[This question paper contains 6 printed pages.]



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

**Sr. No. of Question Paper : 5773** **H**

Unique Paper Code : 222501

Name of the Paper : Mathematical Physics V-(PHHT-515)

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

Semester : V

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. **All** questions carry equal marks.
3. Question No. **1** is compulsory.
4. Attempt any **2** questions from Section **A** and any **2** questions from Section **B.**
5. Use of Scientific Calculators is allowed.

1. Attempt any **five** questions.

   (a) Determine the Fourier transform of f(ax) where a is a constant.

(b) Determine the Fourier transform of the Dirac delta function $\delta(x-a)$.

(c) Prove that $\int_0^\infty te^{-2t}\cos t\,dt = \frac{3}{25}$.

(d) Using Bromwich Integral, determine the inverse Laplace transform of

$$F(s) = \frac{a}{s^2 - a^2}$$

(e) Prove that $\delta(at) = \frac{\delta(t)}{a}$ where $\delta(t)$ is the dirac delta function and a is a constant greater the zero.

(f) Prove that the gradient of a tensor of order one is a tensor of order 2.

(g) Find the Laplace transform the unit step function U(t–a).

(h) Given $ds^2 = 4(dx_1)^2 + 2\,dx_1\,dx_3 + (dx_3)^2 + (dx_2)^2 + 4\,dx_1\,dx_2 + 6\,dx_3\,dx_2$

Find the components of the metric tensor $g_{ij}$.

(3×5=15)



## Section A

2. (a) Determine Fourier cosine transform of $e^{-ax}$.

(b) State Parseval's identity for Fourier transform and using it the above result. Prove that

$$\int_0^\infty \frac{1}{(\omega^2 + a^2)^2}\,d\omega = \frac{\pi}{4a^3}$$

(c) Verify the convolution theorem if F.T. for the functions

$$f(x) = g(x) = \begin{cases} 1, & |x| < 1 \\ 0, & |x| > 1 \end{cases}$$ (6,6,3)

3. (a) Derive an expression for the Laplace transform of a periodic function f(t) where

$$f(t + T) = f(t).$$

(b) Evaluate the inverse Laplace transform of F(s) where

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

(c) Given that U(t) is the unit Heaviside function,

Prove that $\frac{dU(t)}{dt} = \delta(t)$. (6,4,5)

4. (a) Using Laplace transform, solve the following partial differential equation

$\frac{\partial u(x,t)}{\partial t} = \frac{\partial^2 u(x,t)}{\partial x^2}$ with the following conditions

$u(x,0) = \sin 4\pi x;\ u(0,t) = 0;\ u(1,t) = 0,\ 0 < x < 1,\ t > 0$

(b) Evaluate the integral $\int_{-\infty}^{\infty} \sin t\ \delta\left(t - \frac{\pi}{2}\right) dt$.

(c) Determine the Laplace transform of $\sin\sqrt{t}$. (7,3,5)

## Section B

5. (a) Consider 2 lines $x_i = p_i + sa_i$ and $x_i = q_i + tb_i$

Prove that the condition of coplanarity of these 2 lines is given by .



$$\in_{ijk} (p_i - q_i) a_j b_k = 0 .$$

Assume that the lines intersect at a point.

(b) Using tensors prove that

$(a \times b) . (c \times d) = (a.c)(b.d) - (a.d)(b.c)$

(c) What are pseudo tensors? Give 2 examples of pseudo tensors. (5,7,3)

6. (a) Prove that strain is a symmetric tensor of order 2. Express it as a matrix. Discuss the physical significance of the diagonal elements of this matrix.

(b) Prove that $\in_{ijk} \in_{lmn} = \text{determinant} \begin{pmatrix} \delta_{il} & \delta_{im} & \delta_{in} \\ \delta_{jl} & \delta_{jm} & \delta_{jn} \\ \delta_{kl} & \delta_{km} & \delta_{kn} \end{pmatrix}$

and using the above result prove that $\in_{ijk} \in_{ijn} = 2\delta_{kn}$. (6,6,3)

7. (a) Given that $A_{p,q} = \frac{\partial A_p}{\partial x^q} - \begin{Bmatrix} s \\ p\ q \end{Bmatrix}$

Prove that $A_{p,q} - A_{q,p} = \frac{\partial A_p}{\partial x^q} - \frac{\partial A_q}{\partial x^p}$ where $\begin{Bmatrix} s \\ p\ q \end{Bmatrix}$ is the Christoffer symbol of the second kind.

(b) Evaluate $\begin{Bmatrix} 2 \\ 3\,3 \end{Bmatrix}$ for spherical polar coordinates with $x^1 = r,\ x^2 = \theta,\ x^3 = \varphi$.

(c) Show that $A^p B_p$ is invariant. (7,4,4)

[This question paper contains 6 printed pages.]



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

**Sr. No. of Question Paper : 5774** **H**

Unique Paper Code : 222502

Name of the Paper : PHHT-516 : Quantum Mechanics

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

Semester : V

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.
4. Use of non-programmable scientific calculator is allowed.
5. Symbols have their usual meaning.

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

   (a) What is the minimum uncertainty in the energy state of an atom if an electron remains in this state for $10^{-8}$ s?

   (b) Using the expression $[x, p_x] = i\hbar$, find $[x, L_y]$.

P.T.O.

(c) A proton is moving non-relativistically having kinetic energy 1 MeV. Find its de-Broglie wavelength.

(d) Determine whether the following wave functions are physically acceptable solutions of Schrodinger wave equation or not :

(i) $Ae^{x}$

(ii) $Ae^{-x}$

(iii) $Ae^{-x^2}$, $-\infty \leq x \leq \infty$

(e) Find the probability that a particle in a box L wide can be found between $x = 0$ and $x = L/2$ when it is in the first excited state.

(f) For hydrogen atom what are the possible values of $l$ and $m_l$ for $n = 2$?

(g) The azimuthal wave function for the hydrogen atom is

$$\Phi(\phi) = Ae^{i m_l \phi}, \quad 0 \leq \phi \leq 2\pi.$$

Find the normalization constant A.

(h) An electron in H-atom is in the 3p state. Which downward transitions (1s, 2s, 2p) are forbidden by the selection rules?

2. An x-ray photon of wavelength 0.05 nm strikes a free electron at rest and the scattered photon departs at 90° from the initial photon direction.



(a) Determine the momenta of the incident photon, the scattered photon and the scattered electron.

[Given: $\tan^{-1}(0.9542) = 43.66°$, $\sin(43.66°) = 0.69$] (2,4,6)

(b) Determine the Kinetic energy of the scattered electron. (3)

3. (a) Suppose an electron at rest absorbs the incident photon and moves with the speed v along the direction of incident photon. Using the laws of momentum and energy conservation, determine the value(s) of v. (6)

(b) The photoelectric threshold wavelength for a material is 5000 Å. Find

(i) the work function of this material

(ii) the maximum kinetic energy of the photoelectrons if light of 4000 Å strikes the surface of this material

(iii) the stopping potential for 4000 Å photons

(3,4,2)

4. (a) Determine the phase velocity and group velocity of the wave corresponding to a de Broglie wavelength of $\lambda, = h/p = h/mv$. (3,5)

(b) A free particle of mass m is described by a wave function

$\psi(x) = e^{ipx/\hbar}$; p is the momentum of the particle

prove that the probability current density is equal to the speed of this particle. (7)

5. (a) A particle of mass m moves inside an infinite potential well :

$$V = \begin{cases} 0, & 0 < x < L \\ \infty, & x < 0 \text{ and } x > L \end{cases}$$

Find the energy eigenvalues and the normalized wave functions of this particle. (10)

(b) Determine the average of squared-momentum, $< p^2 >$ of this particle, when it is in the ground state. (5)

6. (a) A particle of mass m is moving in a harmonic potential well,

$$V(x) = \frac{1}{2} m \omega^2 x^2, \quad -\infty \le x \le \infty.$$

If this particle is described by a wave function $\psi(x) = A x e^{-m\omega x^2/2\hbar}$, then find

(i). A

(ii) Energy of this particle in the given state. (4,6)



(b) Determine the probability of finding this harmonic oscillator in the classically forbidden region, if it is in the ground state. (5)

$$\left[ \text{Given: } \psi_0(x) = \left(\frac{\beta^2}{\pi}\right)^{1/4} \exp\left(\frac{-\beta^2 x^2}{2}\right), \quad -\infty \le x \le \infty, \quad \beta = \sqrt{\frac{m\omega}{\hbar}} \right.$$

$$\left. \text{and } \frac{2}{\sqrt{\pi}} \int_0^1 e^{-u^2} du = 0.843, \quad \frac{2}{\sqrt{\pi}} \int_1^\infty e^{-u^2} du = 0.157 \right]$$

7. (a) Prove that z-component of angular momentum operator is given by

$$\hat{L}_z = -i\hbar \frac{\partial}{\partial \phi} \qquad (6)$$

(b) An electron in hydrogen atom is in the state $\psi(\theta, \phi) = A \sin^2\theta \, e^{i2\phi}$, find

(i) A,

(ii) L, the magnitude of angular momentum

(iii) $L_z$, the magnitude of z-component of angular momentum

$$\left[ \text{Given: } \hat{L}^2 = -\hbar^2 \left( \frac{\partial^2}{\partial \theta^2} + \cot\theta \frac{\partial}{\partial \theta} + \text{cosec}^2\theta \frac{\partial^2}{\partial \phi^2} \right) \right]$$

(3,4,2)

8. A particle of mass w and energy E moves from a region of potential $V_0$ towards the region of zero potential, as shown below in Fig. (1).

(a) Explain why energy of this particle should be greater than $V_0$.

(b) Derive the expressions for the reflection and transmission co-efficients of this particle. (2,13)

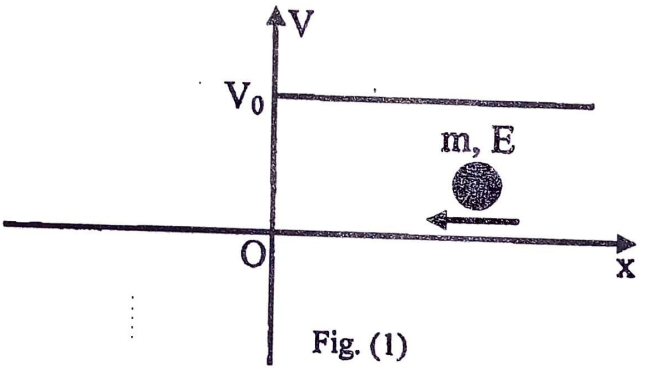



Fig. (1)

**Physical Constants:**

$h = 6.626 \times 10^{-34}$ J.s $= 4.136 \times 10^{-15}$ eV.s

1 eV $= 1.602 \times 10^{-19}$ J

$m_e = 9.1 \times 10^{-31}$ kg, $m_e c^2 = 0.511$ MeV, $m_p c^2 = 938.3$ MeV

$$\int_0^\infty x^n e^{-ax^m} dx = \frac{1}{m a^{\frac{n+1}{m}}} \Gamma\left(\frac{n+1}{m}\right)$$

(3)



[This question paper contains 4 printed pages.]

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

**Sr. No. of Question Paper : 5775** **H**

Unique Paper Code : 222503

Name of the Paper : Atomic & Molecular Physics (PHHT-517)

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

Semester : V

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 including Question No. **1** which is compulsory.
3. Constants are given at the end of the question paper.

1. Attempt any **five** questions :

   (a) Define Bragg's law of X-ray diffraction? What are soft and hard X-rays?

   (b) What is the importance of charge to mass ratio for any charged particle? Write the value of e/m for an electron.

P.T.O.

(c) What is pumping in a LASER? Name any two methods to achieve it.

(d) State and explain Larmor's theorem.

(e) Enumerate the differences between absorption and emission spectra?

(f) All diatomic molecules do not exhibit rotational spectra. Why?

(g) Why are the anti-Stokes lines fainter than Stokes lines in Raman spectrum?

(h) Why a two level laser cannot produce lasing actions? (5×3)

2. (a) Show that Moseley's law as consstant with Bohr's atomic model. (5)

(b) Differentiate between characteristic and continuous x-rays? Using an appropriate graph/diagram, indicate $\lambda_{min}$, $K_\alpha$ and $K_\beta$. (3+3)

(c) Calculate the wavelength of $K_\alpha$ line of Ni ($Z = 28$), given that screening constant =1 and $K_\alpha$ line of Mo ($Z = 42$) is 0.71Å. (4)

3. (a) Why is an inhomogeneous magnetic field needed in the Stem Gerlach experiment? Give an expression for transverse deflection experienced by the atoms. (2,3)



(b) What do you understand by space quantisation of angular momentum? (5)

(c) What is anomalous Zeeman effect? Illustrate with the help of a suitable example. (5)

4. (a) Show that the total magnetic moment of an orbital electron in a state with total angular momentum J is given by : $M_J = g^u B\ J|\hbar$

where $g = 1 + \frac{J(J+1)+S(S+1)-L(L+1)}{2J(J+1)}$ is the Lande g-factor and $\mu_B$ is Bohr magneton. (9)

(b) Explain the meaning of $^{2S+1}L_J$. Find S, L and J for $^2P_2$. State if it represents an admissible state or not with the reason ? (6)

5. (a) Couple a p-state and s-state electron using (i) Russell Saunder's (ii) j-j coupling scheme. (4+4)

(b) Explain the doublet fine structure of $D_1$ and $D_2$ lines using an energy level diagram? (7)

6. (a) In which part of the electromagnetic spectra, the emitted radiation lie for the rotational and vibrational spectra? (2)

(b) Derive the expression for rotational energy levels of a

diatomic spectra? What are characteristic features of rotational spectra? (5+4)

(c) Calculate the moment of Inertia of an HCl molecule about an axis passing through the centre of mass and perpendicular to the line joining two nuclei H and Cl and obtain the rotational energy levels of HC1 in eV (r = 1.3 Å) for J = 2. (4)

7. (a) What is Raman effect? Establish the expression for Raman shift on the basis of quantum theory? What are its applications? (2,3,1)

(b) What is the working principle of He-Ne laser. Using an energy level diagram. What is the importance of adding Ne to He to make a laser? (5,1)

(c) A Raman line for a sample is observed at 2612 Å corresponding to the exciting line at 2536 Å. Calculate the Raman shift in $cm^{-1}$. (3)

Constants :

$m_H = 1.6739 \times 10^{-27}$ kg

$h = 6.62 \times 10^{-34}$ Js

$m_e = 9.11 \times 10^{-31}$ kg

$e = 1.6 \times 10^{-19}$ C

$R_d = 1.09 \times 10^{7}$ $m^{-1}$

Rydberg Constant

[This question paper contains 4 printed pages.]

(4)



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

**Sr. No. of Question Paper : 5776** **H**

Unique Paper Code : 222504

Name of the Paper : PHHT-518 Electronic Devices

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

Semester : V

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 in all.
3. Question No. **1** is compulsory.
4. **All** questions carry equal marks.
5. Non-programmable calculators allowed.

($h = 6.63 \times 10^{-34}$ Js, $k_B = 1.38 \times 10^{-23}$ J/K, $q = 1.6 \times 10^{-19}$ C, $c = 3 \times 10^8$ m/s, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m)

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

   (i) Find the concentration of holes and electrons in p type silicon semiconductor at 300K having resistivity .02Ωcm, $\mu_p = 475$ $m^2/Vs$ and $n_i = 1.45 \times 10^{10} cm^{-2}$.

P.T.O.

(ii) Distinguish between the zener breakdown and avalanche breakdown.

(iii) Show that $I_C = \beta I_B + (1 + \beta) I_{CBO}$, where the symbols have their usual meaning.

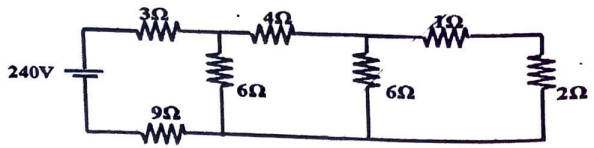
(iv) Explain the Barkhausen criterion for sustained oscillations.

(v) How many RC networks are required for a phase shift oscillator. Justify your answer.

(vi) For an npn transistor in CE configuration $V_{CC} = 10V$; $V_{BB} = 5V$; $R_B = 10K\Omega$; $R_C = 100\Omega$ and $\beta = 150$. Find the value of $V_{CB}$.

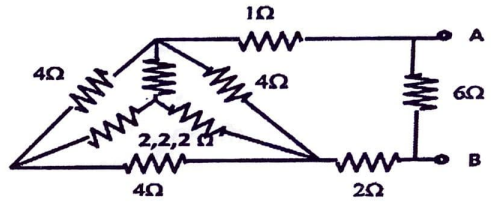
(vii) A UJT Relaxation oscillator has a source voltage $V_{BB} = 40V$, $R = 50K\Omega$ and $C = 2000$ pF. Find the time period of oscillation of the firing voltage of UJT is 15V. (3×5=15)

2. (i) Determine the total resistance between points A and B shown in the figure using T and Pi transformations.






(ii) Draw the circuit diagram of a centre-tapped full wave rectifier. Derive an expression for ripple factor and rectification efficiency.




3. (i) Define drift and diffusion current for a doped semiconductor.

(ii) Obtain the expression for pn diode current equation.

(iii) For an abrupt Si p-n junction diode with $N_a = 10^{19} cm^{-3}$ and $N_d = 10^{16} cm^{-3}$, calculate the depletion layer width and barrier potential at T = 300 K. (Take $\varepsilon_r = 12$). (4,7,4)

4. (i) Draw the hybrid model equivalent circuit of a common emitter amplifier. Derive expressions for voltage gain, current gain, for a CE amplifier in terms of h parameters.

(ii) List the factors that affect the bias stability of a transistor.

(iii) Explain how addition of emitter resistance increases

the stability for a self biased CE amplifier. (8,3,4)

5. (i) Give the circuit diagram of a two stage RC coupled amplifier. Discuss its equivalent circuits in mid and high frequency regions. Also derive the expressions for voltage gain for these regions.

(ii) An amplifier has a voltage gain of 100. The feedback ratio is 0.04. Calculate (i) the voltage gain with feedback (ii) the output voltage of the feedback amplifier for an input voltage of 40 mV. (10,5)

6. (i) Draw the circuit of a Hartley oscillator. Derive an expression for the frequency of oscillation and condition for sustained oscillation.

(ii) Explain the working of an astable multivibrator. (9,6)

7. (i) Show mathematically that the amplitude modulated wave consists of a carrier and two sidebands of constant amplitude. Draw the frequency spectrum of an AM wave.

(ii) Give the circuit diagram of a diode detector and explain its working. (8,7)

8. (i) Explain the construction and working of a JFET. What is pinch off voltage.

(ii) Draw the output and Transfer characteristics for JFET as common source configuration. (9,6)

**(500)**

(5)

01/12/17

Sl -No. 07 Q.P: 6108 ~~SET B~~

Name of the Course: ~~Erstwhile FYUP~~ B.SC (Hons) Physics

Semester: V-~~Semester~~

F-9

Name of the Paper: Quantum Mechanics and its Applications I

Unique Paper Code: 2221501

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.

1. *Attempt any **five** questions of the following* 3 x 5 = 15

(a) Give uncertainty relation between any three canonically conjugate pairs.

(b) Prove that

$$[x,p_y] = 0$$

$$[p_x,p_y] = 0$$

$$[y, p_y] = i\hbar$$

(c) Obtainthe time dependent solution of one-dimensional Schrodinger equation for a particle movingin a time independent potential.

(d) The position and momentum of 1-KeV electron are simultaneously determined. If the position is located within 1Å, what is the percentage of uncertainty in its momentum?

(e) Give three differences between a classical and a quantum mechanical harmonic oscillator.

(f) Find an expression for the most probable distance of an electronfrom the nucleus in the ground state for a hydrogen atom.

(g) Prove that $\boldsymbol{\sigma} \times \boldsymbol{\sigma} = 2i\,\boldsymbol{\sigma}$

(h) What do you understand by effective mass of an electron in a solid. How does it vary with wave vector **k**?

2. (a) Show that the probability current density in three dimensions is given by

$$\boldsymbol{J} = \frac{\hbar}{2im}(\Psi^*\nabla\Psi - \Psi\nabla\Psi^*)$$ 10

(b) Define the expectation values of position, momentum and energy of a free particle.

3. (a)Use Kronig-Penney model to obtain the energy spectrum ofan electron in one dimensional periodic lattice. Show how this model predicts the presence of forbidden bands in the energy spectrum of electrons in a lattice. 10

(b) Distinguish among insulator, semiconductor and conductor on the basis of band theory. 5

4. (a) Solve the Schrodinger equation for a particle moving in one dimensional square potential well of finite width. 10

(b) Obtain the solutions for the above problem graphically 5

5. (a) Solve Schrodinger equation for a linear simple harmonic oscillator to obtain its energy eigen values and eigen functions. 12

(b) Draw the first three wave functions. 3

6. (a) Obtain the Schrodinger equation for hydrogen atom in spherical polar co-ordinates and solve the radial wave equation. 10

(b) What is the expectation value of kinetic energy of an electron in hydrogen atom if its ground state wave function is

$\psi = \frac{1}{\sqrt{\pi}} \frac{e^{-r/a_o}}{{a_o}^{3/2}}$ 5

7. (a) Describe Stern-Gerlach experiment. Discuss the importance of the results obtained. 10

(b) Derive the expression for the magnetic interaction energy for an atom placed in an external magnetic field. 5

S. NO. of Question Paper : 6109

Unique Paper Code : 2221502

Name of the Paper : Electromagnetic Theory

Name of Course : ~~Erstwhile FYUP~~ B.Sc. (Hons) Physics

Semester : V



Duration: 3Hours

Maximum Marks: 75

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

1. **Answer the following questions (any five):** (5 x 3 = 15)

(a) Obtain the boundary condition for electric displacement field vector.

(b) Describe the meaning of plane polarized, circularly polarized and elliptically polarized light.

(c) Calculate the skin depth for a conductor at 1 GHz, given that $\sigma = 3.8 \times 10^7$ mho/m, $\mu = 2.57 \times 10^{-7}$ H/m.

(d) Briefly explain the concept of total internal reflection using Snell's law.

(e) What is Lorentz gauge? Explain its use.

(f) Write down the Maxwell's equation for linear isotropic dielectric medium.

(g) Write the constitutive relations that hold for time-varying fields in a linear, homogenous and isotropic medium ($\mu$, $\varepsilon$, $\sigma$).

2 (a) Show how Maxwell modified Ampere's law to make it consistent with the equation of continuity. Explain the significance of the term displacement current. 7

(b) Show that, for an electromagnetic plane wave, the two vectors $\vec{E}$ *and* $\vec{H}$ are in the same phase in a dielectric medium. 8

3 (a) Show that Maxwell's equation can be expressed as a pair of coupled second order partial differential equations in terms of scalar and vector potentials. Give comparison between Lorentz and Coulomb gauge conditions. 10

(b) Show that the expression for time averaged Poynting vector for time varying fields is given by: 5

$$< \vec{S}(\vec{r},t) > = \; Re\left\{\frac{1}{2}\vec{E}(\vec{r}) \times \vec{H}^{*}(\vec{r})\right\}$$

4. (a) Consider propagation of e m plane waves in a conducting medium and solve for the electric and magnetic fields. Show that for a good conductor the time averaged magnetic contribution dominates the time averaged electric contribution in the e m energy density. 12

(b) Show that the maximum phase difference between $\vec{E}$ *and* $\vec{H}$ vectors inside the conducting medium is $\pi/4$. 3

5 (a) Derive Fresnel's relations for reflection and transmission of e m wave's incident on an interface between two dielectric media, when incident wave has its $\vec{E}$ vector perpendicular to the plane of incidence. 10

(b) Find the expression for the Brewster's angle at which the reflected wave is completely extinguished. Why this angle is called polarizing angle? 5

6 Show that electric field dominates in the near field zone of an electric dipole. Determine the total power radiated. 15

7 Starting from Maxwell's equations, setup the wave equation for an inhomogeneous dielectric medium. Show that there exists only one symmetric TE mode for $0 < V < \pi$, in a step index planar dielectric waveguide, V being the dimensionless wave guide parameter. 15

Sl-No. of Q.P : 6110

| | | |
|---|---|---|
| Name of Course | : | B.Sc. (Hons.) Physics – ~~FYUP~~ |
| Scheme/Mode of Examinations | : | V – Semester |
| Name of the Paper | : | Physics of Devices and Instruments |
| Unique Paper Code | : | 2221503 |
| Duration | : | 3 Hours |
| Maximum Marks | : | 75 Marks |



**Instructions for candidates**

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

*All questions carry equal marks.*

Q1: Attempt any five of the following: (3X5 = 15)

a) What are active and passive transducers? Give one example of each.

b) Draw an equivalent circuit diagram of a UJT.

c) Draw the circuit diagram of an Astable multivibrator using transistors.

d) Determine the bandwidth and center frequency of a bandpass filter which has a lower and upper cutoff frequency of 445 Hz and 7800 Hz, respectively.

e) Draw the block diagram of a regulated power supply.

f) What do you understand by RTD?

g) Write three main differences between active and passive filters?

Q2. (a) Draw the schematic diagram of Enhancement and Depletion Mode MOSFETs and hence discus their characteristic curve. 8

(b) What is a charge coupled device. Discuss its working and application. 7

Q3. (a) Discuss with the help of block diagram the principle and working of Phase Locked Loop. 8

(b) What are IC regulators? What do you understand by Line and load regulation? 7

Q4. (a) Discuss the principle and working of LVDT with a labeled diagram. 7

(b) What is a position transducer? Discuss the working of strain gauge as a position transducer and write its applications. 8

Q5. (a) What is the basic principle of a gas filled detector? Explain the working of an ionization chamber. 8

(b) Briefly describe the working of a scintillation detector. 7

Q6. (a) What is frequency modulation? Explain ASK, PSK, FSK with proper signal diagram. 10

(b) Draw a properly labeled energy band diagram of a metal- semiconductor (n-type) junction in equilibrium. 5

Q7. (a) Draw and explain the block diagram of an electronic communication system. 5

(b) Explain amplitude modulation with appropriate signal diagrams. What is modulation Index? 7

(c) Discuss the working of an envelope detector. 3

(8) 15/12/17

[This question paper contains 2 printed pages]

Sl-No. 0909. 611 Roll No ...

| | | |
|---|---|---|
| Unique Paper Code | : | 2221504 |
| Name of the Paper | : | Computer Programming and Numerical Analysis |
| Name of the Course | : | B. Sc. (H) Physics Erstwhile FYUP |
| Semester | : | V |
| Duration | : | 3 hours |
| Max. Marks | : | 75 marks |



F-9

***Question No.1 is compulsory. Attempt any Two from each Section A & Two from B. Attempt Five questions in all.***

All questions carry equal marks

Non- programmable calculators allowed

1. Answer any ***five*** of the following
   (a) Determine the values of the following functions:
      a. abs(-24)
      b. ceil(89.54)
      c. tolower('A') Gauss
   (b) Explain pivoting in Guass elimination method and its importance
   (c) What is a preprocessor? Give three uses of it.
   (d) How is enumerated type date defined? Give two examples.
   (e) Show that Newton Raphson method has quadratic convergence
   (f) What are forward and backward differences in a difference table ? How are they related?

3×5 =15

## SECTION A

Differentiate

2. (a) Explain the difference between the C/C++ statements (i) break, and (ii) continue. Give two examples of each.
   (b) Write a program in C/C++ to find largest of three numbers.
   (c) What are arrays? Define two dimentional arrays by giving examples.

5×3 =15

3. (a) Bring out the difference between while and do while loops with the help of appropriate flowcharts.
   (b) Write a program in C/C++ to write the first 20 natural numbers using :
      (i) while / do- while and (ii) for loop
   (c) Write a program in C/C++ for the calculation of factorial of a number ?

[This question paper contains 2 printed pages]

5×3 =15

4. (a) ~~Describe~~ Illustrate Bisection method to solve an equation f(x) = 0 in the interval [a,b].

(b) Find the root of the equation by any method correct up to three decimal places

$$x^3 + 1.2x^2 - 4x - 4.8 = 0$$

(c) Use the method of iteration to solve the equation $x = e^{-x}$ $(take\ x_0 = 0)$

5×3 =15

## SECTION B

5. (a) ~~Describe~~ Demonstrate Guass Elimination method to solve three simultaneous equations in three unknown variables.

(b) Find the solution of differential equation : $\frac{dy}{dx} = -2xy^2$; $y(0) = 1$ with h = 0.2 on the interval [0, 1].

(c) Using Eulers method obtain the solution of the differential equation:

$\frac{dy}{dx} = x + y + xy$; $y(0) = 1\ at\ x = 1.0\ (h = 0.25)$

5×3 =15

6. (a) Deduce Newton Gregory Forward difference interpolation formula by the use of forward difference operator.

(b) Given the following table of values

| x | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| f(x) | -3 | 6 | 8 | 13 |

Evaluate f(6) by Newton's divided difference formula.

(c ) Derive second order Runge Kutta formula.

5×3 =15

7. (a) Find first and second derivative of f(x)at x = 1.5 from the following tabulated values:

| x | 1 | 1.5 | 2 | 2.5 | 3 |
|---|---|---|---|---|---|
| f(x) | 3.23 | 3.19 | 3.0 | 2.91 | 2.81 |

Compute the result upto two places of decimal

(b) Evaluate: $\int_1^2 \frac{e^x\,dx}{x}$ using trapezoidal rule for n = 4 correct to five decimal places

(c) Derive Simpson's 1/3 rule of integration .

5×3 =15

This question paper contains 3 printed pages]

(9)



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

S. No. of Question Paper : **6676**

Unique Paper Code : **32221501** **HC**

Name of the Paper : **Quantum Mechanics and Applications**

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

Semester : **V**

**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.

Non-programmable calculators are allowed.

1. Attempt any *five* of the following :

   (*a*) Give the expressions for Energy, Linear momentum and Angular momentum in operator form.

   (*b*) Calculate the commutator $[\widehat{L_x}, \widehat{p_x}]$. (given $[\hat{x}, \widehat{p_x}] = i\hbar$)

   (*c*) Explain uncertainty principle with an example.

P.T.O.

(*d*) Derive the relation between 'magnetic dipole moment' and 'orbital angular momentum' of an electron revolving around a nucleus.

(*e*) Write the quantum numbers for the state represented by $4^2F_{5/2}$.

(*f*) What are symmetric and antisymmetric wave functions ?

(*g*) What are free and bound states ? Explain. 5×3=15

2. Consider a particle trapped inside a one-dimensional finite square well. Solve the time independent Schrödinger equation for the system and obtain the bound state eigenfunctions. Discuss how the energy levels are obtained graphically ? 15

3. (*a*) Calculate the expectation value of the momentum for wavefunction.

$$\begin{cases} \sqrt{\frac{2}{a}}\sin\left(\frac{nx}{a}\right) & \text{for } 0 < |x| < a \\ 0 & \text{for } |x| > a \end{cases}$$

(*b*) Give the theory to explain spreading of a Gaussian wave packet for a free particle in one-dimension. 5,10



4. (*a*) Solve the Schrödinger equation for a Linear Harmonic Oscillator and hence obtain first three eigenfunctions.

(*b*) A particle of mass 1 mg is attached to a spring of spring constant 0.001 $Nm^{-1}$. Calculate its zero point energy. 10,5

5. The 'θ' equation obtained after applying separation for variables to the Schrödinger equation for a 3D hydrogen atom in spherical polar coordinates, is given by

$$\frac{1}{\sin\theta}\frac{d}{d\theta}\left(\sin\theta\frac{d\Theta}{d\theta}\right)+\left(\lambda-\frac{m_l^2}{\sin 2\theta}\right)\Theta = 0.$$

Solve the above equation for $m_l = 0$ (or otherwise) to show that :

$$\lambda = l\,(l+1),\ l = 0,1,2,.....$$ 15

6. (*a*) What is Larmor Precession ? Derive the expression for Larmor frequency.

(*b*) Explain Normal Zeeman Effect with examples and energy diagram. 8,7

7. (*a*) What is spin orbit coupling ? Calculate the change in the energy levels due to this.

(*b*) Show the result of a JJ coupling of two nonequivalent p-electrons. 10,5

(10)



[This question paper contains 4 printed pages]

**Your Roll No.** : .....

**Sl. No. of Q. Paper** : **6677** **HC**

Unique Paper Code : 32221502

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

Name of the Paper : Solid State Physics

Semester : V

***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. Question No. **1** is compulsory. **All** questions carry equal marks

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

5×3=15

(a) Prove that c/a ratio in hcp is $\sqrt{\frac{8}{3}}$.

(b) Sketch the dependence of polarization in dielectrics on the frequency of the applied electric field clearly indicating frequency ranges for the electronic, ionic, and dipolar polarization.

P.T.O.

(c) X-rays of wavelength 1.75 $\overset{0}{A}$ undergoes first order Bragg reflection from (111) plane at $30^0$. What is inter-atomic spacing of the crystal ?

(d) Draw B-H hysteresis curve of a ferromagnetic material on the basis of domain theory. What are hard and soft ferromagnetic materials ?

(e) What is the effect of temperature and doping concentration on mobility of semiconductors ?

(f) Write the expression for the plasma frequency in a material. What is the difference between plasma and plasmons ?

(g) What is the difference between Type-I and Type-II superconductors ? Give one example of each.

(h) Calculae the Debye cut-off frequency of Be whose Debye temperature is 1440 K.

**2.** (a) What is a Brillouin Zone ? Draw and explain first and second Brillouin zones of a square lattice. 10

(b) Calculate the geometrical structure factor of a bcc lattice. Name two planes which will be missing from the X-ray diffraction spectrum. 5





**3.** (a) Distinguish between crystalline and amorphous solids with one example, each. 3

(b) Show that in Einstein model of specific heat.

$$C_v = 3R\left(\frac{\theta_E}{T}\right)^2 e^{-\frac{\theta_E}{T}}$$

where symbols have their usual meanings. 12

**4.** (a) Obtain the dispersion relation in a one dimensional diatomic lattice. 7

(b) Derive an expression for specific heat of solids on the basis of Debye model. How does Debye model differ from Einstein model ? Discuss the variation of specific heat with temperature.

Obtain the values $W_+$ and $W_-$ in the limits

(i) $k \rightarrow 0$

(ii) $k \rightarrow \pi/2a$ where k is the wave vector and 'c' is the separation between two consecutive atoms. 8

**5.** (a) Derive an expression for diamagnetic susceptibility on the basis of classical langevin's theory. 9

(b) Distinguish between dia, para, ferro-and ferri-magnetic materials with examples. 6

**6.** (a) Obtain an expression for local electric field inside a dielectric with cubic symmetry. 10

(b) Derive Clausius-Mossotti formula constant. 5

**7.** (a) Discuss the Kronig – Penny model for a linear lattice. How does it lead to the formation of energy bands in solids ? Find the energy of electron with the change in the strength of the periodic potential under following cases : 9+3+3

(i) $V \to \infty$

(ii) $V \to 0$

**8.** (a) Derive London equations for a superconductor and obtain an expression for penetration depth. 12

(b) A superconducting tin has a critical temperature of 3.7 K in zero magnetic field and a critical field of 0.0306 tesla at 0K. Find the critical field at 2K. 3

[This question paper contains 4 printed pages.]

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

**Sr. No. of Question Paper : 8521** **HC**

Unique Paper Code : 32227505

Name of the Paper : Physics of Devices and Communication

Name of the Course : **Physics : DSE**

Semester : V



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. Question **1** is compulsory.
3. **All** questions carry equal marks.

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

   (a) What is the need for modulation? Differentiate between amplitude and frequency modulation.

   (b) How is cascading of an active filter used for band pass and band rejection?

P.T.O.

(c) What is a CMOS and where do we find its application?

(d) Describe block diagram for an Ideal power supply.

(e) What is the difference between dry etching and wet etching?

(f) How is voltage regulation achieved using an IC regulator?

(g) A JFET has a pinch-off voltage of 4V and saturation current of 10 mA. (a) Determine the value of drain current if Vgs = 2V (b) Find the value of gate to source voltage if $i_D = 7$ mA.

2. (a) Explain working of a Monostable multivibrator using transistors. (8)

(b) Discuss the short circuit protection in a power supply. Explain using a circuit diagram. (7)

3. (a) Define amplitude modulation and modulation index. Derive an equation for amplitude modulated wave and draw its frequency spectrum. Obtain bandwidth, total voltage and total power in amplitude modulated wave. (10)



(b) Determine the power content of carrier and each sideband for an amplitude modulated signal having percentage modulation of 80% and total power of 2500 W. (3)

(c) Explain Overmodulation. (2)

4. (a) Give pin out diagram and working of the 565 PLL IC. (7)

(b) Determine the free running frequency ($f_{out}$), the lock range ($f_L$) and the capture range ($f_C$) when $R_1 = 12k'\Omega$, $C_1 = 0.01$ µF and $C_2 = 10$ µF applied to a 565 PLL. (3)

(c) Analyse circuit of a passive RC low pass and high pass filter giving its frequency response. (5)

5. (a) Discuss with a flow diagram the process of IC fabrication. (6)

(b) Explain the technique of oxidation for IC fabrication. (5)

(c) What is lithography? Which is better photolithography or electron-lithography and why? (4)

6. (a) Explain with help of a band diagram, depletion, inversion and accumulation for a MOS diode. (6)

(b) With the help of schematic diagram, explain the working principle of Charged coupled devices. (6)

(c) Give the drain and transfer characteristics of JFET. (3)

7. (a) Explain various lines and signals used in RS232 for serial communication. What do you understand by handshaking of RS232 in digital data communication? (10)

(b) What is the advantage of using parallel communication over serial communication? (5)