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

(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.

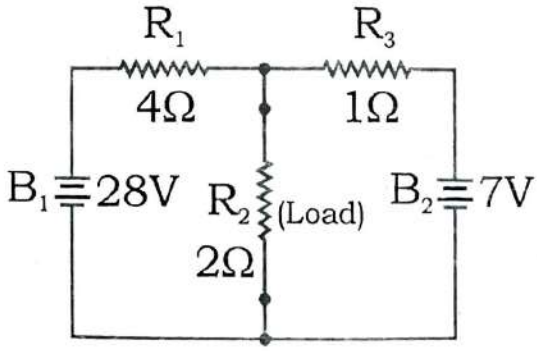
(b) State and prove the 'reciprocity theorem' in case of mutual inductance between two coils.

(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



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[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **1828** **GC-4**

Unique Paper Code : 32221202

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

Name of the Paper : Waves and Optics

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**.

(c) Question **NO.1** is compulsory.

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

(a) A uniform rod of length L is nailed to a post, so that two thirds of its length is below the post. Find the period of small oscillation of the rod.

(b) A person normally weighing 60 kg stands on a platform which is oscillating up and down with an amplitude of 10 cm. If a weighing machine on the platform gives person's weight against time, what will be the minimum and maximum readings shown by it ?

P.T.O.

(c) Find the average and beat frequency from the combined motion of the following :

$\sin(10\pi t) + \cos(11\pi t + \pi/4)$

(d) A ball suspended by a thread 2 m long is deflected through an angle of 2 degree and then released. Assuming the subsequent motion to be simple harmonic; calculate the velocity of ball when it passes through the mean position.

(e) Distinguish between Fresnel and Fraunhoffer diffraction.

(f) Write two points of differences between convex lens and zone plate.

(g) In a grating, if width of slit (b) is equal to d (the grating element), show that the diffraction pattern corresponds to a slit of width 2b. 3×5=15

2. (a) Construct Lissajous figure for the following :

$x = A\cos(12\pi t)$; $y = A\cos(6\pi t + \pi/4)$

6

(b) A uniform string of length L and linear density μ is stretched with tension T between fixed ends at x = 0 and x = L. Derive an expression for the total energy of vibrating string in the n^{th} mode of vibration. 9

3. (a) Derive the differential equation of motion for the longitudinal vibrations of air.

6

(b) Obtain the frequencies of the normal mode of a pipe of length L open at both ends.

4

(c) A wave group is formed by superposition of two harmonic waves of equal amplitude but slightly different frequencies travelling in the same direction in a dispersive medium. Obtain the expressions for group and phase velocity. 5

4. (a) Explain the formation of fringes in case of a wedge-shaped thin film. Derive the expression for fringe width. 2, 5

(b) Distinguish between Fizeau's and Hadinger's fringes. 4

(c) The orange Krypton line of wavelength 6058 Å has a coherence length of ~ 20 cm. calculate the line width and spectral purity. 4

5. (a) Describe a Fabry Perot Interfrerometer and obtain the intensity distribution function in transmitted light. 3,7

(b) Give the principle of optical reversibility and derive Stoke's relations. 5

6. (a) Obtain an expression for intensity distribution for Fraunhoffer diffraction in case of N slits. Also give the conditions for maximas and minimas. 8,2

(b) A circular aperture of radius 0.01 cm is placed in front of a convex lens of focal length 25 cm and illuminated by a parallel beam of light of wavelength 5×10^{-5} cm. Calculate the radius of the first dark ring. 5

7. (a) Discuss the properties of Cornu's spiral. Explain the Fresnel' diffraction pattern due to a straight edge using Cornu's spiral. Draw the intensity pattern for the same. 2, 6,2

(b) For light of wavelength 6×10^{-5} cm and radius of first half period zone equal to 0.6 cm, a zone plate brings rays to focus at its brightest point. Find the focal length of equivalent lens. 3

(c) What is a phase reversal zone plate ? 2

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This question paper contains 4+2 printed pages]

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

S. No. of Question Paper : **860**

Unique Paper Code : **222201** **G**

Name of the Paper : **Mathematical Physics-II**

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.

1. Do any *five* questions : 5×3=15

(*a*) Determine the order, degree and linearity of the differential equation :

$$\left(\frac{d^2y}{dx^2}\right)^2 + \frac{d^2y}{dx^2} + y\frac{dy}{dx} = 0.$$

P.T.O.

(*b*) By calculating the Wronskian of the functions x, x^2, x^3, check whether the functions are linearly dependent or independent.

(*c*) Solve :

$$\frac{dy}{dx} = (1 + x^2)(1 + y^2)$$

if $y(0) = 1$.

(*d*) Find the extreme value of the integral :

$$I = \int_{x_1}^{x_2} \left\{(y')^2 + 2y^2 + y\right\} dx$$

if $y' = \frac{dy}{dx}$.

(*e*) Define generalized momenta for n-particle system and find its time derivative.

(*f*) Define Lagrangian Bracket and prove that :

$$[p_j, p_k] = 0.$$

(*g*) Maximize the value of (m_1, m_2) for fixed value of reduced mass μ where :

$$\frac{1}{\mu} = \frac{1}{m_1} + \frac{1}{m_2}.$$

2. Solve the differential equations : 6.9

(*a*) $\frac{dy}{dx} + \frac{y}{x} = x^3y^3$

(*b*) $(y^4 + 2y)dx + (xy^3 + 2y^4 - 4x)dy = 0$

3. Solve the differential equations : 6.9

(*a*) $\frac{d^2y}{dx^2} - y = e^x \cos x$

(*b*) $\frac{d^2y}{dx^2} + 3\frac{dy}{dx} = 1 - 9x^2$

Given that :

$y(0) = 0$ and $y'(0) = 1$.

4. (*a*) Use the method of undetermined coefficients to solve the differential equation :

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = x^2 + \cos 2x.$$

(*b*) Solve for '*y*' : 7,8

$$x^2\frac{d^2y}{dx^2} + 3x\frac{dy}{dx} + y = \frac{(\log(x))^2}{x}.$$

5. (*a*) Solve the differential equation using method of variation of parameters :

$$\frac{d^2y}{dx^2} + a^2y = \text{cosec } ax.$$

(*b*) Find the value of y and z from the following coupled differential equations : 7,8

$$\frac{dy}{dx} + y = z + e^x$$

$$\frac{dz}{dx} + z = y + 2e^x.$$

6. (*a*) Derive the Euler-Lagrange's equation for a function $f(x, y, y')$.

(*b*) Prove that the shortest path between two points in a plane is the straight line joining the points. 8,7

7. (*a*) Using the Lagrange's method of undetermined multiplier, find out the largest product of x, y and z when they are constrained by the relation :

$$x^2 + y^2 + z^2 = 9.$$

(*b*) Find the shortest distance between the origin and the curve defined by the equation : 8,7

$$5x^2 + 5y^2 + 6xy = 8.$$

8. (*a*) A simple pendulum of mass 'm' and length 'l' is executing simple harmonic motion. Write down the Lagrangian and hence determine the time period of small oscillations.

(*b*) Define Poisson Bracket and show that :

(*i*) $[X, YZ] = Y[X, Z] + [X, Y]Z$

(*ii*) $[p_j, H] = \dot{p}_j$

(*iii*) $[q_j, p_k] = \delta_{jk}$

Here H is the Hamiltonian. 7,8

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This question paper contains 4+2 printed pages] 16/5/17

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

S. No. of Question Paper : **861**

Unique Paper Code : **222202** **G**

Name of the Paper : **Oscillations and Waves**

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.

Q. No. **1** is compulsory.

Non-programmable calculators are allowed.

1. Attempt any *five* of the following :

(*a*) A wave of frequency 20 Hz, has velocity 120 m/sec. How far apart are two points whose displacements are 60 degree out of phase.

(*b*) An object of mass 1 g is hung from a spring and set in oscillatory motion. At $t = 0$ the displacement is 43.78 cm and the acceleration is -1.75 cm/sec^2. Find the spring constant.

(*c*) Distinguish between particle velocity and wave velocity. Write an expression for maximum particle velocity.

(*d*) Show that two superimposed waves of same frequency and amplitude travelling in the same direction cannot give rise to a standing wave.

(*e*) A string of length 0.4 m has a mass of 0.16 gm. If the tension in the string is 70 N, what are the three lowest frequencies it produces when plucked ?

(*f*) Write the equation of displacement of a plane progressive wave.

(*g*) Write *two* differences between stationary and progressive waves. 5×3=15

2. (*a*) Draw Lissajous figure for the combined motion of the following :

$x = \cos(2\omega t)$ and $y = \cos(\omega t + \pi/4)$. 6

(*b*) A uniform string of force constant k and mass m is loaded with mass M. Find the period of vertical oscillation of the system, if m is not negligible as compared to M. 9

3. (*a*) N harmonic oscillations, all of same amplitude and frequency and with equal successive initial phase difference are super posed. Find the amplitude and phase of resultant motion. 10

(*b*) A load of mass 0.5 kg hangs from a string of force constant 10 N/m. The mass is pulled down 0.05 m from its equilibrium position and then released. Find :

(*i*) The distance between two widely separated positions of the masses.

(*ii*) How long does it take to traverse that distance ? 5

4. (*a*) A mechanical harmonic oscillator of mass '*m*' and stiffness constant 'K' is subjected to a viscous damping force that is proportional to its velocity with coefficient of damping force '*p*'. The oscillator is driven by a force F(*t*), such that :

$$F(t) = F_0 \cos \omega t$$

In steady state, the displacement of the oscillator is given by :

$$\Psi = A \cos \omega t$$

Show that, in steady state, the time averaged input power equals the time averaged power dissipated through friction. 12

(*b*) What are the half power points for the power resonance curve for a driven oscillator ? 3

(*a*) Two equal masses '*m*' are connected by three identical massless springs of spring constant *k*. The free ends of the springs are rigidly fixed. Find the frequencies and configurations of the two normal modes if the masses oscillate along the line joining the centres of the masses. 10

(*b*) Prove that the principle of superposition holds only for linear homogeneous differential equations. 5

6. (*a*) What is the difference between group velocity and phase velocity ? 5

(*b*) Set up the differential equation for damped harmonic oscillator and solve it for the case of underdamped oscillations. 10

7. (*a*) For one-dimensional plain wave in a fluid, show that the excess pressure p is given by $p = -k\left(\frac{dy}{dx}\right)$, where k is the volume elasticity of the fluid and $y = y(x, t)$ is the displacement. 8

(*b*) Derive a formula for velocity of transverse waves in a string. 7

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22/5/17

Your Roll No.....

Sr. No. of Question Paper : 862 G

Unique Paper Code : 222203

Name of the Paper : Physics-C-III (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. Attempt **five** question in all.
3. **Question No. 1** is compulsory.
4. **All** questions carry equal marks.

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

   (a) The electrostatic potential is given by $V=(3x^2yz^3-y^2+z)$. Find the magnitude of electric field intensity at point (3, 2, 1).

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

P.T.O.

(c) Show that $\mathbf{P} = \varepsilon_0(\varepsilon_r, -1)\mathbf{E}$, where **E** is electric field intensity and **P** is polarization Vector.

(d) How will the magnetic field intensity at the center of a circular coil carrying current change, if the current through the coil is doubled and radius of the coil is halved?

(e) Define the term hysteresis and draw the hysteresis curves for soft iron and steel.

(f) Evaluate the root mean square value of the following time varying voltage

$V = 3 + 4\ \text{Sin}\omega t + 4\ \text{Cos}\omega t.$

(g) What should be the value of R in the following network so that it could absorb maximum power from the 100 V source:

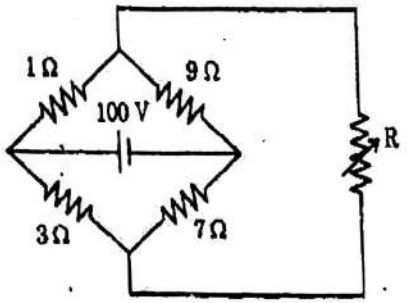

Fig. 1 (5×3=15)

2. (a) State and prove Gauss' law in electrostatics for a spherical surface. Also obtain its differential form.

(b) By using Gauss' law, find the expression for the electric field intensity at a point inside the uniformly charged solid sphere of radius R. (10,5)

3. (a) State Biot–Savart law. Derive an expression for magnetic flux density inside a long solenoid and show that the magnetic flux density at ends is half of that in the middle of the solenoid.

(b) A particle having charge $3\text{x}10^{-9}$ C is moving with a velocity $\mathbf{v} = (2\ \mathbf{i} + 3\ \mathbf{j})$ m/s in an elecrtic field $\mathbf{E} = (3\mathbf{i} + 6\mathbf{j} + 2\mathbf{k})$ V/m and a magnetic field $\mathbf{B} = (2\mathbf{i} + 3\mathbf{j})$ tesla. Find the magnitude and direction of the Lorentz force acting on this charged particle. (10,5)

4. (a) State Faraday's and Lenz's law of electromagnetic induction. Starting from integeral form of Faraday's law derive its differential form.

(b) A coil of wire of certain radius has 600 turns and a self-inductance of 50 mH. What will be the self-inductance of a second similar coil with 500 turns? (10,5)

5. (a) Write Ampere's circuital law in magnetstatics in integral firm and hence derive its differential form. How Maxwell modified Ampere's circuital law to make it consistent with the continuity equation?

(b) Derive the relation $\mu = \mu_0 (1 + \chi)$, where χ is magnetic susceptibility of material and other symbols have their usual meanings. (10,5)

6. (a) Describe an A.C. cuircuit containing inductor L, capacitance C and resistor R in series. Obtain expressions for instantaneous current and impedance. Derive condition for resonance and obtain expression for resonance frequency.

(b) Calculate average power in a given ac circuit containing R, L and C and hence define power factor. (10,5)

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

(b) Obtain Norton's equivalent circuit for the given network. Calculate the current that will flow through a load impedance of 18 Ω connected between A and B. (Take the internal impedance of the emf source to be zero) (8,7)

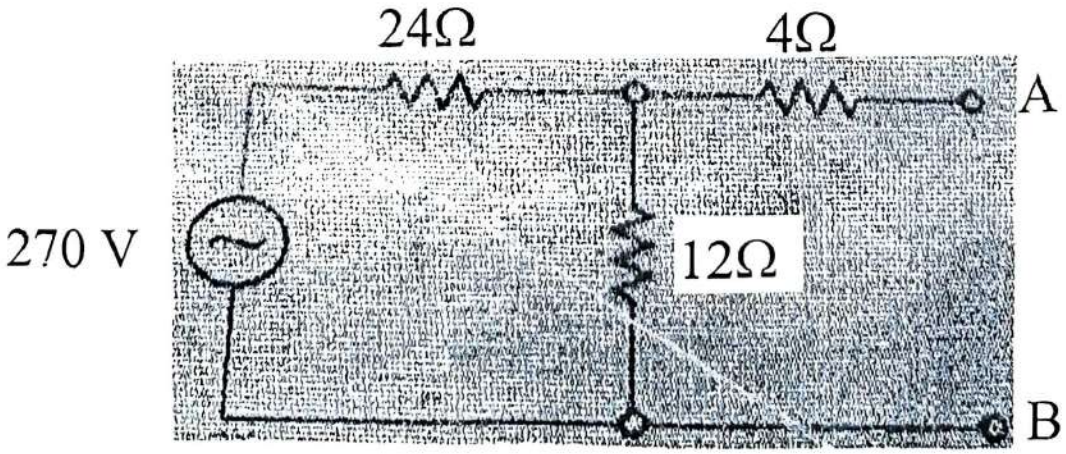

Fig. 2

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

S. No. of Question Paper : **863**

Unique Paper Code : **222204** **G**

Name of the Paper : **Digital Electronics**

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 all *five* questions.

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

(*a*) Draw a logic circuit for the equation :

$$Y = A\bar{B}C + ABC.$$

(*b*) Obtain 2-input OR gate using NAND gates only.

(*c*) Define output offset voltage of an Op-Amp. How is this voltage reduced to zero in 741C ?

(*d*) How is race-around condition eliminated in J-K flip-flop ?

(*e*) Subtract binary equivalent of $(-27)_{10}$ from that of $(68)_{10}$ using 2's complement method in 8-bit arithmetic.

(*f*) How many flip-flops would be required for MOD-3 counter ?

(*g*) What is the difference between decoder and multiplexer ?

2. (*a*) Draw the labeled block diagram of a CRO. Explain how a CRO can be used to measure :

(*i*) Frequency of a signal

(*ii*) Phase difference between two signals.

(*b*) Explain the working of a R-2R ladder network based D/A convertor.

Or

Describe how IC 555 can be used to generate a square wave. Derive an expression for the duty cycle. 7½,7½

3. (*a*) Simplify $F = \Sigma m(0, 2, 3, 6, 7) + d(8, 10, 11, 15)$ using a K-map and draw its logic circuit using only NAND-NAND gates.

(*b*) What is a multiplexer (MUX) ? Draw a logic circuit for an 8-input multiplexer and explain its working.

Or

Draw a logic circuit for a decimal to binary encoder and explain its functioning. 7½,7½

4. (*a*) Draw the circuit for a basic op amp integrator. Find an expression for its output. Draw the output waveform if the input to this circuit is a square wave.

(*b*) Derive an expression for the closed loop gain of a non-inverting amplifier using feedback concept.

Or

Design an Op-Amp circuit to yield :

$$V_o = -\left[\frac{V_a + V_b + V_c}{3}\right].$$ 7½,7½

P.T.O.

5. (*a*) Draw a circuit for a controlled parallel-in parallel-out shift register for 4-bit and explain its functioning.

(*b*) Draw a circuit for a decade counter and explain its functioning.

Or

Explain with an appropriate logic circuit diagram the working of a 4-bit 2's complement adder-subtractor. 7½,7½