Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Empowered Autonomous).

Department of Physics

Date: 18/03/2025

Internal Examination Notice

The students of M.Sc. I and II are hereby informed that the internal examination of current semester is heduled as per following time table:

No.	Class and Sem	Paper Code.	Title of the paper	Date and time
1.	M.Sc. I, SEM II	DSC12PHY21	Quantum Mechanics	27/03/2025 12:00 to 01:00 pm
2.	M.Sc. I, SEM II	DSC12PHY22	Condensed Matter Physics	28/03/2025 12:00 to 01:00 pm
3.	M.Sc. I, SEM II	DSE12PHY21	Solid State Physics-II (Semiconductor Physics)	29/03/2025 12:00 to 01:00 pm
4.	M.Sc. II, SEM IV	DSC12PHY41	Electrodynamics	27/03/2025 12:00 to 01:00 pm
5.	M.Sc. II, SEM IV	DSC12PHY42	Nuclear and Particle Physics	28/03/2025 12:00 to 01:00 pm
6.	M.Sc. II, SEM IV	DSE12PHY41	Physical Properties of Solids	29/03/2025 12:00 to 01:00 pm

Nature of question paper

- **For M.Sc. I and II**

Total Marks (for each paper) = 20

Q: 1) Select correct alternative (02 marks)

Q: 2) Short answer question (any **ONE** out of two) (12 marks)

Q: 3) Short answer question (any **ONE** out of two) (06 marks)

(M.Sc. Co-ordinator)

HOD

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Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

M.Sc. Part-I SEM II Internal Examination (2024-25)

Quantum Mechanics-II

Paper code: DSC12PHY21

Date: - 27/03/2025 Time: - 12:00 – 01:00 pm

Day: - Thursday Total Marks: 20

Instructions: -

1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q.1 Select Correct Alternative: [02]

1. Hilbert's space is ..... dimensional space.

a) infinite b) finite c) constant d) zero

2. The differential cross-section for a scattering by a target is given by $\frac{d\sigma}{d\Omega} = a^2 + b^2 \cos^2\theta$.

If N is the flux of incoming particle, then the number of particles per unit time is σ_{total} = ...

a) $\frac{4\pi}{3} N (a^2 + b^2)$ b) $4\pi N (a^2 + \frac{b^2}{6})$ c) $4\pi N (\frac{a^2}{2} + \frac{b^2}{3})$ d) $4\pi N (\frac{a^2}{1} + \frac{b^2}{3})$

Q.2 Attempt any one [12]

1. What is physical significance of operators in quantum mechanics. Explain the types of operators in detail.
2. Derive the expression of Born approximation, and discuss the validity conditions for Born approximation. Also derive the Scattering by screened Coulomb Potential.?

Q.3 Attempt any one [06]

1) Define eigenvalues and eigenfunctions and summarize the properties of eigenvalues and eigenfunctions.
2) (i) Consider a particle of mass 'm' moving in a potential $V_{(x)} = A | x |$. Estimate the energy of n^{th} state?

(ii) Estimate the energy level of a particle moving in a potential $V_{(x)} = \{\infty \rightarrow x < 0$ and $\frac{x}{a} \rightarrow x > 0$.

In the W.K.B. approximation is?

NAME- SUDARSHAN NIVAS KHUTALE. DATE- 27/03/2023

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13/20

PAPER NAME - Quantum mechanics.

प्र. क्र. Q. No.

(Q-1)

(i) Hilbert's space is infinite dimentional space.

(ii) The differential cross-section for a scattering by a target is given by $\frac{d\sigma}{d\Omega} = a^2 + b^2 \cdot \cos\theta$

If N is the flux of incoming particles then the number of particles per unit time is $\sigma_{total} =$

$$\frac{4\pi}{3} N(a^2+b^2)$$

01

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02	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

Q.2)

(1)

→ Physical significance of operator :-

If due to the certain kinds of uncertainty are given the. if ~~two~~ produce resultant function that. function is operations of operators in which operator.

If determine the two state vectors in the operators.

we will expressed the mathematical operations, multiplication, division, addition, substitution, integration & division, differentiation are kinds of operator.

Types of operator :-

1. Linear operator
2. Hermitial operator
3. Adjoint Hermitial operator.
4. Parity operator
5. Projection operator.

प्र. क्र.
Q. No.

⑥ Identity operator
⑦ inverse operator
⑧ Unitary operator.

(1) Linear operator :

If the linear operator is which is rate by different vectors. are their and function is due to certain operator are their.

$$\hat{A} \cdot f(x) = G(x)$$

Then the linear operator is in differential form :-

$$\hat{A} \cdot f(x) = \frac{d}{dx} \cdot \hat{S}(x).$$

(2) Hermitial operator :-

The Hermitial operator is which operator is changed in inner or scalar vector by function it is called as Hermitial operator.

Section	Q. No.												
	Marks												

Then the $F(x)$ and $G(x)$ are the two types of vector.

$$\hat{A} \cdot f(x) = G(x)$$

$$\hat{A}|\psi\rangle = \int_a^b \psi^* \cdot f(x)\, \hat{A} \cdot G(x) = \int \rho^* \hat{A} \cdot f(x) \cdot G(x)$$

(3) Adjoint Hermitial operator :-

The Adjoint Hermitial operator is self adjoint to itself it is called as Adjoint Hermitial operator

$$\langle \phi | \hat{A} \cdot | \psi \rangle = \langle A \cdot \phi | \psi \rangle$$

(4) Parity operator :-

The operator is as vector when which is parity is changed it is called as parity operator.

$$\hat{P} \cdot f(x) = f(x).$$

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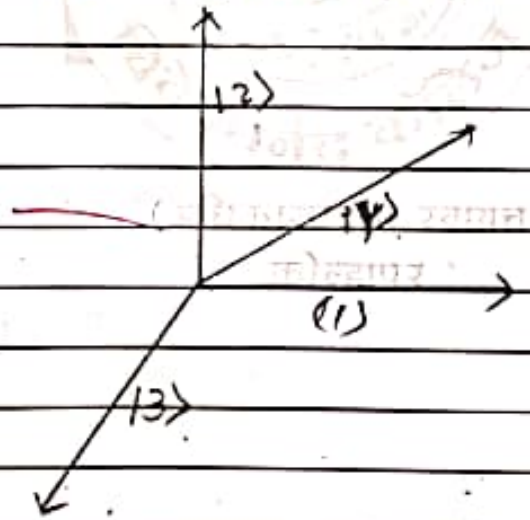
क्र. No.

(5) Projection operator :-

The operator which is the value is orthogonal it is called as projection operator.



$P_i = \langle \psi_i | \psi_i \rangle$

There fore the ϕ is align with the ψ_i

क्र. No.

(6) Identity operator :-

The operator which is the same vector are space unchanged it is called as Identity operator.

$$\hat{A}|\psi\rangle = \int_a^b \psi^*(x)\,\hat{A}\,\phi = \int_a^b \hat{A}\,\langle\psi|\phi\rangle .$$

(7) Inverse operator :-

The operator which is the reverse action of linear operator it is called as inverse operator.

$$\therefore \hat{A}|\psi\rangle = \int \hat{A}\cdot A^{-1}\, dx .$$

(8) unitary operator :-

The operator which is the adjoint or inverse operator is called as unitary operator.

$$\therefore \psi^{\dagger} = \psi^{-1}$$

$$\text{so } U^{\dagger} = U^{-1}$$

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

Q.3)

⇒

Eigen value :-

When operator is operates on function ~~the~~ then function is continous function which is nothing but the eigen function but its continue modified value is called as eigen value.

eigen are real or imaginary vectors.

So there are ;

$$\hat{A} \cdot f(x) = a\, f(x)$$

OR

$$\hat{A} \cdot \psi(x) = a \cdot \psi(x)$$

Then the 'a' is eigen value of operator.

Properties :-

When an operator is in the invers the eigen value is invers eigen value as well as.

Section | Q. No. | Marks

प्र. क्र. / Q. No.

i.e.

$$A^{-1} = \lambda^{-1}$$

When the expectation 'n' number of operator is ;

$$A^{n} \psi(x) = a^{n} \psi(x)$$

When the operator is symmetric then the eigen value are real.

When the operator is invertable matrix then the eigen value are invertible.

eigen function :-

When operator operates on the function then the function is defined as the another function is called as eigen function.

$$\hat{A} \cdot f(x) = a f(x)$$

OR

$$\hat{A} \cdot \psi(x) = a \psi(x)$$

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प्र. क्र.
Q. No.

Properties :-

simultaneous eigen function :-

The function which is the continous and the operator is in acts as simultaneously it is called as simultaneous eigen function.

$\hat{A}.\hat{B}\psi(x) = \hat{A}.(b_n \psi_n) = b_n(\hat{A}.\psi_n) = \psi_n$ & b_n

ψ_n are simultaneous eigen function.

orthogonal eigen function :-.

The function which is orthogonal then.

$\langle \psi_n | \psi_m \rangle = 0 = \delta_{nm} = 0.$

No.												
Marks												

Orthonormal Eigen Function :-

The function is orthonormal then the value is ;

$$\langle \psi_n | \psi_m \rangle = \delta = \delta_{nm} = 1$$

06

Shubham Rajaram Rashivade quantum mechanics

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Centre	V.C.K

18/20

02/05/25

प्र. क्र.
Q. No.

Q.1)

1) Hilbert's space is infinite dimensional space

2) $\frac{4\pi}{3} \cdot N(a^2+b^2)$ ✗

2

ESTD JUNE 1964

02 Section | Q. No. | Marks

प्र. क्र.
Q. No.

Q2)

A operator acts on a operator to obtain the mathematical function. the physical significance of operator is it can gives values like real and imaginary, operator is a function which is used to obtain a mathematical expression of wave form. using it we can obtain mathematical expression like differentiation, multiplication, subtraction, addition.

i.e $\hat{A} f(\psi) = a f(\psi)$

There are number of operators

→ 1) linear operator
2) Hermition operator and adJoint Hermition operator
3) Inverse operator
4) projection operator
5) parity operator
6) Identity operator
7) Unitary operator.

Q. No.													03
Marks													

Linear operator:

Linear operator is used to obtain the function of an operator. a operator acts on a function to obtain new function which is eigen values and eigen vectors.

i.e

$$\hat{A} f(x) = \hat{a}\, g(x)$$

in this a new function is obtained.

if function is in a orbital operator then,

$$\int_a^b f_1^*(x)\cdot dx \int_a^b \hat{a}_2\, g(x)\cdot dx$$

∴ if sum and differentiation of eigen vector can be written as

$$\hat{A} \pm \hat{B} = \hat{B} \pm \hat{A}$$

04 Section | Q. No. | Marks

प्र. क्र.
Q. No.

if a function is in a inverse form

$$\hat{A} \pm \hat{B} = \hat{B} \pm \hat{A}$$

if operator has symmetric eigen ~~values~~ function then the values are real values.

if $\hat{A}$ and $\hat{B}$ ~~f~~ eigen vector are in orthogonal the value of operator is 1

∴

i.e

$$f(\psi_1)\frac{mn}{nm} = \delta \cdot nm = 1$$

if $\hat{A}$ and $\hat{B}$ eigner vector are in ortho ~~gonal~~ normal then the values of two eiger vector are 0

i.e

$$f(\psi_1)nm = \delta nm = 0$$

Hermition operator.

n operator which act s on a inner product and gives scalar quantities or is called Hermition operator.
it gives different values of function.
the values obtained by the operator are real values. which are compler values.

i.e $\hat{A} f(x) = g(x)$

if ~~eigen~~ eigen vector are in orbital form

$$\int_a^b \psi_1^* a_1 f_1 \, dx \int_a^b \psi_2^* a_2 f_2 \, dx$$

a a

Section | Q. No.

Q. No.												
Marks												

Adjoint Hermition operator:

$\phi \hat{A}(\psi) = \phi \hat{A} \phi^{*}(\psi)$

the values the resultant vector is linear and adjoint it gives values of different function.

Inverse operator:

Inverse operator gives inverse values of an operator.

i.e if $\hat{A}$ operators acts on it's function then the resultant vector will be

$\hat{A}(\psi_2) = a(\psi_1)$

if it has $\hat{B}$ operator.

$\hat{B}(\psi_2) = a(\psi_1)$

Section | Q. No. | Marks | 03

क्र. No.

projection operator.

Projection operator is a operator which is hermitian and the value of it's gives are ~~one~~ an its own square of function

$$\hat{P} = \hat{P}$$

it gives same resutant values of it's own square

suppose

$$\hat{P} = \begin{vmatrix} 0 & 1 \\ 1 & 0 \end{vmatrix} \quad \rightarrow (1)$$

$$P = \begin{vmatrix} 0 & 1 \\ 1 & 0 \end{vmatrix} \quad \rightarrow (2)$$

multiplication of these two gives same values.

$$\hat{P} = \hat{P}.$$

Section | Q. No. | Marks

प्र. क्र.
Q. No.

parity operator - π

parity operator gives non-indentical values of a operator

i.e

$$\hat{\Lambda} f(\psi) = \pi |\psi$$

Identity operator.

Identity operator gives Indentical values of a function

$$\hat{I}(\psi) =$$

$$\psi(\hat{I}) = I = (\hat{I})\psi$$

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प्र. क्र.
Q. No.

Unitary operator:

Unitary operator gives it's identical values of it's adjoint and the resultant vector are adjoint and symmetrical to eachother

$$\hat{U}\cdot\bar{U} = \hat{U}\cdot U^{-1}$$

$$\hat{U}+\bar{U} = \hat{U}+U$$

12

Eigen values:

Eigen values given function of an operator. then the function is continuous function

eigen values are real and imaginary values

$$\hat{A} f(x) = a f(x)$$

$$\hat{A} \psi(x) = a \cdot \psi(x)$$

then the $\hat{A}$ is a eigen value of an operator

properties.

1) When the operator is invers the obtained eigen values are inverse eigen values.

i.e $A^{-1} = a^{-1}$

2) when the expectation 'n' of operator is

$$A^n \psi(x) = a^n \psi(x)$$

3) When operator is symmetric the eigen values are real

4) when operator is invertible matrix then the values obtained from it also are invertible values.

Eigen function

~~when operator~~ operates on a function then the function is called as an eigen ~~funt~~ function

$$\hat{A} f(x) = a f(x)$$

$$\therefore \hat{A} \psi(x) = a \cdot \psi(x)$$

04	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

if operator has an orthogonal 1 value δ

$$\langle\psi\rangle \langle\psi_n|\psi_m\rangle = \delta nm = 1$$

if operator has orthogonal values which is '0' then the function $\hat{A}$ and $\hat{B}$ are

~~$\langle\psi\rangle$~~

$$\langle\psi\rangle \langle\psi_n|\psi_m\rangle = \delta m\, \delta nm = 0$$

05

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Department of Physics

M.Sc. Part-I SEM II Internal Examination (2024-25)

Quantum Mechanics-II

Paper code: DSC12PHY21

Date: - 27/03/2025 Time: - 12:00 – 01:00 pm

Day: - Thursday Total Marks: 20

Attendance Sheet

Sr. No.	Name of the students	Roll Number	Sign
1)	Sudarshan Nivas Khutale	1310	
2)	Shubham Rajaram Rashivade	1318	
3)	Aniket Rajendra Powar	1317	
4)	Shrutika Sambhaji Khot	1309	
5)	Yash Mogar Lalgare	1313	
6)	Vishal Bhimrao Ghuttage	1304	
7)	Pooja Jaydip Gadkari	1302	
8)	Rutuja Sukumar Ghatte	1305	
9)	Supriya Raju Ville.	1322	
10)	Mohammad Jaid Zakirhussen Pattekari	1315	
11)	Kureshi Aftab Amir	1312	
12)	Prajkta Dattatray Desai	1301	

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Vivekanand College, Kolhapur (Empowered Autonomous)

M.Sc. Part- I (Sem-II) Internal Examination: 2025

Course Code: DSE12PHY22

Condensed Matter Physics

Day: Friday
Date: 28-03-2025

Time: 12.00 PM – 01.00 PM
Marks: 20

Instructions:

1) All the questions are compulsory.
2) Figures to the right indicate full marks.
3) Draw neat labelled diagrams wherever necessary.
4) Use of log table/calculator is allowed.

Q. 1) Select the correct alternative **(02 marks)**

1. The actual arrangement of the atom is described by the_____ .

a. Crystal structure
b. Solid structure
c. Shell structure
d. composite structure

2. All the atoms in perfect crystal are at specific.....

a. Atomic site
b. Ionic site
c. Crystal site
d. vacant -atomic site

Q. 2) Short answer question (any One out of two) **(12 marks)**

1. Define Brillouin zone for a lattice by considering simple cubic structure. How would you construct the first Brillouin zone for a fcc and bcc lattice.

2. Derive Bragg's law and explain its importance in X-ray diffraction. And , compare the X-ray, electron, and neutron diffraction methods.

Q. 3) Short answer question (any One out of two) **(6 marks)**

1. Explain the concept of reciprocal lattice.

2. Show that the atomic packing factor for fcc and hcp metals are the same.

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NAME- Sudarshan Nivas Khutale Date :- 28/03/202

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Centre	Y.C.K.

18/20

Subject - Condensed matter Physics.

प्र. क्र. Q. No.

(Q.1)

(1) The actual arrangement of the atom is described by the crystal structure. 1

(2) X All the atoms in perfect crystal are at specific Ionic site. 1/2

02 Section | Q. No. 02 | Marks 12

प्र. क्र. Q. No.

(Q.2)

(2)

⇒ Statement of Bragg's law :-

The Bragg's law which is concept associated as crystalline material to the symmetric translation on which is the Atomic Planes.

The Bragg's law in eqn,

$$n\lambda = 2d \sin\theta.$$

where,

'n' is the number of integers called as order of reflection. (usually $n = 1$)

'λ' is the wavelength of incident wave

'd' is the distance in between crystal of arrangement of atoms.

Q. No.													
Marks													03

'θ' is the angle of. diffr-
ction x-rays on crystal planes.

Explaination of Bragg's law :-

The Bragg's law is. Explained with the crystals of. constructive interference., x-ray diffraction and crystal or Atomic structure.

(1) Crystal structure or Atomic structure :-

The crystals are made up of the regularly spacing layer or planes in atoms it is. called as crystal structure or. Atomic structure.

X-Ray diffraction :-

The x-ray diffra-
ction is crystals of the rays. incident. The. scattered of atoms. or molecules in atomic planes.

This theory was say the light falls on the any incident beam or ato electrons. and photons are throw in incident

Q. No.												
Marks												

material, then the atoms or molecule as scattered the light or electeons are flow in any another direction.

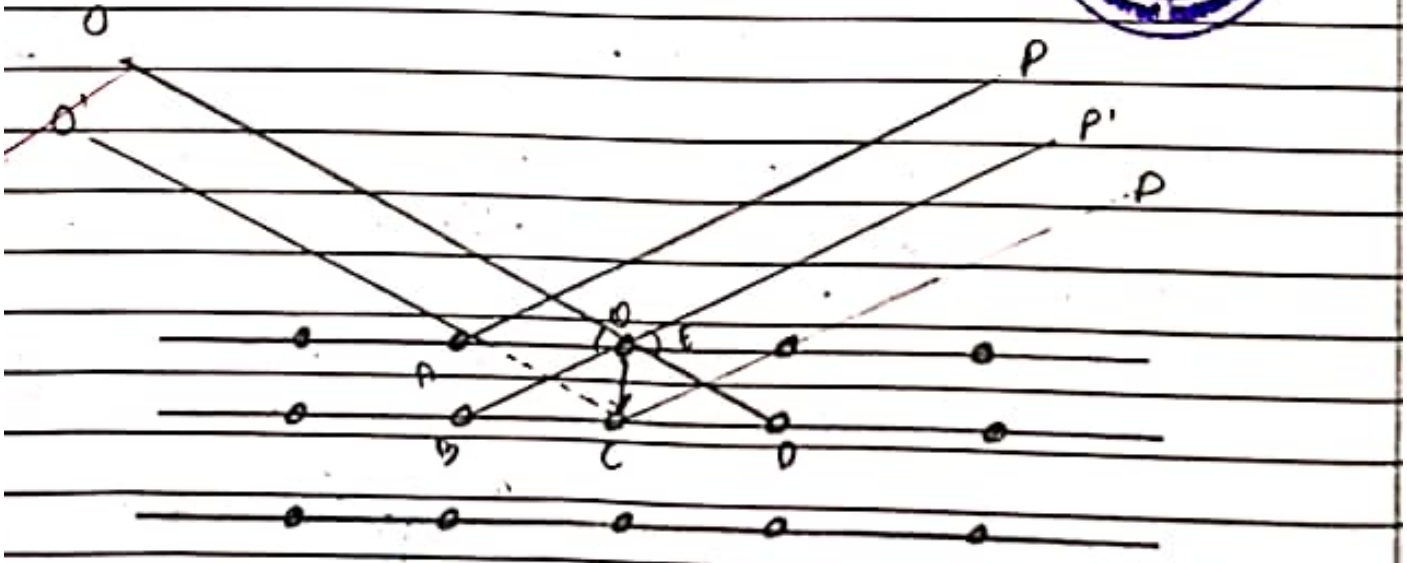
Constructive interference :-

The crystal are constructive interference. then the Bragg's law of eqn. is,

$$\Delta = n\lambda$$

Then the angle of constructive interference is, will get the Bragg's law is,

$$n\lambda = 2d \sin\theta.$$



Bragg' law (construction)

Name: Sudarshan Nivas Khutale.

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Q. No.

The Diffraction Angle of Bragg's law :-

In the Bragg's law the diffraction Angle of (θ) is constructive interference. The the wavelength of (λ) is in the crystal planes.

For example :-

diffraction X-ray = 0.1 nm

Integral spacing = 0.2 nm (d)

∴ We can use the Bragg's law,

$n\lambda = 2d\sin\theta$.

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ction	Q. No.												
	Marks												

क्र. No.

When usual $n=1$

Then,

$$0.1 = 2 \times 0.2 \times \sin\theta$$

$$\sin\theta = \frac{0.1}{0.4} \times \sin\theta. = (0.25)$$

$$\theta = \sin^{-1}(0.25) \simeq 14.5^\circ.$$

Then the Bragg's law are explained in this example.

complair the x-ray, electron and neutron diffraction :-

Q. No.	features	x-ray diffn. (XRD)	electrons diffraction (ed)	neutrons diffraction. (ND)
(1)	Interaction machanism used	x-rays	electron	neutron.

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

Interaction mechanism	Scattered by electrons	Scattered by electrostatic potential	Scattered by Atomic & nuclei.
Penitration Depth.	moderate.	very low	very High.
sample testing	micron to micrometer	Nanometer	millimeter to centimeter.
magnitud scales.	NO	NO	yes.

4 Section | Q. No. Q3 | Marks 05

प्र. क्र. Q. No.

(Q.3)

(1)

⇒

reciprocal lattice :-

(1) The reciprocal lattice which associate with the. emerges from the. Fourier. lattices

(2) The. reciprocal lattice is arrange ment of. atoms.

(3) The reciprocal lattice is direct or real lattice.

(4) The reciprocal lattice is sub lattice. on. dual to the direct lattice.

(5) In a mathe matical expression the reciprocal lattice is the co-varient or cotra varient vectors.

Name: sudarshan Nivas Khutale.

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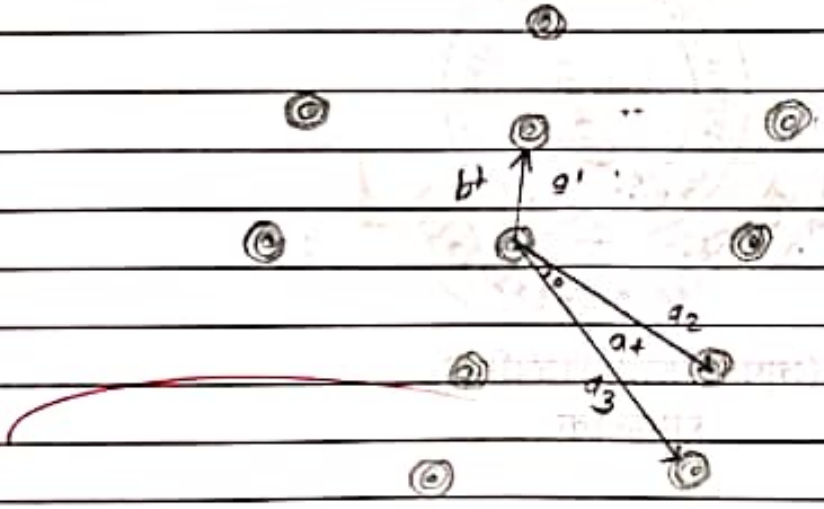

Reciprocal Lattice.

In the Geometric representation the Reciprocal Lattice is Infinite

2 Section | Q. No. 03 | Marks 05

प्र. क्र.
Q. No.

The reciprocal lattice associate with the vectors :-

(1) FCC - Face centre cubic :-

The atoms are present in each face of cube.

$$a_1 = \frac{2\pi}{a} = (\hat{i} + \hat{j})$$

$$a_2 = \frac{2\pi}{a} = (\hat{j} + \hat{k})$$

$$a_3 = \frac{2\pi}{a} = (\hat{k} + \hat{i})$$

(2) BCC - Body centre cubic :-

The atoms are present in centre of Body cubes.

$$b_1 = \frac{a}{2} = (\hat{i} + \hat{j})$$

$$b_2 = \frac{a}{2} = (\hat{j} + \hat{k})$$

05

Section

Q. No.

Marks

03

$$b_3 = \frac{a}{2}(R + \hat{n})$$

Shrutika Sambhaji Khot (28/03/2025)

17/20

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प्र. क्र. Q. No.
Q1

1. The actual arrangement of the atom is described by the crystal structure

2. All the atom in perfect crystal are at Specific Crystal Site.

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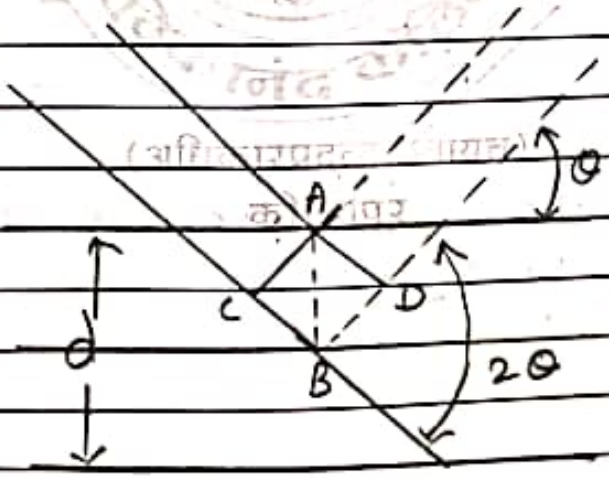
Q. No.												
Marks												

1 Braggs law :-

A set of parallel plases which are also called as braggs plases which are adjacent to each other.

$$n\lambda = 2d \sin\theta$$



where as the

d - is the distance between the plans
λ - wavelength.
θ - the glancing angle.

where as.
let the distance between to adjacent planes is AB.

where as,

$$CB + BD = 2d \sin\theta + d \sin\theta$$

then we can write

$$\therefore n\lambda = 2d \sin\theta.$$

Importance of X ray diffraction

Determination of crystal :-
Structure of Braggs law helps arrangement of atom within crystal the determination of crystal the structure of braggs law is helping in arrangement.

Material Identification :- Different material produces identical diffraction position adding in phase identification. To material Identification the different material which are produces identical are also known as Identical diffraction.

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

3) Phase Identification :- In the identificat of phase interplanner spacing lattice is constructed

4) Quality Central :-

In Quality Central X Ray diffraction is widely used in material solution for testing the condition of purity of deflect.

In the Quality Central X-Ray diffraction is also widely used in material solution to test the condition of material is pure or the purity of is used to detect the x-Ray diffraction in it.

Shrutika Sambhaji Khot

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क्र.. No.

Comparing the X-ray electron and neutron diffraction method.

	Properties	X-Ray	Electron	Neutron
1	Radiation element	XRD	Electronic element	Neutral element
2	Need of Vaccum	No	Yes	No
3	Sensitity of material	Heavy	~~Weak~~ light	~~Weak~~ light
4	Depth	Moderate		
5	Magnetic sensitity	Strong	Weak	Weak

प्र. क्र.
Q. No.

Q3

1 The Concept of Reciprocal b lattice.

→ The Reciprocal lattice is a fundamental concept of crystallography and Solid State physics that represent the periodicity of crystal in Momentum space rather than real space.

Given,

a crystal lattice with real-space lattice vectors a_1, a_2, a_3 it is a lattice reciprocal vector b_1, b_2, b_3 are defined such that

$$a_j b_j = 2\pi \delta_{ij}$$

where,

δ_{ij} is the vector kroneket delta.

The condition ensures that the reciprocal lattice is properly aligned with symmetry of the direct lattice

प्र. क्र.
Q. No.

Construction of Reciprocal lattice.

the reciprocal lattice basic Vector are given by,

$$b_1 = \frac{2\pi (a_2 \times a_3)}{a_1 (a_2 \times a_3}$$

$$b_2 = \frac{2\pi (b a_3 \times b a_1)}{a_1 (a_2 \times b a_3}$$

$$b_3 = \frac{2\pi (a_2 \times b a_3)}{a_1 (a_2 \times a_3)}$$

these equation ensure that reciprocal lattice capture the periodicity of the wave vector.

Physical significance

1) X ray and electron diffraction
2) Band structure in Solids
3) Brillouin zone

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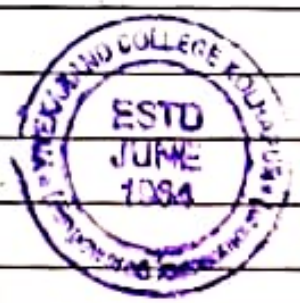
this reciprocal of simple cube structure is also known as simple cubic lattice.



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Department of Physics

M.Sc. Part-I SEM II Internal Examination (2024-25)

Condensed Matter Physics

Paper code: DSC12PHY22

Date: - 28/03/2025 Time: - 12:00 – 01:00 pm

Day: - Friday Total Marks: 20

Attendance Sheet

Sr. No.	Name of the students	Roll Number	Sign
1)	Sudarshan Vivas Khutale.	1310	Khutale.
2)	Shubham Rajaram Rashivade	1318	
3)	Shrutika Sambhaji Khot	1309	
4)	Aniket Rajendra Powar	1317	
5]	Prajkta Dattatray Desai.	1301	
6)	Vishal Bhimrao Ghatage	1304	
7)	Yash Mogar Langare	1313	
8)	Rutuja Sukumar Ghatte	1305	
9)	Supriya Raju olle.	1322	
10]	Pooja Jaydip Gadkari	1302	
11)	Kureshi Aftab Amir	1312	
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M.Sc. Part- I (Sem-II) Internal Examination: 2025
Course Code: DSE12PHY21
SOLID STATE PHYSICS II
(Semiconductor Physics)

Day: Saturday
Date: 29/03/2025

Time: 12-1 pm
Marks: 20

Instructions:

5) All the questions are compulsory.
6) Figures to the right indicate full marks.
7) Draw neat labeled diagrams wherever necessary.
8) Use of log table/calculator is allowed.

Q. 1) Select the correct alternative. **(02 marks)**

3. Solar cell works on the principle of _____.

a. Thomson effect
b. Photovoltaic effect
c. Seebeck effect
d. None of the above

4. In photoconductor when light absorb by semiconductor the number of free electron and holes _____, then electrical conductivity is _____.

a. Decreases, Increases
b. Increases, Decreases
c. Increases, Increases
d. None of the above

Q. 2) Short answer question (any one out of two). **(12 marks)**

5. What is meant by LED? Explain their types.
6. Discuss the principle, construction, and working of a photodetector.

Q. 3) Short answer question (any one out of two). **(6 marks)**

7. Explain the principle, construction, and working of a solar cell.
8. Write a note on Photonic devices.

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ub-solid state physics-II, Name - Rutuja Sukumar Ghatte. (16/20)

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Centre	YCK.

प्र. क्र. Q. No.	
Q.1	1 Solar cell works on the principle of b) Photovoltaic effect
	2 In photoconducter when light absorbed by semiconductor the number of free electrons and holes ⓒ increases then electrical conductivity is increases

2///

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02 Section | Q. No. 07 | Marks 10

प्र. क्र.
Q. No.

2 1 What is mean by LED

- The LED is an semiconductor device that emit light when an electric current passes through it
- It is used in many application including mobile phones, bill boards, traffic lights

How it works?
- When an electric current passed through an LED, electrons recombine with holes and releasing energy in the form of light.
- The colour of the light depend upon energy required for electron to cross the band gap of the semiconductor

- LEDs are more comfortable than indicondencent lamps
- LEDs are used in mobilephone, billboards, traffic light.
- LEDs are more durable

Types of LED
1) Visible LEDs
2) Infrared LEDs
3) organic LEDs

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

1) Visible LEDs

Q2 1

It is a semiconductor device that emit light in visible spectrum when electron recombine with holes which can emitting energy in the form of light.

- It has more efficiency, it produce more light in less power.

How it works

- When an electric current passed through an P-n junction, the electron & holes get recombined & releasing energy in the form of light
- It is semiconductor device that have wavelength which visible to human eye known as visible spectrum.
- The colour of LED depends on the # semi conductor material which is used in semi-conductor device.

Applications

Visible LEDs are used in light, biomaterials, & medical devices & electronic devices.

Section	Q. No.												
	Marks												

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⇒ Organic LEDS

It is a semiconductor device in which organic compounds are used to emit light when electric current passed through it

How it works

- When the electric current is passed through the semiconductor device, the electron & holes are injected in organic compound recombine & release the energy into light energy the organic compound are used in devices are polymers

Advantages

Thin & flexible

OLEDS are thin & flexible

Varient ~~Current~~ colour contrasts

- It has varient colour & colour contrast to see the picture properly

Self emitting

- In this LEDs are self emitting meaning each pixel acts on & off independently

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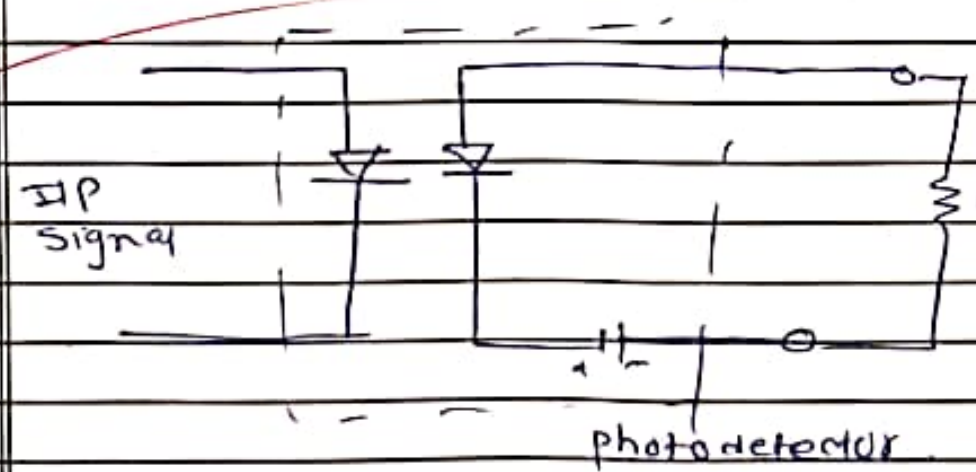
3) Infrared LEDs

1 It is third type of light LEDs ~~from input signal & detected~~ It gives transmission of light from input signals & detect by output signal it is used in optical fiber & communication system to transmit optical waves & optical current



02	Section	Q. No.	03
		Marks	04

प्र. क्र.
Q. No.

3 4 Photonic devices

- Photonic devices which the component degenerated which is the science of optical wave. It is used in solor cell, lasers, various application are used in photonic devices multiple the component of the electron.

- Photonic device component generate current passing through light waves are created photonic devices are used various state of device

1) Lasers - LED lights, emitting diode
Laser diode

2) Detector - Photonic devices are used in Detectors

3) Wave Guide - Photonic devices are used in wave guide

4) Modulators - Photonic devices are used in modulator like

NAME - Sudarshan Nivas Khutale. Date :- 29/03/2025

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Centre	V.C.K.

आ. क्र.
Q. No.

1)

(1) Solar cell works on the principle of Photovolataic effect.

(2) In Photo conductor when light absorb by semiconductor the number of free electron and holes increases, then electrical conductivity is increases.

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Q. No.												
Marks												

Photo detector :- (1) The photodetector is device that device is. a light and converts into the electrical signal.

(2) The photo detector is the light (photons) This device is widely to various used applications Imaging system and optical communications.

(3) The photo electric diode, photo diode are the same working in circuits.

(4) The photo detector is the light sensitive material.

Section | Q. No. | Marks | 03

प्र. क्र. Q. No.

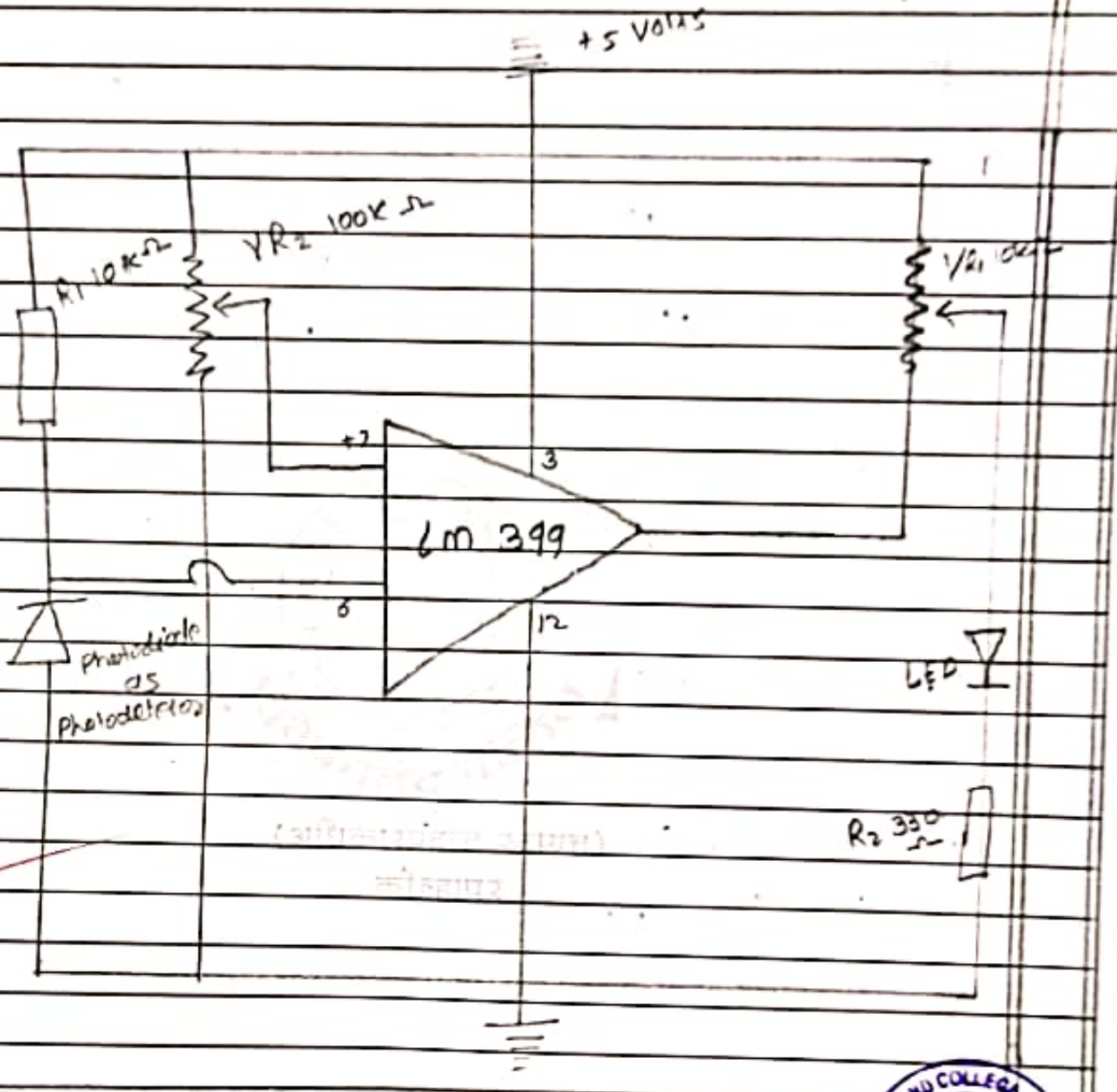

Fig:- (photo detector).

(1) Light sensitive material :-

The photo detector is light sensitive material often to semiconductor material such as silicon (Si), Gallium Arsenide (GaAs)

Section | Q. No. | Marks

प्र. क्र.
Q. No.

(2) electrode :-

The photo detector have an electrode such as that is collection of electrical charges generated the Light sensitive material.

The electod of Photo detector is made up of the metal. (. Gold, Platinum).

(3) optical window :-

The optical window a lens of focus on the incoming Light on the Light sensitive material.

Working of Photo detector :-

The Photodetector is the device converts into the electrical signal. The Photons / Lights are strikes into the photo detector active material of energy of Photon is absorb in semiconductor.

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प्र. क्र.
Q. No.

Generation of charge carrier :-

The incident photon is generated the charge carrier (electron, Photon) of the semiconductor material.

seperation of charge carriers :-

In the charge carrier seperation the electron are moved in opposite side of positive side sixed and the Photons are fixed in negative side two words.

After fixed the charge carriers then the depletion region is generate electric field.

Therefore the Photo-detector is the generated the electric field.

Q. No.	07												
Marks	11												

Principle :-

(1) Thermal :- The electron caused of photons then used to in the mid-gap of decay band theory in semiconductor.

(2) The electron caused of photons conduction band is presented as the vaccum gas.

Photo chemical :- In the photo detector is induced change at the chemical material.

Polarization :- In the polarization the change of polarization material or induced change in polarization sensitive light material.

Application :-

(1) Light detect the signal.

(2) solar cell.

(3) Light sensors & optical communication.

Section | Q. No. 03 | Marks 06 | 03

Photonic Devices :-

- The Photonic Device is the device which is light source in the functions.
- The photonic device is used in modern technologies such as optical communication, medicine, optical communication.

The types of photonic devices :-

(1) LDs - Laser Diodes :-

- These device is coherent laser light device.

(2) LED - Light Emmitting Diodes :-

- The light (Photons) Emmitted as passing electrical current through them.

4 Section | Q. No. | Marks

प्र. क्र. Q. No.

(3) super luminscence Diode :

(4) Light optical detector absorption :-
- Photo detector absorption.
- Photo multiplier absorption.

(5) Non - linear photo detector diode :-
- Non linear crystal.

(6) wave guide and absorption :-
- Photo detctor wave guide
- Non - linear absorption:

(7) optical switches and couplers.
- optical switches
- optical couplers.

(8) optical modulator :-
- electro - modulator.
- semiconductor modulator.

Application :-

(1) The photonic device is used in industries.

(2) medicine and optical communication

(3) The photonic device is used in digital signal / electrical signals.

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Department of Physics

B. Sc. / M.Sc. Part – I, Semester – II, PHYSICS Paper - _____

Title of the Paper: Solid state II (semiconductor Devices)

Name of Teacher: _____

Internal Attendance Sheet

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3)	Supriya R. Ulle						
4)	Pooja J. Gadkari						
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