[This question paper contains 6 printed pages.]

Your Roll No..............

r. No. of Question Paper : **2821** **GC-4**

ique Paper Code : 32221402

me of the Paper : Elements of Modern Physics

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

mester : IV

ration : 3 Hours Maximum Marks : 75

structions for Candidates

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

Attempt **five** questions in all.

Question number **1** is compulsory.

Symbols have their usual meaning.

Answer any **five** of the following : (5×3=15)

(a) Calculate the de Broglie wavelength of an electron accelerated through a potential difference of 100V and 1MV.

(b) Determine the activity of 1 g of ${}_{92}U^{238}$ if its half life is 4.5×10^9y.

P.T.O.

(c) The maximum energy of photoelectrons from Aluminium is 2.3 eV for radiation of 200 nm and 0.90 eV for radiation of 258 nm. Calculate the Planck's constant and the work function of Aluminium.

(d) Write two special characteristics of the light emitted from a laser. Distinguish between spontaneous emission and stimulated emission.

(e) Why do we associate a wave packet and not monochromatic de-Broglie wave with a particle?

(f) Which of the following are eigen functions of the operator d^2/dx^2? Give the eigen values where appropriate, (i) cos x, (ii) e^{-ix}, (iii) $\sin^2 x$.

(g) How does the uncertainty principle rule out the possibility of electron being present inside the nucleus?

2. (a) What is Compton scattering? What is the origin of presence of the unmodified line at all scattering angles? Obtain the expression for change in wavelength

$$\Delta\lambda = \frac{h}{m_0 c}(1-\cos\phi)$$

where symbols have their usual meaning. (2,

(b) In a Compton scattering experiment, X-ray of wavelength 0.24 nm is scattered at an angle 60° relative to the incident beam. Find the wavelength of scattered X-ray. (

(c) Given a dispersion relation

$$w(k) = w(k_0) + (k - k_0)\left(\frac{\partial w}{\partial k}\right)_{k=k_0} + \frac{1}{2}(k - k_0)^2\left(\frac{\partial^2 w}{\partial k^2}\right)_{k=k_0}$$

show that a Gaussian wave packet

$$\psi(x,0) = \sqrt{\frac{2\pi}{\alpha}}\, e^{ik_0x} e^{-x^2/2\alpha}$$

spreads as it propagates in time. (5)

(a) State Heisenberg uncertainty principle for measurement of position and momentum. Using Gamma ray microscope thought experiment proposed by Heisenberg, obtain an expression for the uncertainty relation. (2,5)

(b) Show that the uncertainty principle can be expressed in the form $\Delta E \Delta t \geq \hbar/2$, where ΔE is the uncertainty in the energy and Δt is the uncertainty in time. (3)

(c) An electron of energy 200 eV is passed through a circular hole of radius 10^{-4} cm. What is the uncertainty introduced in the angle of emergence ? (5)

(a) What differences will you observe on the screen of a two-slit experiment if you use (i) photons from a monochromatic source, (ii) electrons from an electron gun, and (iii) bullets from a machine gun? Interpret the results. (4)

P.T.O.

(b) The wave function for a particle moving along positive x-direction is given as

$$\psi(x,t) = A \exp\left(i\left(\frac{px}{\hbar} - \frac{Et}{\hbar}\right)\right)$$

Using this derive expressions for momentum and ki[n] energy operators in one dimension. (

(c) Normalize the wave function given below to find constant 'A' for the Gaussian wavepacket given a

$$\psi(x) = A \exp\left(-\frac{\alpha^2 x^2}{2}\right) \exp(ikx) \text{ given that}$$

$$\int_{-\infty}^{\infty} \exp\left(-\alpha^2 x^2\right) dx = \sqrt{\frac{\pi}{\alpha}}$$

5. (a) Consider a particle of mass m and energy E< approaching, from the left, a one-dimensional poten step given by

$$\begin{aligned} V(x) &= V_0 \quad \text{for} \quad x > 0 \\ &= 0 \quad \text{for} \quad x < 0; \end{aligned}$$

Show that the reflection coefficient is equal to 1. Expl[a] how penetration into classically forbidden region is [n] in conflict with Classical Mechanics and find expression for penetration depth. (5,

(b) Estimate the penetration distance Δx for a small dust particle of radius $r = 10^{-6}$ m and density $\rho = 10^4$ kg/m^3, moving at very low velocity $v = 10^{-2}$ m/sec, if the particle impinges on a potential step of height equal to twice its kinetic energy in the region left of the step. (2)

(c) A particle of mass m is confined within a one-dimensional field-free region between two perfectly elastic and impenetrable walls at $x = 0$ and $x = a$. Obtain the energy eigenvalues and normalized eigenfunctions for the particle. (5)

(a) Discuss the nature of nuclear force. Plot the N-Z graph for stable nuclei. Why do stable nuclei usually have more neutrons than protons ? (3,1,1)

(b) A sample of the isotope ^{131}I, which has a half-life of 8.04 days, has an activity of 5 mCi at the time of shipment. Upon receipt of the ^{131}I in a medical laboratory, its activity is 4.2 mCi. How much time has elapsed between the two measurements ? Calculate the mean life of sample. (4,1)

(c) Calculate binding energy per nucleon for (i) $_5B^{10}$ with mass number 10.0161 a.m.u. (ii) $_{14}Si^{29}$ with mass number 28.9857 a.m.u. Using this calculation find which atom is more stable. Given that mass of proton is 1.0081 a.m.u. and mass of neutron is 1.0089 a.m.u. (4,1)

7. (a) Define mean life and half life of a radioactive substanc
Derive expressions for mean life and half life in tern
of radioactive constant.
(2,

(b) A nuclear reactor of 20% efficiency and an output
700 MW uses $_{92}U^{235}$ as fuel. Each fission reaction giv
200 MeV of energy. Calculate (i) the number of uraniu
atoms undergoing fission per day (ii) mass of uraniu
consumed by the reactor per day. Given that Avogadr
number is 6.023×10^{23}.
(3,

(c) What makes large nuclei (A>210) unstable ? Why
they tend to stabilize by the emission of α-particl
rather than protons ?
(1,

This question paper contains 4+1 printed pages]

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

S. No. of Question Paper : **2822**

Unique Paper Code : **32221403** **GC-4**

Name of the Paper : **Analog Systems and Applications**

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

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.

Non-programmable calculators are allowed.

1. Attempt any *five* of the following :

(*a*) Draw the energy band diagram of an unbiased p-n junction diode with appropriate labels.

(*b*) Differentiate between Zener breakdown and Avalanche breakdown in a p-n junction diode.

(*c*) The energy gap of the semiconducting material of an LED is 1.37 eV. What is the wavelength of the emitted light ?

(*d*) Draw the output characteristics of a transistor in CE mode and identify the active, cut-off and saturation regions.

(*e*) Distinguish between Class A and Class B amplifiers with the hep of load line and Q point.

(*f*) Explain the Barkhausen's criterion for sustained oscillation.

(*g*) What is the difference between differential and common mode inputs for an Op-amp ?

(*h*) For a 4-bit binary R-2R ladder D/A converter the input levels are 0 = 0V and 1 = + 10V.

Find the output voltage caused by :

(*i*) 0011

(*ii*) 1001 and

(*iii*) 1111. 5×3=15

2\. (*a*) Obtain an expression for the barrier width of a p-n junction diode, assuming a step junction.

(*b*) In a Ge sample a donor type impurity is added to the extent of 1 atom per 10^8 Ge atoms. Find the concentration of electrons and holes in the sample. Given $N_i = 2.5 \times 10^{13}$ electrons/cm^3 and number of Ge atoms is 4.41×10^{22} per cm^3.

3\. (*a*) Explain the working of a center-tap full wave rectifier using suitable diagram and obtain the expressions for :

(*i*) ripple factor and

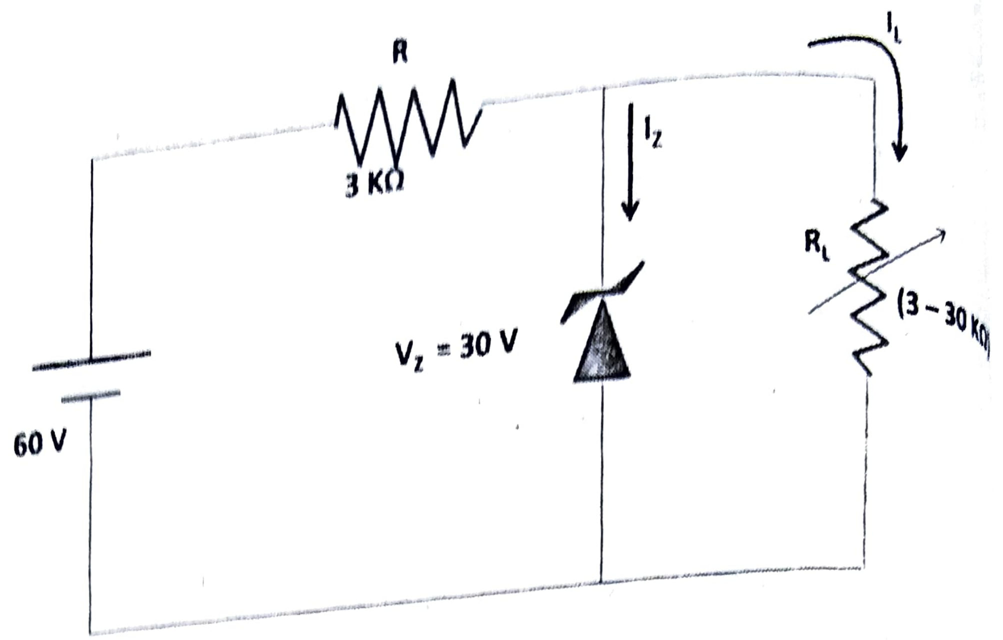
(*ii*) rectification efficiency.

(*b*) Find the current through the Zener diode in the following circuit when load resistance R_L is :

(*i*) 30 kΩ

(ii) 5 kΩ and

(iii) 3 kΩ.



4. (a) What are the factors that affect the bias stability of a transistor ? Compare the "voltage divider bias circuit" with the "fixed bias circuit" with respect to the stability. Explain how the self-biasing resistor improves the stability.

(b) Obtain the general expression for stability factor S of a common-emitter configuration. 10

5. Explain the working of RC coupled amplifier and give its frequency response. How does the gain change at low, mid and high frequencies ? Derive the expressions for the gain in the mid and high frequency regions. 28

(a) Draw the circuit diagram of an RC phase shift oscillator using transistor and state the conditions for sustained oscillations. Derive an expression for its frequency.

(b) In a Colpitt's oscillator $C_1 = 0.1\ \mu F$, $C_2 = 0.01\ \mu F$ and $L = 50\ mH$, find the frequency of oscillation. 10,5

(a) Draw the circuit of an op-amp as an integrator and find an expression for its output. Draw the output waveform when the input to the integrator is a square wave.

(b) What would be the output of an op-amp in the inverting mode if input resistance is 1 kΩ and feedback resistance is (i) 2 kΩ and (ii) 20 kΩ for a dc input signal of 1.5 V ? ($V_{sat} = \pm 14$ V). 10,5

This question paper contains 4 printed pages]

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

S. No. of Question Paper : 2916

Unique Paper Code : 32223902 GC-4

Name of the Paper : Computational Physics Skills

Name of the Course : B.Sc. (Hons.)/B.Sc. (Prog.) : Skill Enhancement Course : Physics

Semester : IV

Duration : 3 Hours Maximum Marks : 50

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

Question No. 1 is compulsory.

Attempt *three* questions from each section.

1. Attempt any *five* questions : 5×1=5

(*a*) Describe the Fortran statement IMPLICIT REAL (*a-z*).

(*b*) Draw the flowchart to find the inverse of a real number.

(*c*) Name with syntax, the logical operators in Fortran.

P.T.O.

(d) Write the Fortran syntax for the expression

$$e^{x} + \tan^{-1}(x) + x^2.$$

(e) Write latex code to create title page o

document.

(f) Explain with one example, how to include

packages in a Latex file.

(g) Write the gnuplot statements to define the rang

in a plot.

SECTION A

2. Write a Fortran program to find roots of a qu

equation.

3. Write a Fortran function to calculate factorial of a numbe

a Fortran program using this function to evaluate the v

series :

$$\sin(x) = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}$$

4. Write the syntax of two Nested DO loops in Fortran. Give an example. 5

5. Write a Fortran program to arrange a list of 10 numbers in ascending order. 5

SECTION B

6. Write the syntax of any five latex environments. 5

7. Write the output of the following Latex code : 5

```
\begin{equation}
Y_0=\frac{a\sin(n\frac{\phi} {2})} {\sin\frac{\phi} {2}}
\end{equation}
```

8. Write the Latex code to generate following table : 5

x	y	x^2	y^2
1	2	1	4
2	2	4	4
3	5	9	25
4	4	16	16

9. Explain with example the labelling and referencing in a Latex document.

SECTION C

10. Write the gnuplot statements to plot fifth column of against its third column with linetype 5 and linewi

11. Describe the use of gnuplot statements "set x "set key".

12. Write gnuplot statement to make 3D plot of $x^2 + y$ you change the viewing angles of this plot ?

13. Explain how one can use Greek symbols to label x (ll in gnuplot.

This question paper contains 3 printed pages]

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

S. No. of Question Paper : **2918**

Unique Paper Code : **32223904** **GC-4**

Name of the Paper : **Basic Instrumentation Skills**

Name of the Course : **Physics : Skill Enhancement Course for B.Sc. (Hons.)/B.Sc. (Prog.)**

Semester : **IV**

Duration : **3 Hours** Maximum Marks : **50**

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

Attempt any *five* questions in all.

Question No. **1** is compulsory.

1. Attempt any *five* of the following : 2×5

(*a*) What are the different parameters that can be measured using a Q-meter ?

(*b*) What is the significance of mean value and how do you estimate the error in the mean value ?

(*c*) What is the difference between an oscillator and a signal generator ?

P.T.O.

29|

(d) What is the role of phosphor on CRO screen ?

(e) Why is the CRO a very good device to measure volta[ge] compared to an ordinary analog voltmeter ?

(f) What is overload protection in a digital multimeter

(g) What are Lissajous figures ? On what factor does t[he] shape of the figure depend ?

2. (a) Clearly distinguish between systematic errors, rando[m] errors and logarithmic errors with examples.

(b) What do you mean by loading effect of an instrument Discuss the loading effect of a multimeter with the he[lp] of an example.

3. (a) A milliammeter with full scale deflection of 100 μA h[as] a resistance of 500 Ω. Find the resistance of t[he] multimeter necessary to use this instrument as voltmeter reading from 0 to 50 V.

(b) Draw the block diagram of AC millivoltmeter and menti[on] its specifications ?

4. (*a*) Give the functioning and block diagram of a CRO. 7

(*b*) What is the sweep time in CRO ? 3

5. (*a*) Explain the principle of operation of a Wheatstone Bridge for measurement purposes. 4

(*b*) Name few variants of Wheatstone Bridge along with their differences. 3

(*c*) Explain the usage of headphone as null detector. 3

6. (*a*) Explain a technique to measure frequency response of an audio amplifier. 5

(*b*) Explain a technique to test a diode using a DMM. 3

(*c*) What do you mean by -3dB cutoff frequency ? 2

7. (*a*) Why is it more suitable to measure time period than frequency in a frequency counter ? 3

(*b*) Draw the block diagram and explain the working of a digital multimeter. 7

This question paper contains 4 printed pages]

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

S. No. of Question Paper : **2750**

Unique Paper Code : **32225415** **GC-4**

Name of the Paper : **Thermal Physics and Statistical Physics**

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

Semester : **IV**

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

(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.

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

(*a*) A reversible engine works between two temperatures whose difference is 100°C. If it absorbs 746 J from the source and gives 546 K to the sink, calculate the temperature of the source and sink.

(*b*) Calculate the change in entropy when 1 gram atom solid mercury at its melting point is raised to a temperature of 40°C. Given for mercury, melting point = −39°C, latent heat of fusion = 3 cal/gm, mean specific heat = 0.0335 cal/gm-K and one gram atom of mercury = 200 gm. 2.

(*c*) A motor car tyre has a pressure of 2 atm at a room temperature of 27°C. If the tyre suddenly bursts, find the final temperature considering the process to be adiabatic.

(*d*) Arrange the root mean square speeds of H, He, H_2O molecules in ascending order at room temperature and for He molecule, arrange the root mean square velocity, most probable velocity and average velocity in ascending order at room temperature.

(*e*) Is "glass of hot milk" an isolated system ? Justify your answer.

(*f*) Consider that a system consisting of N number of molecules initially in a volume V and at temperature T, pressure P is disintegrated into two systems. Which of all the system properties will change and which will remain unchanged ?

(g) Define entropy and then relate it to second law of thermodynamics.

(a) Using the first law of thermodynamics, establish :

$$C_P - C_V = R\left[1 + \frac{2a}{RTV} + \ldots\ldots\right]$$

for a van der Waals' gas, where the symbols have their usual meaning. 9

(b) Compute the work done by a perfect gas for a quasi-static adiabatic expansion. 6

(a) Show the equivalence of Kelvin Planck and Clausius statements for second law of thermodynamics. 8

(b) Verify Carnot theorem. Is the refrigerator at home a Carnot engine ? 7

(a) Establish the Maxwell's relations of thermodynamics. 8

(b) Using Maxwell's relation, derive Clausius Clapeyron equation and interpret the results. 4,3

(a) What do you understand by transport phenomena in gases. Verify that $\kappa = \eta C_v$, where κ is conductivity and η represents viscosity. 3,6

(b) Derive Maxwell's velocity distribution law in terms of energy of the molecules. 6

6. (*a*) Explain the spectral distribution of Black Body radiation with proper graphical representation. 6

(*b*) Derive Planck's law of radiation and hence derive Rayleigh Jean's law and Wein's law from it. 9

7. (*a*) Obtain the expression for thermodynamic probability and the most probable distribution function for a system obeying Fermi-Dirac statistics. 10

(*b*) Find the number of microstates for a system of two e particles and three quantum states if the system obeys M-B, B-E and F-D statistics. 5

This question paper contains 8 printed pages]

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

S. No. of Question Paper : **872**

Unique Paper Code : **222601** **G**

Name of the Paper : **Electromagnetic Theory [PHHT-619]**

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

Semester : **VI**

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.

All questions carry equal marks.

Question No. **1** is compulsory.

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

(*a*) What is meant by gauge invariance of Maxwell's equations ?

P.T.O.

(*b*) An optical fibre has a core of refractive index 1.5 and a cladding of refractive index $\sqrt{2}$. Calculate the acceptance angle and the numerical aperture of the fibre.

(*c*) Calculate the reflection coefficient at normal incidence for a plane e.m. wave incident on very good conductor (non-magnetic) from vacuum.

(Take, $f = 2 \times 10^{15}$ Hz, $\sigma = 8 \times 10^{8}$ mho/m) 2

(*d*) If a parallel polarized e.m. wave is incient from air onto distilled water with $\mu_r = 1$ and $\varepsilon_r = 81$, find the Brewster angle θ_B.

(*e*) Show that R and T are both equal at normal incidence on the interface between two dielectrics (both non-magnetic) if the ratio of their refractive indices is $3 + 2\sqrt{2}$.

3.

(*f*) Calculate the minimum thickness of a calcite plate that would convert a plane polarized light of wavelength 5890 Å into circularly polarized light.

(Given, $\mu_0 = 1.732$ and $\mu_e = 1.414$)

(g) A radio wave of frequency 20 MHz is incident on the ionosphere at an angle of 60° and is completely reflected. What is the plasma frequency of the reflecting layer ?

(h) Can perfectly static fields possess momentum and angular momentum ?

2. (a) Show that Maxwell's equations can be expressed as two coupled second order partial differential equations in terms of scalar and vector potentials. How does the above equations get simplified using Coulomb gauge for potentials ? 8,4

(b) Given, $V = -y(x + ct)$ Volt and $\vec{A} = y\left[t + (x/c)\right]\hat{x}$ Wb/m, where $c = 1/\sqrt{\mu_0 \varepsilon_0}$. Find $\vec{B}$ and $\vec{E}$. 3

3. (a) State Poynting's theorem. Prove that :

$$\oiint_S \left(\vec{E} \times \vec{H}\right) \cdot d\vec{S} = -\frac{\partial}{\partial t}\iiint_V \left(\frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\mu_0 H^2\right) dV - \iiint_V \vec{J} \cdot \vec{E}\, dV$$

Interpret each term in the above equation. 2,7,3

(b) Derive equation of continuity using Maxwell equations.

4. (a) Prove that e.m. waves travel with the velocity of li[ght] in vacuum. Also, prove that intrinsic impedance vacuum is equal to 120 π Ω.

(b) An e.m. wave travels in the medium ($\mu_r = 1$) with [the] electric field : 6.

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

Find :

(i) magnitude of the velocity of the wave, and

(ii) magnetic field $\vec{H}$.

2

5. (a) Starting from the Maxwell's equations in conductin[g] medium, show that in good conductor the magnetic fiel[d] lags behind the electric field by 45° and obtain the rati[o] of their amplitudes. 7.

9

(*b*) For an e.m. wave propagating through a conducting medium with $\mu_r = 1$, $\varepsilon_r = 9$ and intrinsic impedance $40\pi \angle 1.43° \ \Omega$, magnetic field is :

$$\vec{H} = \frac{-2}{5\pi} e^{-0.05x} \cos\left(2 \times 10^8 t - 2x\right) \hat{y} \ \text{A/m}.$$

Find the electric field, $\vec{E}$. 3

6. (*a*) A plane e.m. wave travelling in a dielectric medium (μ_1, ε_1) is incident on another infinitely large dielectric (μ_2, ε_2) at an angle θ_1 with the normal to the boundary. If the polarization of the incident wave is perpendicular to the plane of incidence, determine the reflection and transmission coefficients. 12

(*b*) A ray of light is incident normally from air ($\mu_r = 1$, $\varepsilon_r = 1$) to glass ($\mu_r = 1$, $\varepsilon_r = 2.25$). Calculate the percentage of the reflected light. 3

7. (*a*) Show that in an electrically anisotropic dielectric medium the permittivity tensor is a symmetric tensor. 4

(*b*) The plane e.m. waves in anisotropic dielectric satisfy the relation :

$$\vec{k} \times \left(\vec{k} \times \vec{E} \right) + \mu_0 \, \omega^2 \, \vec{D} = \vec{0}.$$

Prove that :

$$\frac{\cos^2 \psi_1}{v^2 - v_1^2} + \frac{\cos^2 \psi_2}{v^2 - v_2^2} + \frac{\cos^2 \psi_3}{v^2 - v_3^2} = 0.$$

where, v is the phase velocity of the wave, ψ_1, ψ_2 and ψ_3 are the angles which the wave vector $\vec{k}$ makes with the principal axes and $v_1 = c/\sqrt{\kappa_1}$, $v_2 = c/\sqrt{\kappa_2}$ and $v_3 = c/\sqrt{\kappa_3}$, κ_j being the dielectric constant along the jth direction. 7

(*c*) The polarized light beam is given by :

$$\vec{E} = \left[40 \cos(\omega t - kz)\hat{x} + 40 \sin(\omega t - kz)\hat{y} \right] \text{ V/m}$$

Determine its state of polarization (with orientation). If this beam passes normally through half-wave plate, then write an expression for the emerging beam. 2

8.

8. Consider a plane e.m. wave guided along the z-axis by a planar dielectric wave guide bounded by the planes $x = -d/2$ and $x = d/2$. The refractive index profile is :

$$n(x) = \begin{cases} n_1; & |x| < d/2 \\ n_2; & |x| > d/2 \end{cases}$$

such that $n^2 = n^2(x) = n^2(-x)$.

(*a*) Starting from the Maxwell's equations (consider the medium to be non-magnetic), prove that for TE modes, the field distribution is given by :

$$E_y(x) = \begin{cases} Ce^{-\beta x}; & x > d/2 \\ A\cos(\alpha x) + B\sin(\alpha x); & |x| < d/2 \\ De^{\beta x}; & x < -d/2 \end{cases}$$

where, $\alpha^2 = k_0^2 n_1^2 - k^2$ and $\beta^2 = k^2 - k_0^2 n_2^2$ such that $k_0^2 n_2^2 < k^2 < k_0^2 n_1^2$.

Also, $k_0 = \omega\sqrt{\mu_0 \varepsilon_0}$ is the free space wave number and k is known as the propagation constant. 10

(*b*) Prove that the eigenvalue equation associated with the symmetric TE mode is given by :

$$\gamma \tan \gamma = \sqrt{V_0^2 - \gamma^2}$$

where $\gamma = \dfrac{\alpha d}{2}$, and $V_0 = \dfrac{k_0 d}{2}\sqrt{n_1^2 - n_2^2}$.

This question paper contains 4+2 printed pages]

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

S. No. of Question Paper : **873**

Unique Paper Code : **222602** **G**

Name of the Paper : **Statistical Physics [PHHT-620]**

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

Semester : **VI**

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.

Symbols have their usual meanings.

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

(*a*) Explain the significance of partition function in statistical thermodynamics.

P.T.O.

(*b*) Calculate the wavelength corresponding to maxim emission from the Sun's surface at a temperature 6000 K. ($b = 2898$ μm K) 2.

(*c*) Discuss the limitations of law of equipartition of energ

(*d*) Under what conditions do the Bose-Einstein a Fermi-Dirac distribution approach the Maxwell-Boltzma distribution. 3.

(*e*) Give the equilibrium temperatures of two systems temperature +300 K and –300 K in thermal contact.

(*f*) Write *two* properties of photons which make the different from other bosons.

(*g*) The Fermi energy for metal A is 3.15 eV. Find its valu for metal B given that the free electron density in meta B is nine times that in metal A.

(*h*) What are the basic assumptions of Planck's theory o Black body radiation ?

2. (*a*) Explain the meaning of thermodynamic probability. How does thermodynamic probability differ from conventional definition of probability ? 3

(*b*) Establish the relation between entropy and thermodynamic probability and show that the constant occurring in the relation is the Boltzmann's constant. 7.5

3. (*a*) Prove that the single particle partition function for an ideal monoatomic gas enclosed in a cube (volume V, maintained at temperature T) is given by :

$$Z_S = \left(\frac{2\pi m k_B T}{h^2}\right)^{3/2} V$$

where, m is the mass of each particle of gas and h is the Planck's constant. 4

(*b*) Assuming that this gas consists of N identical and indistinguishable particles, prove that the expression for the entropy (S) of this gas is given by :

$$S = Nk_B\left(\frac{5}{2} + \ln\frac{Z_S}{N}\right)$$

and hence show that this expression resolves Gibbs' paradox. 7.4

4. (*a*) State and prove Kirchhoff's law for Black body radiation. Discuss one of its applications.

(*b*) Derive the expression for pressure exerted by diffuse radiation.

(*c*) Show thermodynamically that when the radiations enclosed in an enclosure are adiabatically expanded $TV^{1/3}$ is a constant.

5. (*a*) Show that the number of modes of vibrations per unit volume of an enclosure in the frequency range ν and $\nu + d\nu$ is given by :

$$N_\nu d\nu = \frac{8\pi\nu^2}{c^3} d\nu.$$

Using this expression, deduce the Rayleigh-Jean's law of energy distribution.

(*b*) Prove that the energy emitted per unit area per second from a black body is proportional to the fourth power of its absolute temperature.

5. (a) Show that number of microstates associated with a given macrostate for B-E statistics is given by :

$$W = \prod_i \frac{(n_i + g_i - 1)!}{n_i!(g_i - 1)!}$$

where, n_i represents the number of particles in the energy level ε_i having degeneracy g_i. 4

(b) Using Stirling's approximation and maximizing $S = k_B \ln(W)$, subject to the constraints that total energy E and total number of particles N are constant, show that B-E distribution function is given by :

$$n_i = \frac{g_i}{e^{\alpha + \beta\varepsilon_i} - 1}$$

where, α and β are Lagrange multipliers. 8

(c) Show that chemical potential of a boson gas is negative. 3

(a) Obtain the expressions for E_{F_0}, the Fermi energy at T = 0 K and P_0, the zero-point pressure of electron gas. 5,2 (*b*) Prove that the average kinetic energy per particle of Fermi gas at $T = 0$ K is given by :

$$\langle E \rangle = \frac{3}{5} E_{F_0} .$$ 6

(*c*) Why $\langle E \rangle$ in part (*b*) is not zero ? 2

8. (*a*) Show that the matter in white dwarf stars behave like a strongly degenerate relativistic electron gas.

(*b*) What is Bose-Einstein condensation ? Derive an expression for the temperature at which this phenomenon occurs. 2,8

This question paper contains 4 printed pages]

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

S. No. of Question Paper : **874**

Unique Paper Code : **222603** **G**

Name of the Paper : **Solid State Physics (PHHT-621)**

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

Semester : **VI**

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 calculator is allowed.

Do any *five* : 5×3=15

(*a*) Differentiate between covalent and van der Waal bond with examples.

(*b*) Show that the volume of a unit cell in the direct lattice is reciprocal of the volume of a unit cell in the reciprocal lattice.

(*c*) Show that the number of normal modes of vibration in a linear monatomic lattice of finite length is equal to the number of mobile atoms.

(*d*) What is the observed temperature dependence of lattice heat capacity in solids ?

(*e*) Applying Hund's rule, find magnetic nature of Cr^{2+} and Mn^{2+}. (Atomic No. of Cr = 24, Mn = 25).

(*f*) Why is dielectric constant of water 81 at zero frequency and 1.8 at optical frequencies ?

(*g*) Explain Meissner effect in superconductors. What is the magnitude of magnetic susceptibility for superconductor ?

(*h*) Why does the conductivity of a metal decrease while that of a semiconductor increase with rise in temperature ?

2. (*a*) Prove that the reciprocal lattice vector G_{hkl} is perpendicular to the crystal planes (*hkl*) and that the interplanar spacing is :

$$d_{hkl} = \frac{2\pi}{|G_{hkl}|}.$$

(*b*) Deduce the Bragg's law from the diffraction condition 2K. G + G^2 = 0. Show that its geometrical interpretation leads to the concept of the Brillouin zone in crystals.

(c) The Bragg angle reflection from the (111) planes in face centered cubic Aluminum is 19.2° for an X-ray wavelength of 1.54 Angstrom. Compute the cube edge of the unit cell. [Given sin(19.2°) = 0.329]. 4

3. (a) What are the phonons ? Describe qualitatively the characteristics of acoustical and optical phonons with reference to dispersion curve of linear diatomic lattice. 5

(b) Derive an expression for the lattice heat capacity of a solid following Einstein's model. Discuss the assumption and prediction of this model and compare it with experimental observations. 10

4. (a) Derive an expression for the electronic polarizability in a sinusoidally varying electric field. 6

(b) Distinguish between normal and anomalous dispersion. 4

(c) Derive Clausius-Mossotti relation for molar polarizability. 5

5. (a) What is the origin of the permanent magnetic moment for an atom or ion ? How does magnetic moment arise in Iron group of solids ? 4

(b) Find an expression for diamagnetic susceptibility using Langevin's theory. Calculate the molar diamagnetic susceptibility for atomic hydrogen.

[Given : mean square distance of electron from the nucleus $\langle r^2 \rangle = 0.84 \times 10^{-16}$ cm^2] 7

(c) State the assumptions of Weiss theory of ferromagnetism. How does a ferromagnetic substance differ from a paramagnetic substance ? 4

6. (a) Derive the Law of Mass Action governing the relative concentrations of electrons and holes in a semiconductor. 8

(b) Explain qualitatively the Hall effect in Semiconductors. 4

(c) State Bloch's theorem. 3

7. (a) Compare the variation of entropy and specific heat with temperature for a superconductor with that of a normal conductor ? 4

(b) Give an account of the mechanism proposed by Bardeen, Cooper and Schrieffer for formation of superconducting state. What were the main achievements of BCS theory ? 6

(c) Explain the terms : 5

(i) London penetration depth

(ii) Coherence length.

This question paper contains 7 printed pages]

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

S. No. of Question Paper : 875

Unique Paper Code : 222604 G

Name of the Paper : Nuclear and Particle Physics [PHHT-620]

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

Semester : VI

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.

Symbols have their usual meanings.

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

(*a*) What are the spin (integer/half-integer) and charge of the nucleus : $^{14}_{7}N$?

P.T.O.

(b) Which nucleus would you expect to be more stable : $^{7}_{3}Li$ or $^{8}_{3}Li$? Give reason.

(c) Tritium ($^{3}_{1}H$) has a half life of 12.5 years against beta decay. What fraction of a sample of tritium will remain undecayed after 25 years ?

(d) Find the density of $^{12}_{6}C$ nucleus.

(e) Mention any *three* conservation laws which govern the nuclear reactions.

3.

(f) Why free neutron does not decay into an electron and a positron ?

(g) Define atomic mass unit (amu) and show that energy equivalence of 1 amu is 931.5 MeV.

(h) List *two* failures of Liquid drop model.

2. (a) Prove that nuclear density is independent of mass number.

5

(*b*) Find the energy needed to remove a neutron from the nucleus of the calcium isotope ${}^{42}_{20}\mathrm{Ca}$. 5

[Given : $m({}^{42}_{20}\mathrm{Ca}) = 41.958622\mathrm{u}$, $m({}^{41}_{20}\mathrm{Ca}) = 40.962278\mathrm{u}$, $m({}^{1}_{0}n) = 1.008665\mathrm{u}$]

(*c*) Find the Binding Energy per nucleon in ${}^{20}_{10}\mathrm{Ne}$. 5

[Given : $m({}^{1}_{1}\mathrm{H}) = 1.007825\mathrm{u}$, $m({}^{20}_{10}\mathrm{Ne}) = 19.992439\mathrm{u}$]

3. (*a*) Derive the Coulomb energy term and asymmetry energy term of semi-empirical binding energy formula. 5,5

(*b*) Derive a formula for the atomic number of most stable isobar of given mass number A. 5

4. (*a*) Show that mean (or average) lifetime of a radioactive sample is given by $\tau = \frac{1}{\lambda}$. 5

(*b*) Radioactive material A (decay constant λ_A) decays into material B (decay constant λ_B) which is also radioactive.

Prove that the amount of material B remaining after time t is given by :

$$N_B = \frac{\lambda_A N_{AO}}{\lambda_B - \lambda_A}\left(e^{-t\lambda_A} - e^{-t\lambda_B}\right)$$

where, $N_A = N_{AO}$ and $N_B = 0$ at $t = 0$. 10

5. (*a*) Consider a slab of some material whose area is A, thickness is x and it contains n atoms per unit volume. If N particles incident normally on the slab's face of area A, then prove that number of surviving particles is given by :

$$N = N_0 e^{-n\sigma x}$$

where σ is the cross-section of nucleus. 5

(*b*) A fast moving particle a (rest mass m_a and kinetic energy K_a) strikes a stationary target nucleus X (rest mass m_x) to produce a light nucleus b (rest mass m_b and kinetic energy K_b) and the heavy nucleus Y (rest mass m_y and kinetic energy K_y) moving at angles θ_b and θ_Y respectively with respect to the original direction of particle *a*. Prove that the Q-value of this reaction ($a + X \rightarrow Y + b$) is given by :

$$Q = \frac{K_a}{m_Y}(m_a - m_Y) + \frac{K_b}{m_Y}(m_b + m_Y) - \frac{2}{m_Y}(m_a m_b K_a K_b)^{1/2} \cos\theta_b.$$

10

6. (*a*) What is the working principle of a Betatron ? Derive the Betatron condition. 2,5

(*b*) Calculate the average energy gained per turn by an electron in a Betatron. 5

(*c*) A cyclotron with a radius of 1 m has a magnetic field of 2 Tesla. Determine the maximum energy of the accelerated proton. 3

7. (*a*) The working of radiation detectors is based upon three main properties of the particles and rays emitted in nuclear interactions. Name them. 3

(*b*) Explain the principle, construction and working of a GM counter. 2,3,3

(*c*) An electron and a proton with the same energy E approach a step potential barrier whose height U is greater than E. Which one of them has the greater probability of transmission ? Give reason. 2,:

8. (*a*) Find the energy of each of the gamma-ray photons produced in the decay of a neutral pion at rest. Why must their energies be the same ? 2,1

[Given : Rest mass of neutral pion = 135 MeV/c^2]

(*b*) What are antiparticles ? What happens when electron and positron annihilate ? 2,2

(c) Determine whether four conservation principles (component I_3 of Isotopic spin, Spin, Strangeness number, Baryon number) are preserved or violated in the following reactions :

(i) $\Lambda^0 \rightarrow \pi^+ + \pi^-$

(ii) $\pi^+ + p \rightarrow \pi^+ + p + \pi^- + \pi^0$. 4,4

This question paper contains 4 printed pages.]

Your Roll No..............

r. No. of Question Paper : 1888 **GC-4**

nique Paper Code : 42221201

ame of the Paper : Electricity, Magnetism and EMT

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

emester : II

uration : 3 Hours Maximum Marks : 75

nstructions 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, $\vec{B} = 20\,\hat{j} + 100\ \hat{k}$ Tesla. For what value of α will the Lorentz force on the charge be zero.

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

(c) Five thousand lines of a electric force enter in a cer 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)

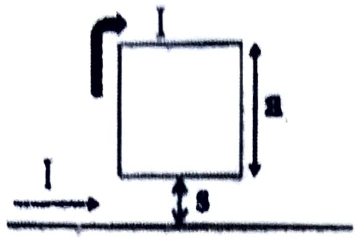
(b) A dielectric completely fills the space between the plates of a parallel plate capacitor. Show that the induced charge varies with the dielectric as:

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

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



(c) Distinguish between diamagnetic, paramagnetic
ferromagnetic materials.

6. (a) Show that for two interacting coils, M $\leq$ $M \leq \sqrt{L_1 L}$
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 ea
outside its atmosphere with intensity of 2.0 cal/c
min. Find the peak value of **E** and **B** for sunlight at
earth.

(b) Write the Maxwell's equations for vacuum. Der
electromagnetic equations and find the velocity of th
waves in free space.

This question paper contains 4 printed pages]

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

S. No. of Question Paper : **2942**

Unique Paper Code : **42514413**

GC-4

Name of the Paper : **Electronics IV : Microprocessor and Microcontroller**

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 any *Five* questions in all.

Question No. **1** is compulsory.

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

(*a*) Why are Stack Pointer and Program Counter 16-bit registers ?

(*b*) Define Instruction cycle, T-states and machine cycle.

(*c*) Differentiate between microprocessor and microcontroller with the help of block diagrams.

(*d*) What is the major difference between 8051, 8052 and 8031 microcontrollers ?

(e) Describe the role of 'Clock' in microprocessor. Spe the crystal frequency required for an 8085 system operate at 1.1 MHz.

(f) Define register bank in 8051 microcontroller.

(g) List the four operations commonly performed by 80 microprocessor.

(h) Explain the function of the following :

(i) READY

(ii) HOLD.

2. (a) Draw labeled Pin Out diagram of 8085 microprocess

(b) Explain the Bus structure of 8085 with the help diagram.

8

(c) What is the function of Accumulator ?

3. (a) Discuss the classification of instructions in 8085 mic processor according to word size and function with help of *one* example each.

(b) Define Subroutine. Explain its use. Also describe instructions used to generate a subroutine in 8085 mic processor.

4. (*a*) What is 'interrupt' in microprocessor ? List them in order of their priority in 8085 microprocessor. Differentiate between hardware and software interrupts. Also differentiate between maskable and non-maskable interrupts in 8085 microprocessor.

(*b*) Explain PSW register in 8051 with the help of its bit diagram. Show status of CY, AC and P flags after addition of 38H and 2F H in the following instructions :

MOV A, # 38 H

ADD A, # 02F H. 8,7

5. (*a*) Draw pin out diagram of 8051 microcontroller.

(*b*) Define a loop in 8051. Briefly explain how loop action is performed in 8051 with the help of instructions. Also differentiate between LJMP and SJMP instructions.

(*c*) Briefly explain RAM memory space allocation in 8051 microcontroller. 6,6,3

6. (*a*) Discuss addressing modes in 8051 microcontroller in detail. Explain each mode with at least *one* example.

(*b*) Write a program to add two 16-bit numbers. The numbers are 3CE7H and 3B8DH. Place the sum in R7 and R6. R6 should have lower byte. 10,5

7. (*a*) Explain bit addressability feature of 8051 in brief.

(*b*) Write a program to perform the following :

(*i*) keep monitoring the P1.2 bit until it becomes high

(*ii*) when P1.2 becomes high write value 45H to port 0

(*iii*) sends a high to low (H- to -L) pulse to P2.3.

(*c*) Briefly discuss architecture of embedded systems.

8. (*a*) Write an 8051 C language program to convert packed BCD 0 × 29 to ASCII and display the bytes on port P1 and P2.

(*b*) Write an assembly language program for 8085 microprocessor to divide an eight bit number 20H by 03H using a subroutine.

8,7

[This question paper contains 4 printed pages]

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

S. No. of Question Paper : 2943

Unique Paper Code : 42224412 GC-4

Name of the Paper : Waves and Optics

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 Number 1 is compulsory.

1. Attempt any *five* parts from the following :

(*a*) If two simple harmonic motions having angular frequencies 440 radian/sec and 396 radian/sec are superimposed, calculate the time period of beats and the number of beats produced.

(*b*) Explain the physical characteristics that determine quality, pitch and loudness of a musical sound.

P.T.O.

(*c*) Distinguish between Fresnel and Fraunhofer class of diffraction.

(*d*) Explain why the reverberation time is larger for an empty hall than for a crowded hall.

(*e*) Give the statements of Huygen's principle of propagation of wave front.

(*f*) Why do thin films appear coloured in white light ?

(*g*) Why are Newton's rings circular ?

(*h*) How is a zone plate different from a covex lens ? 5×3=15

2. (*a*) Trace graphically or analytically the motion of a particle which is subjected to two perpendicular simple harmonic motions of equal frequencies, different amplitudes and having a phase difference of :

(*i*) $\alpha = 0$

(*ii*) $\alpha = \pi/2$

(*b*) Derive the expression for total energy contained in a simple harmonic motion.

10+5=15

3. (*a*) Explain the formation of standing waves on a stretched string.

(*b*) A string 50 cm long is stretched by a load 25 kg and has a mass of 1.44 gm. Find the frequency of the second harmonic. 10+5=15

4. (*a*) What do you understand by electromagnetic waves ? Show that electromagnetic waves are transverse in nature.

(*b*) If intensity is increased by a factor of 20, then how many decibel is the sound level increased ? 10+5=15

5. (*a*) Show that in Young's double slit experiment, the fringe width is directly proportional to the wavelength of light.

(*b*) In case of Newton's ring experiment, calculate the diameter of ninth bright ring having radius of curvature of plano convex lens 10 cm and wavelength of light λ = 40 nm. 10+5=15

6. (*a*) A zone plate has focal length of 50 cm at a wavelength of 6000 Å. What will be its focal length at a wavelength of 5000 Å ?

(*b*) Explain with the help of diagram the intensity distribution due to Fresnel diffraction at a straight edge. 4+11=15

7. (*a*) Give the necessary theory to derive expression for the intensity distribution pattern in a plane transmission grating.

(*b*) A grating of width 2 inches is ruled with 15000 lines per inch. Find the smallest wavelength separation that can be resolved in second order at a mean wavelength of 5000 Å. 12,3

8. (*a*) Give the difference between Haidinger fringes and Fizeau fringes.

(*b*) Explain how Michelson's interferometer can be used to determine the wavelength of monochromatic light ?

(*c*) Prove that the diameters of dark Newton's rings are proportional to the square roots of natural numbers in reflected mode for normal incidence. 3,6,6

This question paper contains 4 printed pages.

Your Roll No. ....

Sl. No. of Ques. Paper : **51** **G**

Unique Paper Code : **235666**

Name of Paper : **Mechanics and Discrete Mathematics (MAPT–606)**

Name of Course : **B.Sc. (Prog.) Math. Sciences**

Semester : **VI**

Duration : **3 hours**

Maximum Marks : **75**

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

Attempt any two parts from each question. All questions are compulsory. Marks are indicated.

1. (a) A particle of mass m oscillates in a line with natural period $2\pi/n$. If an applied periodic force $F\cos pt$ now acts in the line so that the particle is instantaneously at rest at zero time at a distance d from the centre of oscillation, prove that the displacement of the particle at a subsequent time t is:

$$d\cos(nt)+F[\cos(pt)-\cos(nt)]/(n^2-p^2)m$$ 8

(b) Two light rings can slide on a rough horizontal rod. The rings are connected by a light inextensible string of length a, to the mid point of which is attached a weight w. Show that the greatest distance between the rings, consistent with the equilibrium of the system is:

P. T. O.

$$\frac{\mu a}{\sqrt{1+\mu^2}},$$

where μ is the coefficient of friction between either ring and the rod. 8

(c) Find the mass centre of a cubical box with no lid, the sides and bottom being made of the same thin material. 8

2. (a) Derive an expression for radial and transverse components of velocity and acceleration of a particle moving along a plane curve. 8

(b) Mud is thrown off from the tyre of a wheel (radius a) of a car travelling at a speed v, where $v^2 > ga$. Neglecting the resistance of the air, show that no mud can rise higher than a height $a + \frac{v^2}{2g} + \frac{ga^2}{2v^2}$ above the ground. 8

(c) A simple pendulum of mass m and length a is hanging in equilibrium. At time $t=0$, a small horizontal disturbing force X comes into operation and continues to act varying with time according to the formula $X = mb \sin 2pt$ where $p^2 = g/a$. Find a formula giving the position of the pendulum at any time. 8

3. (a) How many vertices and how many edges do K_n have? For which value of m and n is $K_{m,n}$ regular? 7

(b) Find the adjacency matrix for C_n. 7

(c) Let G be a graph with v vertices and e edges. Let M be the maximum degree of the vertices of G and let m be the minimum degree of the vertices of G.

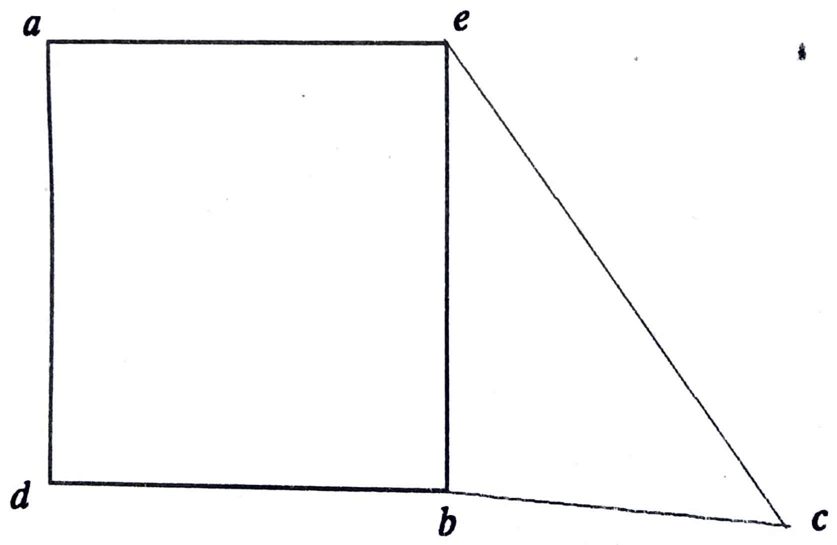
Show that:

(i) $2e/v \geq m$

(ii) $2e/v \leq m$. 7

4. (a) Show that every connected graph with n vertices has at least $(n-1)$ edges. 7

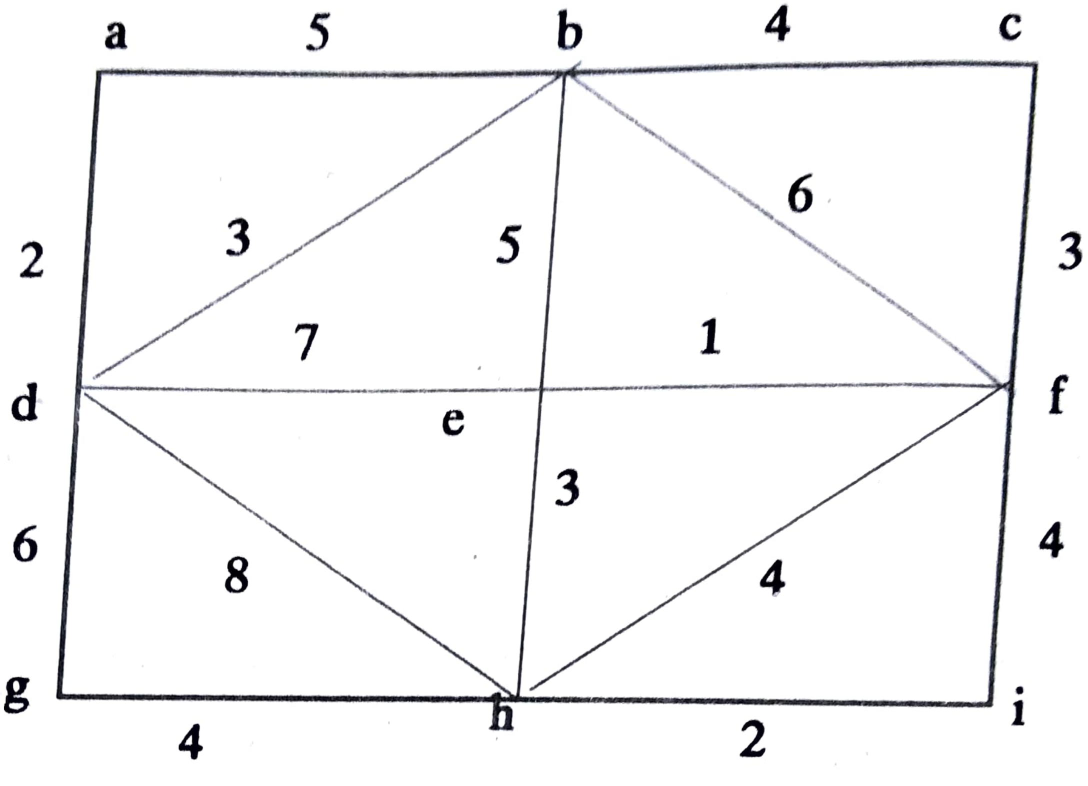
(b) How many paths of length four are there from a to e in the graph G? Identify all the paths. 7



(c) What is the Konigsberg Bridge Problem? Write the graphical representation of this problem. Is it possible to cross all seven bridges in a continuous path without recrossing any bridge? Justify your answer. 7

5. (a) Prove that an undirected graph is a tree if and only if there is a unique simple path between any two of its vertices. $7\frac{1}{2}$

(b) Use Prim's Algorithm to find a minimum spanning tree for the weighted graph. Also find total weight. $7\frac{1}{2}$



(c) Use Huffman coding to encode their symbols with given frequencies A : 0·10, B : 0·25, C : 0·05, D : 0·15, E : 0·30, F : 0·07, G : 0·08. What is the average number of bits required to encode the symbol? $7\frac{1}{2}$

[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 ?

(b) When does magnetic forces do no work on a mov
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 $V = \frac{1}{r} + 2$ determi
whether $\vec{E}$ is rotational or irrotational.

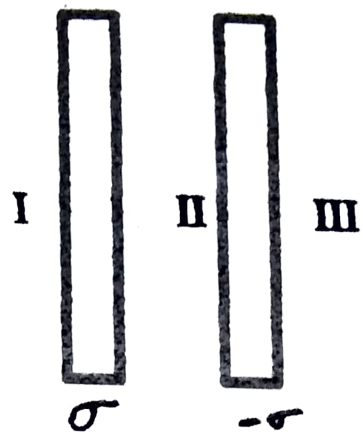
(g) What is the critical damping resistance in a ballis
Galvanometer ?

(h) A magnetic vector potential $\vec{A}$ is given by $3x^3\hat{i} + yz$
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 ρ = 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 st current, I = 16 A in anti-clockwise direction. magnetic field will be observed at the center of loop.

(c) The magnetic field in a region is given by $\vec{B} = 3\hat{i} +$ Tesla. Calculate the magnetic flux across the surf 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 mo coil galvanometer. Using them write the equatio motion of the coil. Under what conditions does it sl 'ballistic' behaviour. (2+2+3

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

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

2

(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 $\vec{E} = -\frac{\partial \vec{B}}{\partial t}$. (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)

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 3 printed pages.]

Your Roll No..............

Sr. No. of Question Paper : **145** **G**

Unique Paper Code : 222663

Name of the Paper : Solid State and Nuclear Physics (PHPT 606)

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

Semester : VI

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. **All** questions carry equal marks.

1. (a) What is a Reciprocal Lattice ? Mention its importance . Sketch any one unit cell of a simple cubic lattice and draw the planes : (122), (111), (201). (10)

   (b) Derive an expression for interplanar spacing for a family of parallel planes *(hkl)*. (5)

P.T.O.

2. (a) Define the polarizability of the atoms and molec... Obtain the Clausius Mossottirelation between pol... ability and dielectric constant of a solid. (2...

(b) Describe powder method of X-ray diffraction.

3. (a) Discuss the formation of allowed and forbidden ene... bands on the basis of Kronig Penny model. (1...

(b) Define the effective mass of an electron and give... physical significance. (...

4. (a) Distinguish the superconducting state from the norm... state of a metal. (3...

(b) What is Meissner effect ? Obtain an expression for t... London penetration depth of magnetic field for... superconductor. (3,...

5. (a) What is β decay ? Explain with full reaction. (2,...

(b) Polonium - 212 emits an α-particle of 8.776 Me... energy. Calculate the disintegration energy or energ... available in the reaction. (3...

(c) Distinguish between nuclear fission and nucle... fusion. (6...

6. (a) What are the salient features of nuclear forces w. r. t. their range and strength. (10)

(b) Write the following reactions by putting appropriate particles on the arrows.

$${}_{92}U^{238} \rightarrow {}_{90}Th^{234} \rightarrow {}_{91}Pa^{234} \rightarrow {}_{92}U^{234} \rightarrow {}_{90}Th^{230} \rightarrow {}_{88}Ra^{226}$$

(5)

7. (a) Enumerate five conservation laws obeyed in nuclear reactions in particle physics. (10)

(b) What do you understand by mass defect and binding energy ? (5)

8. (a) Classify various types of elementary particles in reference to their lepton numbers and spin. (10)

(b) Define Baryons. What is Baryon number of nucleons and pions ? (5)

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 :

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

(*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 :

$$y(0) = 0 \text{ and } y'(0) = 1.$$

860

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,

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

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

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

(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

This question paper contains 4+2 printed pages]

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 :

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

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

5. (*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

[This question paper contains 4 printed pages.]

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

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

Attempt **five** question in all.

Question No. 1 is compulsory.

All questions carry equal marks.

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 ... ial V is given by (½) CV^2

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

(d) How will the magnetic field intensity at the cen[tre of] a circular coil carrying current change, if the c[urrent] through the coil is doubled and radius of the c[oil is] halved? 3.

(e) Define the term hysteresis and draw the hyste[resis] curves for soft iron and steel.

(f) Evaluate the root mean square value of the follo[wing] time varying voltage

$$V = 3 + 4\sin\omega t + 4\cos\omega t.$$

(g) What should be the value of R in the following ne[twork] so that it could absorb maximum power from th[e 100] V source: 4.

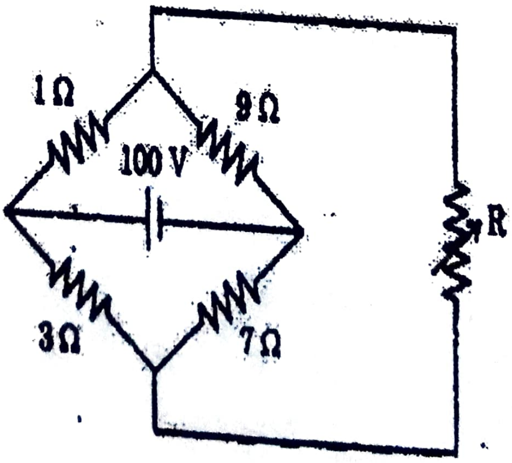


Fig. 1

(5×3 5.

2. (a) State and prove Gauss' law in electrostatics [fo]r spherical surface. Also obtain its differential for[m].

(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 3×10^{-9} C is moving with a velocity **v** = (2 **i** +3 **j**) m/s in an elecrtic field **E** = (3**i** +6**j**+2**k**) V/m and a magnetic field **B** = (2i+3j) 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?

P.T.O.

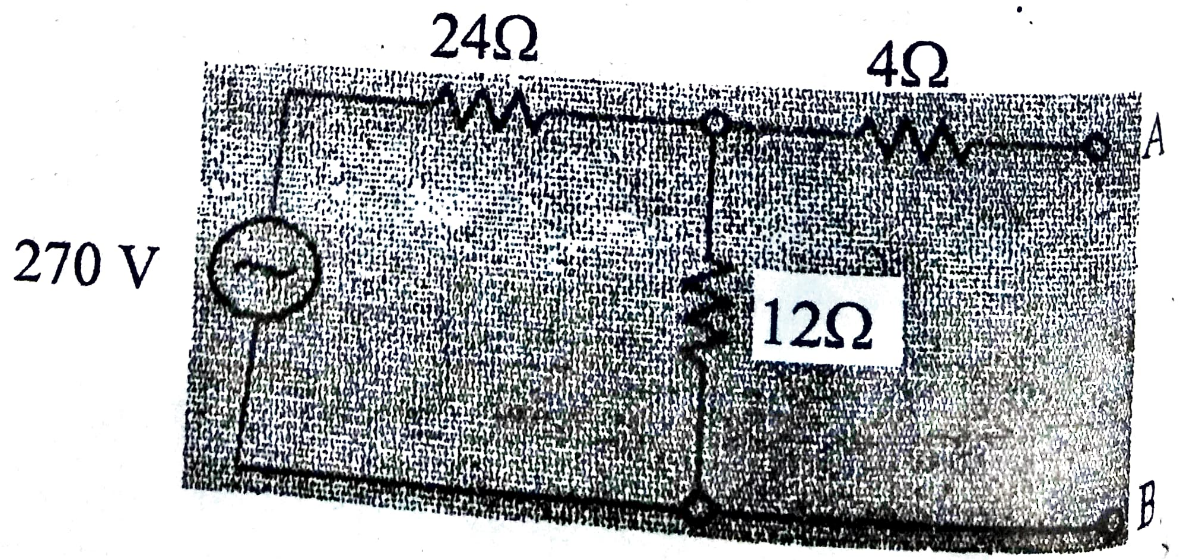
(b) Derive the relation $\mu = \mu_0 (1 + \chi)$, where χ is magneti susceptibility of material and other symbols have thei usual meanings. (10,5)

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

(b) Calculate average power in a given ac circuit containin 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 give network. Calculate the current that will flow through load impedance of 18 Ω connected between A and (Take the internal impedance of the emf source to zero) (8,



[This question paper contains 4 printed pages]

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

Sr. No. of Question Paper : 863 G

Paper Code : 222204

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 ?

P.T.O.

(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

8½

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

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

(b) A long cylinder carries a charge density that is proportional to the distance from the axis : ρ =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

P.T.O.

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.

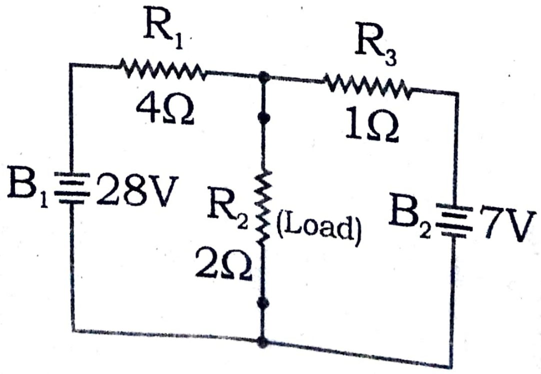
   (c) State the Faraday's laws of electromagnetic induction. Derive the differential and integral forms of the Faraday's law.

$5 \times 3 = 15$

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 $\overset{0}{A}$ 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

 P.T.O.

(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

[This question paper contains 4+1 printed pages]

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

S. No. of Question Paper : 2451

Unique Paper Code : 32225201 GC-4

Name of the Paper : Mechanics

Name of the Course : GE : Physics for Honours

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.

Attempt *four* questions from the rest of the paper.

Attempt any *five* of the following :

(*a*) A unit vector is $0.4\hat{i} + 0.8\hat{j} + c\hat{k}$. Calculate the value of c and also the cosine of the angle which the vector makes with x-axis.

(*b*) Solve the following differential equation :

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

(*c*) Does the centre of mass of solid body necessarily lie within the body ? Give examples.

P.T.O.

(d) For a particle of mass m, position $\vec{r} = 12\hat{i} + 8\hat{j}$ and $\vec{v} = 6\hat{i}$, calculate its angular momentum about the origin.

(e) What is Hooke's law ? Sketch labelled stress-strain diagram.

(f) The length of a rod is 10 meters in reference frame A. What is its length as seen by an observer in reference frame B, when reference frame B has a velocity of $0.8c\,\hat{i}$ relative to reference frame A.

(g) The maximum and minimum distances of a comet from the sun are 8×10^{12} metre and 1.6×10^{12} metre respectively. If its velocity when nearest to the sun is 60 metres/sec, what is the velocity when farthest ? 5×3

2. (a) If the vectors $(\hat{i} + 2\hat{j} + 4\hat{k})$ and $(5\hat{i})$ represent the two sides of a triangle, find a vector perpendicular to the plane of the triangle.

(b) Obtain expressions for the velocity and acceleration of a particle moving at constant speed in circular orbit of constant radius r.

(c) Discuss physical significance of the following differential equation, $\frac{d^2x}{dt^2}+\omega^2 x=0$. Also find its general solution. 3,6,6

3\. (a) Define linear momentum of a moving particle. Derive an expression for the total momentum of a system of particles. Show that if the total linear momentum of system of particles is conserved the centre of mass is either moving with a constant velocity or is at rest.

(b) State and prove Work Energy theorem.

(c) Force acting on a particle is given by $\vec{F}=(2xy+2z)\hat{i}+x^2\hat{j}+2xz\hat{k}$. Calculate the work done on a particle in moving it from position (0, 1, 2) to (5, 6, 8). 6,6,3

4\. (a) A bomb of mass 4M explodes in flight at a time when its velocity is $5\hat{i}+4\hat{j}$ m/sec. It splits into two fragments of masses M and 3M and the smaller mass M is observed to fly with a velocity $10\hat{i}+100\hat{j}$ m/sec after the explosion. Calculate the velocity of larger fragment of mass 3M just after the explosion.

(*b*) Deduce equation of motion of rocket and neglecting gravity, find the instantaneous velocity of the rocket.

(*c*) Given that $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ and $\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$. Find the torque $\vec{\tau}$. Show that if $\vec{r}$ and $\vec{F}$ lie in the given plane $\vec{\tau}$ has no component in that plane. 4,7,4

5. (*a*) State Kepler's laws of planetary motion. Derive expressions for the velocity and time period of a satellite in circular orbits.

(*b*) What are central forces ? Give *two* examples. Show that in central force field :

(*i*) the angular momentum is conserved;

(*ii*) areal velocity is constant. 7,8

6. (*a*) What is simple harmonic motion ? Explain the following physical quantities associated with simple harmonic motion :

(*i*) Time Period

(*ii*) Frequency

(*iii*) Amplitude

(*iv*) Phase.

(*b*) Show that for a harmonic oscillator, mechanical energy remains constant and it is proportional to the square of the amplitude.

(*c*) In Simple Harmonic Motion when the displacement is one half of the amplitude, what fractions of the total energy are kinetic and potential ? 6,5,4

7. (*a*) Find the work done in stretching the wire.

(*b*) Define modulus of rigidity and Poisson's ratio. Deduce an expression for couple in twisting a cylinder by an angle θ. 5,10

8. (*a*) Obtain formula for relativistic addition of velocities.

(*b*) We observe two galaxies A and B moving in opposite directions with speeds 0.5c and 0.4c respectively. What is the velocity of B as seen from galaxy A.

(*c*) Explain the concept of time dilation in relativity. What is proper interval of time ? Deduce an expression for time dilation. 6,3,6

[This question paper contains 4+2 printed pages]

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

S. No. of Question Paper : 867

Unique Paper Code : 222401 G

Name of the Paper : Mathematical Physics IV (PHHT-411)

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

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,

taking at least *one* question from each Section.

Section A

1. (*a*) Determine the identity element for the binary operation,

$(a, b) * (c, d) = (ac, bc + d)$.

(*b*) Is the set $\{1, -1, i, -i\}$ a group under multiplication ?

$\left(i = \sqrt{-1}\right)$

P.T.O.

(c) Given a set of vectors, $U = \{(a, b, c) : a \leq b \leq c\}$ in R^3.

Determine whether U forms a subspace of R^3 or not.

(d) Find the basis and dimension of the solution space W of the system of homogeneous linear equations :

$$x + 4y + 2z = 0$$

$$2x + y + 5z = 0.$$

3+3+4+5

2. (a) It is given that $\{\alpha, \beta, \gamma\}$ is a set of linearly independent vectors. Determine whether the vectors $\alpha - 2\beta$, $\alpha + \beta + \gamma$, $\beta - \gamma$ are linearly independent or linearly dependent.

(b) Show that the transformation, $T : R^3 \to R^2$ defined by

$$T(x, y, z) = (x + 2y - 3z, 4x - 5y + 6z)$$

is a linear transformation.

(c) Let T be a linear transformation, $T : R^3 \to R^3$, such that,

$$T\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} x+z \\ x-z \\ z \end{pmatrix}.$$

Find the matrix representation of T, with respect to the basis, $\{e_1, e_2, e_3\}$, where,

$$e_1 = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, e_2 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, e_3 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}.$$

5+5+5

Section B

3. (a) Show that all the eigen values of a unitary matrix have unit magnitude.

(b) Assuming that A, $I - A$, $I - A^{-1}$ are all non-singular matrices, show that :

$$(I - A)^{-1} + (I - A^{-1})^{-1} = I.$$

(c) Show that any *two* eigen vectors corresponding to two distinct eigen values of a Hermitian matrix are orthogonal. 5+5+5

4. (a) Determine the eigen values and eigen vectors of the matrix,

$$A = \begin{pmatrix} 3 & 1 \\ -6 & -4 \end{pmatrix}.$$

(b) Diagonalize the matrix,

$$A = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}.$$

5+10

5. (a) Solve the coupled differential equations, using the matrix method :

$$\frac{dx}{dt} = -ax - by$$

$$\frac{dy}{dt} = bx - ay$$

The initial conditions are, $x(0) = 0$; $\left.\frac{dy}{dt}\right|_{t=0} = 1$.

(*b*) Using Cayley-Hamilton theorem, for the matrix,

$$A = \begin{pmatrix} 3 & 1 \\ 2 & 2 \end{pmatrix},$$

determine A^{-1}. 10+5

Section C

6. Consider a uniform flexible chain hanging from a support under the action of gravity. At time $t = 0$, the chain is given an arbitrary displacement, $y(x, 0) = y_0(x)$ and is released from rest. Establish the wave equation for this system, and solve it to determine the displacement $y(x, t)$ at a later time t. Here, x is the vertical distance measured from the free end of the chain and $y(x, t)$ is the displacement in the transverse direction. 5+10

7. Solve the one-dimensional wave equation :

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}, \quad 0 < x < L$$

The initial conditions are,

$$u(x, 0) = \begin{cases} \dfrac{2kx}{L} & \text{if } 0 < x < L/2 \\ \dfrac{2k}{L}(L - x) & \text{if } L/2 < x < L \end{cases}$$

$$\left.\frac{\partial u}{\partial t}\right|_{t=0} = 0.$$

8. Derive the one-dimensional heat conduction equation, given by,

$$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$$

Find the temperature in a laterally insulated bar of length L whose ends are kept at 0°C, assuming the initial temperature is given by :

$$u(x, 0) = \begin{cases} x & \text{if } 0 < x < L/2 \\ L - x & \text{if } \dfrac{L}{2} < x < L \end{cases}$$

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

S. No. of Question Paper : **868**

Unique Paper Code : **222402** **G**

Name of the Paper : **Optics [PHHT-412]**

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

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

(*a*) Write down *two* conditions for observing a sustained interference pattern.

(*b*) Show that when light is reflected from a denser surface, a phase change of π is introduced in the reflected ray.

(c) What is the total number of lines a grating must have in order just to separate the sodium doublet (λ_1 = 5890 Å and λ_2 = 5896 Å) in the second order ?

(d) What are the requirements for recording a hologram ? Give at least *two*.

(e) Two coherent beams of wavelength 5000 Å reaching a point would individually produce intensities 1.44 and 4.00 units. If they reach there together, the intensity is 3.04 units. Calculate the lowest phase difference with which the beams reach that point.

(f) The observed visibility is 0.3 with the two light beams having intensities in the ratio 1 : 9. Find the degree of coherence.

(g) What is the radius of the first half-period zone in a zone plate behaving like a convex lens of focal length 70 cm for light of wavelength 7000 Å ?

(h) Using Fermat's principle, establish the law of reflection.

2. (a) Derive expressions for the equivalent focal length and the positions of principal points and focal points of a coaxial system of two thin lenses separated by a finite distance. 6,2,2

(b) Plot the principal points and focal points for a hemisperical glass lens of radius 10 cm and refractive index 1.5 placed in air. 5

3. (a) What are coherent sources ? 2

(b) Derive an expression for the resultant intensity of the interference pattern when two coherent beams of light (intensities I_1 and I_2 having phase difference ϕ) are superposed. Find the visibility of fringes if :

(i) $I_1 = I_2$

(ii) $I_2 = 2I_1$. 7,2,2

(c) What will be the resultant intensity when the sources of intensities I_1 and I_2 are incoherent ? 2

4. (a) Calculate the path difference between two consecutive reflected rays in a wedge shaped film (formed by two plane surfaces inclined at an angle θ) and prove that the fringe width β is given by :

$$\beta = \frac{\lambda}{2\tan\theta\sqrt{\mu^2 - \sin^2 i}}$$

where, μ is the refractive index of the film, 'i' is the angle of incidence and 'λ' is the wavelength of the incident light. 7,4

(b) What do you mean by localised and non-localised fringes ? Give *one* example of each. 4

5. (a) Prove that the diameters of Newton's dark rings are proportional to the square roots of natural numbers in reflected mode for normal incidence. 7

(b) Explain how Michelson's interferometer can be used to determine : 4,4

(i) the wavelength of monochromatic light

(ii) the refractive index of thin transparent film.

6. (a) Plane waves of wavelength λ impinge normally on a double-slit arrangement (two slits each of width a separated by an opaque space of width b), prove that intensity at any point P on screen (parallel to the plane containing double slits) due to Fraunhofer diffraction is given by :

$$I = 4I_0 \frac{\sin^2 \beta}{\beta^2} \cos^2 \gamma$$

where, $\beta = \frac{\pi}{\lambda} a \sin \theta$, $\gamma = \frac{\pi}{\lambda}(a + b) \sin \theta$, θ is the angle of diffraction and I_0 is the intensity at centre on the screen. Show the intensity pattern graphically. 8,3

(b) Prove that in the limit $a \to 0$, the above equation can be reduced to the equation for the intensity distribution in Young's double slit experiment. 2

(c) Prove that in the limit $b \to 0$, the above equation can be reduced to the equation for the intensity distribution for a single-slit of width $2a$. 2

7. (*a*) Derive Fresnel's integrals. Calculate the value of intensity by an unobstructed wavefront. 6,2

(*b*) Using Cornu's spiral, explain the Fresnel diffraction pattern due to a straight edge. 7

8. (*a*) What are half period zones ? Discuss Fresnel's diffraction due to a circular aperture in terms of half period zones. 2,10

(*b*) A zone plate has focal length of 50 cm at a wavelength of 6000 Å. What will be its focal length at a wavelength of 5000 Å ? 3

This question paper contains 7 printed pages]

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

S. No. of Question Paper : **1129**

Unique Paper Code : **235463** **G**

Name of the Paper : **Mathematics II (Analysis and Statistics)**

PHHT-413

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

Semester : **IV**

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

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

Attempt as per directions.

Section A

Do any *two* questions.

1\. (*a*) State and prove M_n-Test for uniform convergence of a sequence of functions.

(*b*) Show that :

$$\tan^{-1}(x) = x - \frac{x^3}{3} + \frac{x^5}{5} \text{ ....} \quad \text{for } x \in [-1, 1]$$

and hence deduce that :

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} \text{ ....} .$$ 6½+6

P.T.O.

2. (a) Show that the sequence $<f_n>$ where :

$$f_n(x) = \frac{nx}{1+n^2x^2}, \quad x \in R$$

is not uniformly convergent on R.

(b) Show that if a series $\sum f_n$ converges uniformly to f in an interval $[a, b]$ and its terms f_n are continuous at a point x_0 in the interval (a, b), then the sum function f is also continuous at x_0. 6½+6

3. (a) Prove that if a power series :

$$\sum a_n x^n,$$

is such that $a_n \neq 0$, for all n and

$$\lim_{n\to\infty}\left(\frac{a_{n+1}}{a_n}\right) = \frac{1}{R},$$

then $\sum a_n x^n$ is convergent for $|x| < R$ and divergent for $|x| > R$. Show that series $\sum_{n=1}^{\infty} \frac{x^{n-1}}{n^2}$ is convergent for all $x \in (-1, 1)$. Also check the convergence of this series at $x = \pm 1$.

(*b*) State Weierstrass M-Test for uniform convergence of series of functions. Show that the series :

$$\sum_{n=1}^{\infty} \frac{x}{n(1+nx^2)}$$

is uniformly convergent on R. 6½+6

Section II

4. Do any *three* parts :

(*a*) Show that the integral :

$$\int_0^{\pi/2} \frac{\sin^m x}{x^n}\, dx$$

is convergent if $n < m + 1$.

(*b*) Test the convergence of :

$$\int_0^{\infty} e^{-x^2} dx .$$

(*c*) Prove that the Gamma function :

$$\int_0^{\infty} x^{m-1} e^{-x}\, dx$$

is convergent if $m > 0$.

(*d*) Test the convergence of :

$$\int_0^{\pi/2} \frac{\sin x}{x^p} \, dx .$$

(*e*) Show that :

$$\int_0^a \frac{\log(1+ax)}{1+x^2} \, dx = \frac{1}{2} \log(1+a^2) \tan^{-1} a .$$ 5,5,5,5,5

Section III

5. Do any *one* part :

(*a*) Find a formula for the probability distribution of the total number of heads obtained in four tosses of a balanced coin.

(*b*) If X has the probability density :

$$f(x) = \begin{cases} ke^{-3x} & \text{for } x > 0 \\ 0 & \text{elsewhere} \end{cases}$$

find *k*, the distribution function of the random variables X and use it to evaluate :

$$P(0.5 \leq X \leq 1).$$ 5,5

Do any *three* parts :

6. (*a*) Find the moment generating function of the random variable whose probability density is given by :

$$f(x) = \begin{cases} e^{-x} & \text{for } x > 0 \\ 0 & \text{elsewhere} \end{cases}$$

and use it to find an expression for μ_r'.

(*b*) If the joint probability density of two random variables X and Y is given by :

$$f(x, y) = \begin{cases} x + y & \text{for } 0 < x < 1,\ 0 < y < 1 \\ 0 & \text{elsewhere} \end{cases}$$

Find the joint distribution function of these two random variables.

(*c*) Find the probabilities that a random variable having the standard normal distribution will take on a value :

(*i*) less than 1.72;

(*ii*) between 1.30 and 1.75.

(*d*) Let X and Y be two random variables with variance σ_x^2 and σ_y^2 respectively and r is the coefficient of correlation between them. If U = X + KY and V = X + (σ_x/σ_y)Y, find the value of K so that U and V are uncorrelated. 5,5,5,5

7. Do any *three* parts :

(*a*) The means of two single large samples of 1000 and 2000 members are 67.5 inches and 68 inches respectively. Can the samples be regarded as drawn from the same population of standard deviation 2.5 inches ?

(*b*) A random sample of 10 boys had the following I.Q's 70, 120, 110, 101, 88, 83, 95, 98, 107, 100. Do these data support the assumption of a population mean I.Q. of 100 ?

($t_{0.05}$ at 9 d.f. = 2.262)

(*c*) Two random samples of sizes 8 and 10, drawn from the two normal populations are characterized as follows :

Population	Sum of squares of deviations from their respective means
I	84.4
II	102.6

Can they be regarded as drawn from the two normal populations with the same variance ?

($F_{0.05}$ for 7 and 9 d.f. = 3.29)

(*d*) The theory predicts the proportion of beans in the four groups A, B, C and D should be 9 : 3 : 3 : 1. In an experiment among 1600 beans, the numbers in the four groups were 882, 313, 287 and 118. Does the experimental result support the theory ?

($\chi^2_{0.05}$ for 3 d.f. = 7.815) 5,5,5,5

This question paper contains 4+1 printed pages]

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

S. No. of Question Paper : **2820**

Unique Paper Code : **32221401** **GC-4**

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

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

Semester : **IV**

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

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

All questions carry equal marks.

Question No. **1** is compulsory.

Attempt **2** questions from Section A

and **2** questions from Section B.

Use of scientific calculators is allowed.

1. Attempt any *five* questions : $5 \times 3 = 15$

(*a*) Determine the solutions of the equation $z^4 = 1$ where z is a complex number. Represent the solutions graphically.

P.T.O.

(*b*) Locate the name the singularities in the finite z plane of the function :

$$f(z) = \frac{\ln (z - 2)}{(z^2 - 1)^2}.$$

(*c*) Evaluate :

$$\oint_C \frac{3z^2 - 6}{z - 2}\, dz$$

over a circle C in the counterclockwise direction. C is described by $|z| = \pi$.

(*d*) Find the real part of (i^{2i}).

(*e*) Show that $x\delta(x) = 0$, where $\delta(x)$ is the Dirac delta function.

(*f*) If $F(\omega)$ is the Fourier transform of $f(t)$, then prove that the Fourier transform of :

$$f(at) = \frac{1}{a} F\left(\frac{\omega}{a}\right)$$

where a is a constant.

(*g*) Determine the Laplace transform of :

$$f(t) = \sin^2 2t.$$

(h) Evaluate :

$$\int_0^\infty t e^{-3t} \sin t \, dt$$

using Laplace transform.

Section A

Attempt any *two* questions from this section.

2\. (a) Verify Cauchy's theorem for the function :

$$f(z) = 2z^2 + 3z - 7,$$

if C is a square with vertices at $-1 \pm i, 1 \pm i$.

(b) Using De Moivre's theorem, prove that : 10.5

$$\cos 3\theta = 4\cos^3\theta - 3\cos\theta$$

$$\sin 3\theta = 3\sin\theta - 4\sin^3\theta$$

3\. (a) Expand :

$$f(z) = \frac{z}{(z-1)(2-z)}$$

in a Laurent's series valid for the given regions :

(i) $1 < |z| < 2$

(ii) $|z - 1| > 1$

(*b*) Evaluate :

$$\frac{1}{2\pi i}\int_C \frac{\cos \pi z}{z^2 - 1}\, dz$$

around a square with vertices at $\pm i, 2 \pm i$.

6.

10,5

4. Using the method of contour integration prove any two of the following : 7½+7½

(*a*) $\displaystyle\int_0^\infty \frac{dx}{1 + x^6} = \frac{\pi}{3}$

(*b*) $\displaystyle\int_0^\pi \frac{d\theta}{1 + \sin^2 \theta} = \frac{\pi}{\sqrt{2}}$

(*c*) $\displaystyle\int_0^\infty \frac{\cos 3x}{(1 + x^2)(x^2 + 4)}\, dx = \frac{\pi}{2}\left(\frac{e^{-3}}{3} - \frac{e^{-6}}{6}\right).$

7.

Section B

Attempt any *two* questions from this section.

5. (*a*) Determine the Fourier transform of the function $f(t)$:

$$f(t) = 1 - t^2 \text{ for } |t| < 1$$
$$= 0 \text{ otherwise}$$

Hence evaluate :

$$\int_0^\infty \frac{t\cos t - \sin t}{t^3} \cos \frac{t}{2}\, dt$$

(*b*) State and prove the convolution theorem for Fourier transforms. 8,7

(a) Given $f(t) = 1$ for $-1 < t < 1$;

$= 0$ otherwise

Express $f(t)$ as a Fourier integral and hence evaluate :

$$\int_0^{\infty} \frac{\sin \omega \cos \omega t}{\omega} d\omega .$$

(b) State the convolution theorem for Laplace transform. Use this theorem to evaluate the inverse Laplace transform of : 8,7

$$F(s) = \frac{1}{s^2 (s^2 + 1)}$$

(a) Using Laplace transform, solve the following set of simultaneous differential equations :

$$\frac{dx(t)}{dt} + y(t) = 0$$
$$\frac{dy(t)}{dt} - x(t) = 0 \text{ given } x(0) = 1; y(0) = 0 .$$

(b) Determine the Laplace transform of a periodic function $f(t)$ with period T. 10,5

Sl No of Q.P : 1588

100

F-8

Unique Paper Code : 2221402

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

Name of the Paper : Mathematical Physics –III

Semester : IV

Duration: 3 Hours Maximum Marks : 75

Instruction for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Atleast one question from each section.

SECTION A

Q1.

a) Prove that $\left|\tanh\frac{\pi(1+i)}{4}\right| = 1.$ (3)

b) Find all the roots of $(1+z)^5 = (1-z)^5$ (3)

c) Derive the necessary and sufficient condition for a complex function $f(z) = u(x,y) + i\,v(x,y)$ to be analytic. (9)

Q2.

a) Evaluate

$$\oint_C \frac{e^{2z}}{(z+1)^4}\,dz$$ (5)

b) Find the principal value of $\ln(\sqrt{3}-1)$ (4)

c) Evaluate (6)

$$\oint_C \frac{dz}{(z-a)^n} \qquad n = 2,3,4\ldots\ldots\ldots$$

Where z=a is inside the simple closed curve C.

Q3.

a) Find the residue of $f(z) = \frac{\operatorname{cosec} z \operatorname{cosech} z}{z^3}$ at z=0. (5)

b) Expand $f(z) = \frac{1}{z-3}$ in a Laurent series valid for $|z| < 3$ and $|z| > 3$. (6)

c) Locate and name all the singularities of the function (4)

$$f(z) = \frac{(z+3)}{(z^2-1)}$$

Q4. Using Contour Integration, evaluate any **two** of the following

a) $\int_0^{2\pi} \frac{\cos 3\theta}{(5-4\cos\theta)}\, d\theta$

b) $\int_0^{\infty} \frac{dx}{x^4+1}$

c) $\int_0^{\infty} \frac{\cos 2\pi x}{x^4+4}\, dx$ (7 ½ , 7 ½)

SECTION B

Q5.

a) Find the Fourier transform of

$$f(t) = e^{-a|t|}, -\infty < t < \infty, a > 0$$ (5)

b) Using Convolution theorem, find the inverse Fourier transform of

$$\frac{1}{12 + 7i\omega - \omega^2}$$ (7)

c) Prove that $x\,\delta(x) = 0$. (3)

Q6.

a) Verify convolution theorem for the function $f(t) = g(t) = e^{-t^2}$. (5)

b) If $F(\omega)$ is the Fourier transform of the function $f(t)$, then find Fourier transform of $f''(t)$. (5)

c) Show that (5)

$$\delta'(x) = -\frac{\delta(x)}{x}$$

SECTION C

Q7.

a) Using Laplace transform, prove that $\int_0^{\infty} \cos t^2\, dt = \frac{1}{2}\sqrt{\frac{\pi}{2}}$ (8)

b) Find the Laplace transform of $\int_0^{\infty} \frac{\sin t}{t} dt$ (7)

Q8.

a) A resistance R in series with inductance L is connected with e.m.f. E(t). The current i is given by

$$L\frac{di}{dt} + Ri = E(t)$$

If the switch is connected at t=0 and disconnected at t=a, find the current i in terms of t. (8)

b) Using Convolution theorem of Laplace transform, find (7)

$$L^{-1}\left\{\frac{s}{(s^2+1)(s^2+4)}\right\}$$

Q. No. 07 Q.P. 1589 1589

Unique Paper Code : 2221403

Name of the Paper : Analog System and Applications

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

F-8

Semester : IV

Duration : 3 Hours

Maximum Marks : 75

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

Attempt any **five** questions in all. Question No. 1 is **compulsory**.

Non programmable calculators are allowed.

Q. 1 Attempt any five of the following

(a) Draw the I-V characteristics of a photodiode.

(b) Silicon at T = 300 K is doped with impurity concentrations of $N_d = 5 \times 10^{16}$ cm^{-3} and $N_a = 2 \times 10^{16}$ cm^{-3}. Determine the resistivity of the material.

(c) Draw the input and output characteristics of n-p-n common emitter transistor.

(d) Define CMRR of operational Amplifier.

(e) Draw the energy band diagram of an unbiased p-n junction diode with appropriate labels.

(f) Obtain a relation between the current gains α and β of a BJT.

(g) What is meant by drift and diffusion currents in doped semiconductors?

(h) What is meant by PIV rating of a p-n junction diode? What will be the PIV of diodes in (i) centre tapped full wave and (ii) bridge full wave rectifiers, if the output of both is 12V.

3x5=15

Q. 2 (a) Explain the concept of potential energy barrier.

(b) Derive the Volt Ampere equation for a p-n junction diode.

(c) For an abrupt pn junction in a Ge doped semiconductor with donor and acceptor concentrations of $N_d = 10^{23}$ m^{-3} and $N_a = 10^{22}$ m^{-3}. Calculate the potential barrier. Given that $N_i = 2 \times 10^{19}$ m^{-3}, T = 300 K and $k = 1.38 \times 10^{-23}$ J/K.

2,10, 3

Q. 3 (a) Explain the working of a half wave rectifier using suitable diagrams and obtain the expressions for (i) ripple factor and (ii) rectification efficiency.

(b) A zener diode (with zener voltage = 10 V) is operated with source voltage of 20 V and a series current limiting resistance 1 kΩ. Find the current through the zener diode when R_L is (i) 10 kΩ (ii) 2 kΩ and (iii) 1 kΩ.

11, 4

Q. 4 (a) Find the operating point and draw the dc load line of voltage divider biasing circuit. Given that $R_1 = 25\ k\Omega$; $R_2 = 8k\Omega$; $R_c = 3k\Omega$; $R_E = 1k\Omega$; $\beta = 75$; $V_{CC} = 24$ V and $V_{BE} = 0.7$ V.
(b) Draw a diagram for the voltage divider bias circuit of an n-p-n transistor in CE configuration. Derive an expression for the stability factor (S) using Thevenin's equivalent circuit.

5,10

Q. 5 (a) Using `h` parameters, obtain expressions for current gain, voltage gain, input impedance and output impedance for transistor in CE configuration.
(b) For a 4-bit binary R-2R ladder D/A converter the input levels are 0=0V and 1= +10V. Find the output voltage caused by (i) 0011, (ii) 1001 and (c) 1111.

12, 3

Q. 6 (a) Draw the circuit diagram of an RC phase shift oscillator using transistor and state the conditions for sustained oscillations. Derive an expression for its frequency.
(b) In a Colpitt's oscillator $C_1 = 0.1\ \mu F$, $C_2 = 0.01\ \mu F$ and $L = 50$ mH, find the frequency of oscillation.

12, 3

Q. 7 (a) Design a circuit using an op-amp to get the output expression as

$$V_o = -(0.1\ V_1 + V_2 + 10\ V_3)$$ where V_1, V_2 and V_3 are the inputs.

(b) Explain the working of an op amp as a zero crossing detector.
(c) Draw the circuit of an Op-amp as a differentiator and find an expression for its output. Draw the output waveform when the input to the differentiator is a triangular wave.

5, 4, 6