Total No. of Questions : 7]

SEAT No. :

P440

[Total No. of Pages : 3

[4324] - 103

M.Sc. (Semester - I)

PHYSICS

PHY UTN - 503 : Mathematical Methods in Physics

(2008 Pattern)

Time : 3 Hours] *[Max. Marks :80*

Instructions to the candidates:-

1) ***Question No. 1 is compulsory. Attempt any four questions from the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and pocket calculators is allowed.***

Q1) Attempt any four of the following : **[16]**

a) Find the dimensions and basic of the solution space W for a homogeneous system.

$x + 2y + 2z - s + 3t = 0$

$x + 2y + 3z + s + t = 0$

$3x + 6y + 8z + s + 5t = 0$

b) Find whether the following set of vectors is dependent or independent.
{(1, 3, –1, 4) , (3, 8, –5, 7) , (2, 9, 4, 23)}

c) Find the Laplace transform of ($t^3.e^t$).

d) Write the generating function for $P_n(x)$. Show that $P_n(x) = (-1)^n P_n(-x)$.

e) Prove that e^x *(cos y + i sin y)* is an analytic function.

f) Define spherical harmonic function $Y_l^m(\theta,\phi)$. Write the orthogonality condition for it.

Q2) a) State Schwarz inequality for two vectors u, *v*, $\in$ V. Find the cosine of the angle between two vectors belonging to inner product space V.

P.T.O.

i) $u = (2, 3, 5)$ and $v = (1, -4, 3)$

ii) $u = (1, 3, -5, 4)$ and $v = (2, -3, 4, 1)$ **[8]**

b) Find the eigenvalues and orthonormalized eigenvectors of the matrix

$$\begin{pmatrix} 5 & 0 & \sqrt{3} \\ 0 & 3 & 0 \\ \sqrt{3} & 0 & 3 \end{pmatrix}$$

[8]

Q3) a) Let U & W be the subspaces of R^4 generated by $\{(1,1,0,-1), (1, 2, 3, 0) (2, 3, 3, -1)\}$ and $\{(1, 2, 2, -2), (2, 3, 2, -3), (1, 3, 4, 3)\}$ respectively. Find i) dim. $(U + W)$ and ii) dim. $(U \cap W)$ **[8]**

b) Write the generating function for Bessel's function $J_n(x)$. Hence prove the recurrence relations **[8]**

$$J_{n-1}(x) + J_{n+1}(x) = \frac{2n}{x} J_n(x) \text{ and } J_{n-1}(x) - J_{n+1}(x) = 2J'_n(x)$$

Q4) a) State and prove Taylor's theorem. **[8]**

b) Show that the Laplace transform of Dirac delta function is one i.e. $\mathcal{L}\{\delta(t)\} = 1$. **[8]**

Q5) a) Develop the Fourier series representation of the function **[8]**

$f(x) = -\pi \quad -\pi < x < 0$

$= x \quad 0 < x < \pi$

b) State Cauchy's integral formula and prove that $f(z_0) = \frac{1}{2\pi i} \int \frac{f(z)}{z - z_0} dz$ **[8]**

Q6) a) Using Schmidt orthogonalization procedure construct first three Legendre polynomials $u_n(x) = x^n \quad n = 0, 1, 2$ ---

$w(x) = 1 \quad -1 \le x \le 1$ **[8]**

b) Let T be the Linear operator on R^3 defined by **[8]**

$T(x, y, z) = (2x, 4x - y, 2x + 3y - z)$ show that

i) T is invertible &

ii) Find T^{-1}.

Q7) a) Determine whether following matrices are Hermitian. Write the reasoning.

i) $\begin{pmatrix} 2 & 2+3i & 4-5i \\ 2-3i & 5 & 6+2i \\ 4+5i & 6-2i & -7 \end{pmatrix}$ ii) $\begin{pmatrix} 3 & 2-i & 4+i \\ 2-i & 6 & i \\ 4+i & i & 7 \end{pmatrix}$

[4]

b) Use the Calculus of residue to prove $\int_0^{2\pi} \frac{d\theta}{2+\cos\theta} = \frac{2\pi}{\sqrt{3}}$ **[4]**

c) Find Fourier sine transform of the function $f(x) = x$ where $0 \leq x \leq 2$ **[4]**

d) The Rodrigue's formula for Laguerre polynomials is

$L_n(x) = \frac{e^x}{n!}\frac{d^n}{dx^n}(x^n \ \bar{e}^x)$ for integral n using this generate $L_0^{(x)}, L_1^{(x)}$ & $L_2^{(x)}$. **[4]**

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SEAT No. :

P446

[Total No. of Pages : 3

[4324]-301
M.Sc. (Semester - III)
PHYSICS
PHY UTN - 701 : Solid State of Physics
(2008 Pattern)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No. 1 is compulsory and solve any four questions from the remaining.***
2) ***Figures to the right indicate full marks.***
3) ***Draw neat labelled diagrams wherever necessary.***
4) ***Use of logarithmic table and pocket calculator is allowed.***

Given :

Mass of electron	=	9.1×10^{-31}kg
Charge of electron	=	1.6×10^{-19}C
Plank's constant	=	6.626×10^{-34} J-s
Boltzmann constant	=	1.38×10^{-23} J/K
Avogadro's number	=	6.023×10^{26} /kmol
Bohr magneton	=	9.27×10^{-24} A-m^2
Permeability of free space	=	$4\pi \times 10^{-7}$ Henry/m
Permittivity of free space	=	8.85×10^{-12}C^2/N-m^2

Q1) Attempt any four of the following : **[16]**

a) Evaluate the temperature at which there is 1% probability that a state with energy 0.5 eV above fermi level is occupied by an electron according to F-D statistics.

b) The magnetic field strength of silicon is 1000 A/m. If the magnetic susceptibility is -0.3×10^{-5}. Calculate flux density and magnetization in silicon.

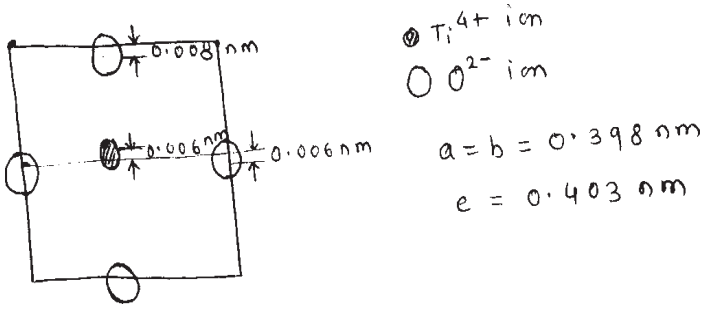
c) A super conducting material has a critical temperature of 3.7 K in zero magnetic field and a critical field of 0.0306 Tesla at zero K. Find the critical field at 2K.

d) Obtain an expression $U_g = \frac{\hbar k}{m}$ according to band theory.

P.T.O.

e) A paramagnetic substance has 10^{28} atoms/m^3. The magnetic moment of each atom is 1.8×10^{-23} A-m^2. Calculate the paramagnetic susceptibility at 300 K.

f) Calculate the net polarization in Bati O_3. Make the use of following diagram and data.



Q2) a) Explain Langevin's classical theory of paramagnetism. Hence obtain an expression for paramagnetic susceptibility. **[8]**

b) Explain Kronig - Penny Model. Plot the corresponding graph for $p = \frac{3\pi}{2}$. Interprete the result. **[8]**

Q3) a) Explain thermodynamics of superconductivity with special reference to the stabilization energy. **[8]**

b) What do you mean by plasmon? Write the expression for dispersion relation in transverse optical mode and show it graphically. Hence explain transparancy of alkali metals to uv. **[8]**

Q4) a) Write the definition of the following with its formula and unit : **[8]**

i) Magnetic induction.

ii) Magnetic field intensity

iii) Magnetization

iv) Magnetic susceptibility.

b) What is ferroelectricity? Write atleast four characteristics, examples and applications of ferroelectric materials. **[8]**

Q5) a) Explain the formation of energy gap on the basis of nearly free electron model. **[8]**

b) Distinguish between ferromagnetism, ferrimagnetism and antiferro magnetism. **[8]**

Q6) a) Derive an expression for paramagnetic susceptibility due to conduction electrons. **[8]**

b) i) Describe Josephson superconducting tunneling. **[4]**

ii) Distinguish between type - I and type - II superconductor. **[4]**

Q7) a) Explain the concept of hole based on band structure. **[4]**

b) Calculate the mean free path of potassium, if its fermi energy is 2.1 eV and electrical conductivity is $1.5 \times 10^7/\Omega$-m

Given : concentration of electrons $n = 1.38 \times 10^{28}/m^3$. **[4]**

c) The curie temperature of Iron is 1043 K. Assume that Iron atoms when in the metallic form have moments of two Bohr magneton per atom. Iron is bcc and edge of the cube is 2.86Å. Calculate the saturation magnetization. **[4]**

d) Write the expression for E_{local} and explain depolarizing field in detail. **[4]**

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