[This question paper contains 8 printed pages.]

Your Roll No.....

E

Sr. No. of Question Paper : 4550

Unique Paper Code : 32221201

Name of the Paper : Electricity and Magnetism

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

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. **1** is compulsory.
3. Answer any **four** of the remaining **six** questions.

1. Attempt all parts of this question. (5×5=25)

P.T.O.

(a) A point charge 'q' is located at the centre of a cube having edge of length 'd'. What is the value of flux over one face of the cube? If the charge is placed at one corner of the cube, then what will be the value of electric flux through each face of the cube?

(b) Suppose the electric field in some region is found to be, $E = kr^3 r$ in spherical coordinates where, is a constant with appropriate units.

(i) Find the charge density.

(ii) Find the total charge contained in a sphere of radius R centered at the origin.

(c) Find the magnetic field at origin corresponding to the vector potential $\vec{A} = (y\cos(ax))\hat{i} + (y + e^x)\hat{k}$.

(d) What is displacement current? How is it different from the conduction current.

(e) State and prove maximum power transfer theorem. What is the maximum efficiency of any circuit.

2. (a) Find the electric field at a distance s from an infinitely long straight wire which carries a uniform line charge λ. (6)

(b) Derive the expression for the magnetic field at a point on the axis of a circular coil of radius a and carrying current I. Obtain an expression for the magnetic dipole moment of loop. (6.5)

3. (a) A spherical condenser consists of two concentric conducting spheres of radii a and b ($a > b$). The outer sphere is grounded and a charge Q is placed on the inner sphere. The outer conductor then contracts from radius a to c. Find the work done by the electric force? (6.5)

(b) The magnetic field intensity is H = 1200 Amp/m in a material when B = 2 Wb/m^2. When H is reduced to 400 Amp/m, B = 1.4 Wb/m^2, calculate the change in the magnetization M. (4)

(c) Explain why diamagnetism is temperature independent. (2)

4. (a) A sphere of radius R, filled with material of dielectric constant k, have a small concentric spherical cavity of radius a. A free point charge q is placed at the center. Find the polarization vector P and bound charges σ_b and ρ_b.

(3.5,3)

(b) Derive the expression for quality factor Q and bandwidth β of a series RLC circuit. (3,3)

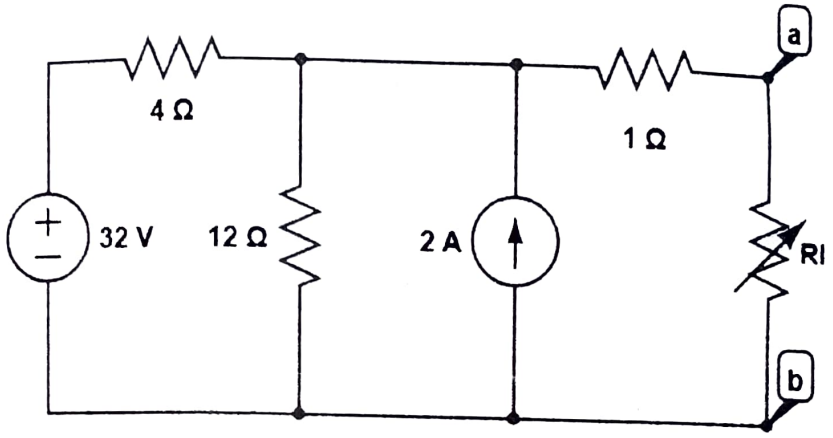
5. (a) A point charge 'q' is placed inside a hollow grounded, conducting sphere of inner radius 'a'. Using the method of images,

(i) Find the potential inside the sphere. (4)

(ii) Find the induced surface-charge density.

(2)

(b) Find the Thevenin equivalent of the circuit below and find the current through R1 = 6Ω.



(5,1.5)

6. (a) In a parallel plate air capacitor having plate separation 0.04 mm, an electric field of 4×10^4 V/m is established between the plates. The battery is then removed and a metal plate of thickness 0.03 mm is inserted between the plates of the capacitor. Determine the potential difference across the capacitor,

(i) before the introduction of metal plates (2)

(ii) after the introduction of metal plates (2)

(iii) if dielectric slab with dielectric constant 2.5 and same thickness is inserted instead of the metal plates (2)

(b) Find the emf induced in a rectangular loop due to a current carrying long wire placed in the plane of the loop. Also find the induced emf when the loop moves away from the wire with a constant speed v so that it's orientation w.r.t. the wire does not change. (3,3.5)

7. (a) A thin metal sphere of radius b has a charge Q.

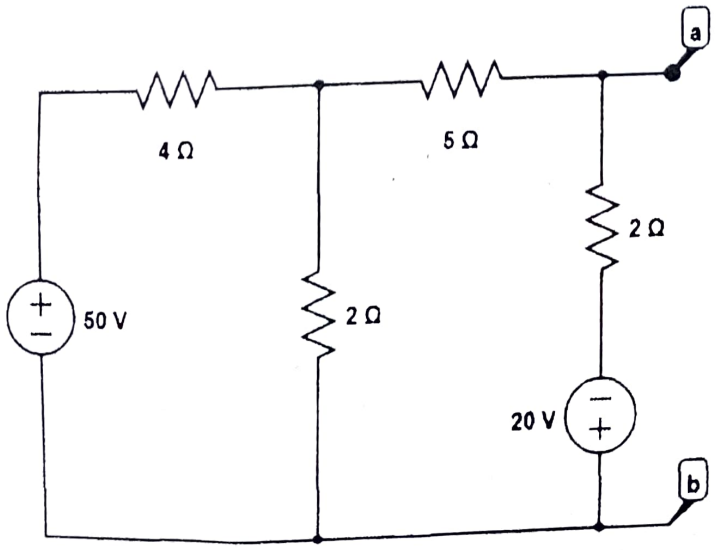
(i) What is its capacitance? (2)

(ii) What is the E-field energy density at a distance r from the center of the sphere? (1)

(iii) What is the total energy of the field? (2)

(iv) Compute the work expended in charging the sphere by carrying infinitesimal charge from infinity. (1.5)

(b) Using the node voltage method, find V_{oc} and I_{sc} at the terminal ab of the following network :



(6)

[This question paper contains 4 printed pages.]

Your Roll No.....

E

Sr. No. of Question Paper	:	**4532**
Unique Paper Code	:	32221401
Name of the Paper	:	Mathematical Physics III
Name of the Course	:	**B.Sc. (H) Physics**
Semester/Annual	:	IV

Duration : 3 Hours

Maximum Marks : 75

Instructions

1. Write your Roll Number on the top immediately on the receipt of the question paper.
2. Attempt five questions in all.
3. Question number 1 is compulsory. Attempt two questions each from section A and B.
4. The Principal Branch of argument of complex number z in all the questions is taken to be $-\pi < \theta \leq \pi$
5. Use the following definition for the Fourier transform of $f(x)$:
$$\mathcal{F}(f(x)) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(x)e^{-ikx}dx$$
6. Use the following definition for the Fourier Sine transform of $f(x)$:
$$\mathcal{F}_s(f(x)) = \sqrt{\frac{2}{\pi}}\int_{0}^{\infty} f(x)sin(kx)dx$$
7. Use the following definition for the Fourier Cosine transform of $f(x)$:
$$\mathcal{F}_c(f(x)) = \sqrt{\frac{2}{\pi}}\int_{0}^{\infty} f(x)cos(kx)dx$$
8. *The definition of* convolution of two functions $f(x)$ and $g(x)$ for Fourier transform is:
$$(f * g)(x) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(y)g(x-y)dy$$
9. Some useful Fourier and Laplace Transforms are given at the end.

P.T.O.

Q1. Attempt **any *five*** parts. All parts carry equal marks. (5 × 3 = 15)

a) Obtain the rectangular form of the ellipse $|z + 3| + |z - 3| = 10$.

b) Find the principal branch of i^i.

c) Without evaluating the integral, show that $\left|\int_\Gamma \frac{dz}{1+z}\right| \leq \frac{3\pi}{4}$; where Γ is the arc of circle $|z| = 3$ from $z = 3$ to $z = 3i$ lying in the first quadrant.

d) Given, Laplace Transform, $\mathcal{L}(J_0(t)) = \frac{1}{\sqrt{1+s^2}}$, find the Laplace Transform, $\mathcal{L}(e^{-at}J_0(bt))$.

e) Find Inverse Laplace Transform of $\frac{1}{(s^2 + a^2)(s^2 + b^2)}$.

f) Find the Fourier Transform of $cos(ax)$ in terms of Dirac-delta functions.

g) If $g(x) = f(bx + a)$ and F(k) is the Fourier transform of $f(x)$, determine the Fourier transform of $g(x)$.

h) Solve the integral $\int_0^5 (\sin x)\, \delta[(x - 2)(x - 4)]\, dx$

Section – A

Q2.

a) Using de-Moivre's theorem prove that:

$$cos(4\theta) = 8cos^4(\theta) - 8cos^2(\theta) + 1$$

and hence show that

$$cos\frac{\pi}{8} = \left(\frac{2+\sqrt{2}}{4}\right)^{1/2}$$

6, 2

b) Prove:

$$coth^{-1}z = \frac{1}{2}ln\left(\frac{z+1}{z-1}\right)$$

7

Q3.

a) **Prove that the function $u(x, y) = 2x(1 - y)$ is harmonic. Find its conjugate function $v(x, y)$ such that $f(z) = u + iv$ is analytic.** 7

b) Evaluate the following integrals using Cauchy's Integral Formulae where C: $|z| = 3$

i. $\frac{1}{2\pi i}\oint_C \frac{e^{zt}}{(z^2+1)^2}dz,\ t > 0$

ii. $\oint_C \frac{\sin^6(z)}{\left(z-\frac{\pi}{6}\right)^3}dz$ 4, 4

Q4.

a) Use Residue theorem to evaluate **any one** integral of the following: 9

i. $\int_0^\infty \frac{x^2}{(x^2+9)(x^2+4)^2}dx$

ii. $\int_0^{2\pi} \frac{d\theta}{a + b\cos\theta + c\sin\theta};\ a^2 > b^2 + c^2$

(b). Expand the function $f(z) = \frac{z}{(z-1)(2-z)}$ in a Laurent series valid for

i. $1 < |z| < 2$

ii. $|z-1| > 1$ 3, 3

Section – B

Q5.

a) Find the Fourier transform of

$$f(x) = \begin{cases} (1-x^2), |x| < 1 \\ 0, |x| > 1 \end{cases}$$ 7

b) Verify the Convolution theorem (Fourier transform) for the functions

$$f(x) = g(x) = e^{-x^2}$$ 8

Q6.

a) If Laplace transform of f(t) is $\mathcal{L}(s)$ then prove that Laplace transform of $\frac{f(t)}{t}$ is $\int_s^\infty \mathcal{L}(u)du$. Use this result to evaluate Laplace transform of $\frac{\sin(t)}{t}$. 8

b) Taking the Laplace Transform of $f(t) = \int_0^\infty \frac{x\sin(tx)}{1+x^2}dx$, show that $f(t) = \frac{\pi}{2}e^{-t}$ for $t > 0$. 7

Q7.

a) A particle moves along a line so that its displacement x from a fixed point O at any time t is given by $x''(t) + 4x'(t) + 5x(t) = 80$. Initial conditions are $x(0) = x'(0) = 0$. Using Laplace Transform, find its displacement at any time $t > 0$. 8

P.T.O.

b) Prove that

$$\mathcal{F}^{-1}\left(\frac{1}{k^4+5k^2+4}\right) = \frac{\sqrt{2\pi}}{12}\left(2\,e^{-|x|} - e^{-2|x|}\right)$$ 7

Some useful Laplace Transforms:

$$\mathcal{L}(sin(at)) = \frac{a}{s^2+a^2}, Re(s) > 0, s \neq \pm ia$$

$$\mathcal{L}(cos(at)) = \frac{s}{s^2+a^2}, Re(s) > 0, s \neq \pm ia$$

$$\mathcal{L}(e^{at}) = \frac{1}{s-a}, Re(s) > a$$

$$\mathcal{L}(t^a) = \frac{\Gamma(a+1)}{s^{a+1}}, Re(s) > a$$

Useful Fourier Transform:

$$\mathcal{F}(e^{-ax^2}) = \frac{1}{\sqrt{2a}} e^{-k^2/(4a)}, a > 0$$

Useful Inverse Fourier Transform:

$$\mathcal{F}^{-1}\left(\frac{1}{a^2+k^2}\right) = \frac{\sqrt{2\pi}}{2a} e^{-a|x|}$$

also, $\mathcal{F}^{-1}[a\,g(k) + b\,h(k)] = a\,\mathcal{F}^{-1}[g(k)] + b\,\mathcal{F}^{-1}[h(k)]$

(a and b are constants)

Useful Integral:

$$\int_{-\infty}^{\infty} e^{-ax^2+bx}\,dx = e^{b^2/(4a)}\sqrt{\frac{\pi}{a}}; a > 0, b \text{ can be purely imaginary also.}$$

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper	:	**4688** **E**
Unique Paper Code	:	32221402
Name of the Paper	:	Elements of Modern Physics
Name of the Course	:	**B.Sc. (Hons) Physics –CBCS Core**
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 1** is compulsory
4. **All questions** carry equal marks
5. **Symbols** have their usual meanings
6. Use of **non-programmable** calculators is allowed

Answer **any five** questions from the following.

1. (a) The irradiated power of a body at 333°C is 1000 J/s. If the temperature of this body is raised to 666°C, find the radiated power of the body.

   (b) What is the physical significance of a wave function? What conditions must be satisfied by an acceptable wave function?

   (c) What voltage must be applied to an electron microscope to produce electrons of wavelength 0.20Å.

(d)The spectral line of wavelength 450 nm has a width of 10^{-4} nm. Find the average time that the atomic system remains in the corresponding energy state?

(e) How is the time dependent Schrodinger wave equation obtained from the time independent Schrodinger equation.

(f) What inferences can be drawn from the single and double slit/s experiment with electrons?

(g) Find the penetration depth of an electron having kinetic energy 10 keV when it strikes a potential step of height 15 keV.

(h) Determine the approximate density of a nucleus treating it as a uniform sphere. (Given: mass of a nucleon = 1.7×10^{-27} kg.) (3×5=15)

2. a) Draw the Energy vs wavelength curve of a blackbody for three different temperatures $T_1 < T_2 < T_3$. Show that the Wein's law and Rayleigh Jeans law of black body radiation are the special cases of Planck's law. (5)

(b) The threshold wavelength of potassium is 558 nm. What is the work function for potassium? What is the stopping potential when light of 400 nm is incident on potassium? (5)

(c) Calculate the energy in electron volt of a photon of wavelength 10 Å. What is the momentum of this photon? (5)

3. (a) Distinguish between phase velocity and group velocity and obtain an expression for both. Derive the relation between them. (5)

(b) Show that the Compton wavelength is independent of the nature of the scatterer and the original wavelength of the incident beam. (5)

(c) An electron has a deBroglie wavelength equal to that of a photon, show that the ratio of the kinetic energy of the electron to the energy of photon is

$$\frac{(m^2c^4 + h^2\nu^2)^{\frac{1}{2}} - mc^2}{h\nu}$$ (5)

4. (a)Show mathematically the value of wavelength calculated from the Davisson Germer experiment matches the value of the wavelength calculated from the deBroglie's hypothesis. (5)

(b) Estimate the minimum energy of a proton existing inside the nucleus using Heisenberg's uncertainty principle. (Size of the nucleus= 1×10^{-15}m) (5)

(c)Explain why it is plausible to define probability current density in quantum mechanics by the following expression

$$J = (e\hbar/2m)\ (\psi^* \text{ grad } \psi - \psi \text{ grad } \psi$$

The symbols have the usual meaning (5)

5. (a) What is quantum mechanical tunneling? Obtain an expression for the transmission probability for a beam of particles each with mass m and energy E ($E<V_0$) incident on a rectangular potential barrier:

$V(x) = 0$ for $x<0$

$= Vo$ for $0<x<a$

$= 0$ for $x>a$ (10)

(b) Obtain and draw the first two normalized wave functions for a particle in a one dimensional potential box. (5)

6 (a) What are nuclear forces and their characteristics? Also draw the N-Z plot and explain the stability of the nucleus. (5)

(b) Calculate the binding energy of an alpha particle from the following data in MeV and Joules. (Given: mass of He atom = 4.00260 amu, mass of neutron = 1.008665amu, mass of proton=1.007276amu) (5)

(c) Calculate the total energy released if 1.2 kg of 235 U undergoes fission, taking the disintegration energy per event to be Q = 208 MeV. (5)

7. (a) Explain why electron positron pair creation necessarily requires the presence of a nucleus. (5)

(b) Calculate the time required for 20% of a sample of thorium to disintegrate. Assume the half life of thorium to be 1.4×10^{10} years. Calculate the mean life time of thorium nucleus. (5)

(c) Bring out the differences between atomic absorption, spontaneous emission and stimulated emission of photons in a laser system? Discuss the main criteria that must be met to achieve laseraction. Which method is used to achieve this criteria? (5)

Some useful constants

1. Planck constant, $h = 6.626 \times 10^{-34}$ J.s
2. $\hbar = 1{,}05 \times 10^{-34}$ J.s
3. Boltzmann constant, $K = 1.38 \times 10^{-23}$ $J.K^{-1}$
4. Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg
5. Charge of electron, $e = 1.6 \times 10^{-19}$ C
6. Speed of light in vacuum, $c = 3 \times 10^{8}$ $m.s^{-1}$
7. Stefan-Boltzmann constant, $\sigma = 5.67 \times 10^{-8}$ $W.m^{-2}.K^{-4}$
8. Rest mass energy of electron = 512 KeV
9. Velocity of electron in free space= $3x10^{8}$ m/s

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4812 **E**

Unique Paper Code : 32221403

Name of the Paper : Analog Systems and Applications

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

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.
4. Use of scientific calculators is allowed.

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

   (a) Define drift and diffusion currents in doped semiconductors.

   (b) Explain the difference in physical mechanisms of avalanche and Zener breakdown in p-n. junction.

P.T.O.

(c) Draw I-V characteristics of the ideal diode and compare it with that of a practical diode, under forward bias and reverse bias conditions?

(d) A common emitter circuit has beta of 98, a collector current of 50 mA and base current of 500 μA. Calculate the reverse saturation current.

(e) Distinguish between Class A, Class B and Class C amplifiers with the help of load line and Q point.

(f) Define PIV, ripple factor and rectification efficiency in a rectifier circuit.

(g) An Op-Amp has a CMRR value of 55 dB and a differential mode gain of 1200. Find the common mode gain.

2. (a) For an abrupt p-n junction find the expression for potential V_B as a function of x for the case where N_a and N_d are of comparable magnitudes. Hence show that the barrier potential is given as follows :

$$V_B = q.N_a.N_d(W_p+W_n)^2 \ /2*\varepsilon(N_a + N_d)$$

wherein W_p and W_n are depletion widths on p and n sides respectively and all other symbols have their usual meaning.

(10)

(b) Find the conductivity of a bar of pure Silicon of length 1 cm and cross-sectional area 1 mm^2 at 300K. Given $\mu_n = 0.13\ m^2/Vs$, $\mu_p = 0.05\ m^2/Vs$, $n_i = 1.5 \times 10^{16}\ m^{-3}$ and $e = 1.6 \times 10^{-19}$ C. (5)

3. (a) Explain the working of a center-tap full wave rectifier using suitable diagrams and obtain the expressions for (i) ripple factor and (ii) rectification efficiency. (10)

(b) What is a tunnel diode? Draw the I-V characteristics of the tunnel diode and briefly explain them. (5)

4. (a) Derive the stability factors for "voltage divider bias circuit" and "fixed bias circuit" and hence explain why "voltage divider bias circuit" is preferred over "fixed bias circuit". (10)

(b) Describe "DC load line" and "Q-point" of a transistor in CE configuration with appropriate diagram. (5)

5. (a) Draw the circuit diagram of a two stage RC coupled amplifier using transistors and also its frequency response curve. Why does the gain fall in low frequency range and high frequency range? (10)

(b) What do you understand by the term small signal analysis? Draw the equivalent circuit in hybrid parameters for an n-p-n transistor in (i) CE configuration and (ii) CB configuration configurations. (5)

6. (a) Draw the circuit and explain the working of a 4-bit R-2R ladder network DAC using op- amp. In a 4-bit DAC, 0001 input results into 0.8 V output. What is the maximum output voltage of this DAC? (10)

(b) Draw the circuit of a voltage comparator using op-amp to give $+V_{sat}$ at the output if the input voltage is less than - 2V and $-V_{sat}$ for input more than +2V. (5)

7. (a) Draw the circuit of an Op-amp as a basic differentiator and find an expression for its output. Draw the output waveform when the input to the differentiator is a square wave. (10)

(b) A five -bit D/A converter produces an output of 9mV for a digital input of 10010. Find the output voltage for a digital input of 11011. Also find its full scale output voltage. (5)

[This question paper contains 8 printed pages.]

Your Roll No.....

E

Sr. No. of Question Paper : 4514

Unique Paper Code : 32221601

Name of the Paper : Electromagnetic Theory

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

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. Question No. **1** is compulsory.
3. Answer any **four** of the remaining **six**.
4. Use of non-programmable scientific calculator is allowed.

1. Attempt any **five** questions :

   (a) How do you optically distinguish between quarter wave plate and half wave plate.

P.T.O.

(b) A polarimeter tube of 25 Cm long containing a sugar solution of unknown concentration rotates the plane of polarization of electromagnetic wave by 10 degrees. Specific rotation of sugar is given as 60 degrees per decimeter/gm/cc, find the concentration of the sugar solution.

(c) In case of electric field vector E be perpendicular to the plane of incidence, find the reflection and transmission coefficient for normal incidence on a air-glass interface ($n_1 = 1$, $n_2 = 1.5$).

(d) The conduction current density in a dielectric is given by $J=0.02$ Sin $(10^9$ t) Amp/m^2. Find the displacement current density if $\sigma = 10^3$ mho/m and $\varepsilon_r = 6.5$.

(e) What is the plasma frequency and minimum penetration depth for a collision free plasma having 10^{12} electrons/m^3 ?

(f) Calculate Numerical Aperture and Acceptance angle for a fiber if $n_1 = 1.458$ and $(n_1 - n_2)/n_1 = 0.01$.

(g) Show that in a good conductor the magnetic field lags the electric field by 45°. (3×5=15)

2. (a) A plane em wave propagating in a conducting medium is characterized by the parameters ε, μ and σ and show that propagation constant is complex in this case. (8)

(b) In a homogeneous region, where $\mu_r = 1$ and $\varepsilon_r = 50$

$$E = 20\ \pi \exp i(\omega t - \beta z)\ a_x \text{ Volt/m}$$

$$H = H_0 \exp i(\omega t - \beta z)\ a_y \text{ Tesla}$$

Here a_x and a_y are unit vectors in the x and y directions. Find ω and H_0 if the wavelength is 1.78m. (4)

(c) Derive the expression of skin depth for a good conductor. (3)

3. (a) State and prove Poynting theorem for a linear isotropic homogeneous medium. Explain the physical significance of each term. What is the physical significance of Poynting vector? (10)

(b) If all the energy from a 1000 W lamp is radiated uniformly, calculate the average value of the intensities of electric and magnetic fields of radiation at a distance of 2m from the lamp.

(5)

4. (a) Show that Maxwell's equations can be written as two coupled second order differential equations in terms of scalar potential V and vector potential A. What is Lorentz condition and how can these equations be uncoupled using it? (8)

(b) For the propagation of electromagnetic wave through plasma derive an expression for the cut-off frequency ω_p and explain its significance.

(7)

5. (a) Discuss the phenomenon of total internal reflection on the basis of electromagnetic theory. Prove that though the wave fields do exist in the second medium yet the energy flow through the surface into the second medium is zero.

(b) An electromagnetic wave whose electric field is polarized parallel to plane of incidence, is incident from free space to non-magnetic, non-conducting medium having $\varepsilon = 3\varepsilon_0$, here the wave is not reflected back from the interface. Determine the angle of transmission. (5)

6. (a) Starting from Maxwell's equations, obtain the eigen value equation for wave propagation through an optical planar waveguide for TE mode. Write its solution for the symmetric TE mode. (8)

(b) Distinguish between a step index and graded index optical fiber. Plot the variation of the refractive index with radial distance for step index and the graded index fibers. A pulse of light propagates through 1 km length of a step index fiber having a core of refractive index 1.5 and a cladding of refractive index 1.49. Calculate the pulse dispersion suffered by light on passing through the fiber. (7)

7. (a) Derive Fresnel's formulae for wave propagation in an anisotropic medium and explain the phenomenon of double refraction with the help of this. (10)

(b) A plate of 0.10 mm thickness is used as a retardation plate. For what wavelength in the visible region (400nm – 800nm) will it act as (i) quarter wave plate and (ii) half wave plate. For calcite $n_0 = 1.5443$ and $n_e = 1.5533$. (5)

Given : $\varepsilon_0 = 8.85 \times 10^{-12}$ Farad/m

$\mu_0 = 4\pi \times 10^{-7}$ Henry/m

$c = 3 \times 10^8$ m/s

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

[This question paper contains 4 printed pages.]

Your Roll No.....

E

Sr. No. of Question Paper	:	**4794**
Unique Paper Code	:	32221602
Name of the Paper	:	Statistical Mechanics
Name of the Course	:	**B.Sc. (Hons) Physics**
Semester	:	VI

Maximum Marks : 75

Duration : 3 Hours

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. **All** questions carry equal marks.
5. **Non- programmable Scientific calculators** are allowed.

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

(a) Draw a phase space for a one-dimensional classical linear harmonic oscillator of mass m having total energy $E = p^2/2m + m\omega^2 x^2/2$. Calculate the total number of microstates available to it, if the energy of a harmonic oscillator lies between 0 and E.

(b) Discusswhether law of equipartition of energy can be applied to the following systems or not:

P.T.O.

(i) classical harmonic oscillators

(ii) gas consisting of free particles moving non- relativistically

(iii) nucleons in a nucleus.

(c) Assume a system of N bosons, each of mass m, is confined to a one-dimensional box of length L at temperature T = 0 K. The energy levels of the system are given by $E_n = n^2h^2/(8mL^2)$, where n= 1, 2,... and $h$is Planck's constant. Find the total energy of the system in terms of N, L, and h.

(d) Plot the variation of specific heat with temperature for ideal Bose-Einstein gas and explain its behavior in the strongly degenerate and classical regions.

(e) For Silver atom, with one electron per atom at room temperature, the number density n = $5.86\times10^{28}m^{-3}$. Find the nature of the degeneracy of the system under consideration.

(f) A cubical cavity of side $1m$ is filled with black body radiation. Calculate the number of independent standing waves with wavelengths in the range 8.0 mm and 9.0 mm.

(g) Calculate the normal radiation pressure generated by an incandescent bulb of $200W$ at a distance of $1m$. (5×3=15)

2. (a) Using the partition function of classical ideal monoatomic gas consist of N indistinguishable particles at fixed temperature T in volume V: $Z(N,V,T) = (V^N/N!)[2\pi mk_BT/h^2]^{3N/2}$:

Derive the Sackur-Tetrode relation assuming N >>1. Show that the entropy given by the Sackur- Tetrode equation is an extensive parameter.

(b) A partition divides a box into two chambers 1 and 2, each of volume V. Assume that chamber 1 and 2 chamber contain the same ideal gas consisting of $2N$particlesand N particles respectively attemperature T. Using the Sackur-Tetrode relation, calculate the entropy of mixing after the partition is removed and the contents are allowed to mix to reach at equilibrium (Assume that the temperature remain constant throughout the process). (8, 7)

3. (a) Consider an isolated paramagnetic salt consisting of dipoles of magnetic moment μ,located in an external magnetic field B. Out of these N dipoles, n dipoles are parallel to B and rest are anti-parallel. Show that the total energy E, the entropy S and the absolute temperature T of the system are given respectively as

(i) $E = (N-2n)\,\mu B$

(ii) $S = -Nk_B\,[x\,ln\,(x) + (1-x)\,ln\,(1-x)]$, where $x = n/N$

(iii) $1/T = [k_B/2\,\mu B]\,ln\,(n/(N-n))$

(b) A system consists of 12 identical butdistinguishable particles which can occupy non-degenerate energy levels. Initially, the system is in the macrostate which is defined by (6,3,2,1) particles in the energy levels $(0, \varepsilon, 3\varepsilon, 5\varepsilon)$.

(i) Calculate the number of microstates and entropy of the system in its initial state.

(ii) If a small amount of energy is added to the above-mentioned system such that only one particle is raised from the ground level (zero energy) to first excited level (ε), calculate the number of microstates available in this final microstate.Hence, find the change of entropy when system undergoes from initial to final state. (8, 7)

4. (a) Consider a completely degenerate non-relativistic gas of electrons in3 –dimensions. Obtain the expressions for average energy per particle, Fermi velocity and Fermi pressure.

(b) Consider the model of a white dwarf star: a sphere consisting of helium gas of mass $M = 10^{30}\ kg$ at a density of $\rho = 10^{10}\ kg\ m^{-3}$ and temperature T of the order of $10^6 K$. Using these data, find the nature of electron gas inside a white dwarf star. (Given: mass of proton $\approx 10^{-27}\ kg$, mass of electron $\approx 10^{-30}\ kg$) (8, 7)

5. (a) Prove that for photon gas, internal energy (U) and (S) entropy at given temperature T are related by the following relation: $TS = 4U/3$.

(b) How does Bose–Einstein condensation explain the superfluid properties of liquid $4He$? (10,5)

6. (a) A blackbody cavity at temperature T is filled with N_0, N_1, N_2, ... oscillators having energies 0, $h\nu$, $2h\nu$, ,...respectively. Calculate the total number of oscillators and determine average energy of the oscillators. If Planck's constant tends to zero, what would be the effect on the average energy of the oscillators?

(b) Calculate the average energy of a Planck oscillator, vibrating with frequency 3×10^{14} Hz at 2000 K. Compare it with a classical oscillator. (10,5)

Constants:

$k_B = 1.38 \times 10^{-23} JK^{-1}$

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

$h = 6.626 \times 10^{-34}\ Js$

$c = 3 \times 10^8\ ms^{-1}$

$\sigma = 5.67 \times 10^{-8}\ J\ m^{-2} s^{-1} K^{-4}$

(2000)

[This question paper contains 4 printed pages.]

Your Roll No.....

F

Sr. No. of Question Paper : 1206

Unique Paper Code : 2222011201

Name of the Paper : Mathematical Physics - II (DSC - 4)

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

Semester : II

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt FOUR questions in all
3. Question No. 1 is compulsory.
4. Use of non-programmable scientific calculator is allowed.

P.T.O.

1. Attempt ALL questions. Each question carries equal marks. (3×5=15)

(a) Let u_1, u_2, u_3 be orthogonal coordinates. Prove that $|\nabla u_p| = h_p^{-1}, p = 1,2,3$

(b) Write the expression only of the general solution near x = –1 using Frobenius method of

$$y'' + xy' + (2x-1)y = 0$$

(c) Using the expression of the generating function of the Legendre Polynomials $P_n(x)$ find the expression for $P_2(x)$ and $P_3(x)$.

(d) Evaluate using Beta function property $\int_0^\infty \frac{z^{m-1}}{1+z}\,dz = \frac{m}{\sin m\pi}$ the integral $\int_{-\infty}^{\infty} \frac{e^{2u}}{1+e^{3u}}\,du$

(e) Is the given function periodic, $f(t) = \sin(10+\pi)t$. If yes, what is its period?

2. (a) Find the Fourier series expansion of the function

$$f(x) = x^2 \ , \quad 0 < x < 2\pi$$ (10)

(b) Plot the even and odd components of a function defined by $f(t) = \begin{cases} e^{-t} & , t > 0 \\ 0 & , t < 0 \end{cases}$ (5)

3. (a) Derive the expression for $\nabla^2 \varphi$ in cylindrical coordinates. (10)

(b) Represent the vector $\vec{A} = z\hat{\imath} - 2x\hat{\jmath} + y\hat{k}$ in cylindrical coordinates (ρ, ϕ, z). Thus determine A_ρ, A_ϕ and A_z (5)

4. (a) Prove that $P_n(x)$ is the coefficient of t^n in the expansion of $\frac{1}{\sqrt{1-2xt+t^2}}$ in the ascending powers of t. Hence find the value of $P_n(1)$ (10)

(b) Evaluate using the orthonormalization property of Legendre polynomial

(i) $\int_{-1}^{1} P_3(x)\, P_4(x)\, dx$,

(ii) $\int_{-1}^{1}[P_2(x)]^2\,dx$ (5)

5. (a) Find the general solution near x = 0 using Frobenius method of :

$$x\,y'' + (1-2x)\,y' + (x-1)\,y = 0 \qquad (10)$$

(b) Identify and name the nature of singularities

$$(1-x^2)^2\,y'' + x(1-x)\,y' + (1+x)\,y = 0 \qquad (5)$$

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1244 **F**

Unique Paper Code : 2222011203

Name of the Paper : Electrical Circuit Analysis (DSC-6)

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

Semester : II

Duration : 2 Hours Maximum Marks : 60

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 and attempt **any three** from the remaining four questions.

4. Use of non-programmable scientific calculator is allowed.

P.T.O.

1. Attempt all questions. Each question carries equal marks. (3x5=15)

(a) Determine the form factor and peak factor for a half-rectified sinusoidal wave.

(b) What is the principle of duality in network analysis? How can it be used to solve problems in network analysis?

(c) Calculate average and rms values of the current, $i(t) = 10 + 10 \sin \omega t$.

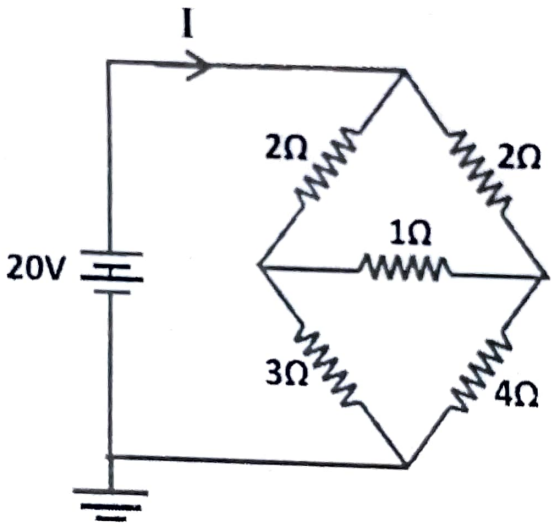
(d) A 0.1 μF capacitor is first charged and then discharged through a 10MΩ resistor. Find the time in which the potential will fall off half of its maximum value.

(c) Discuss briefly how a voltage source can be converted into a current source and vice-versa.

2. (a) Derive an expression for resonance frequency of a series LCR circuit having an alternating voltage source. Calculate the resonant frequency and quality factor of the circuit for given values of C = 550 nF, R = 60 Ω and L= 260 mH respectively. (8)

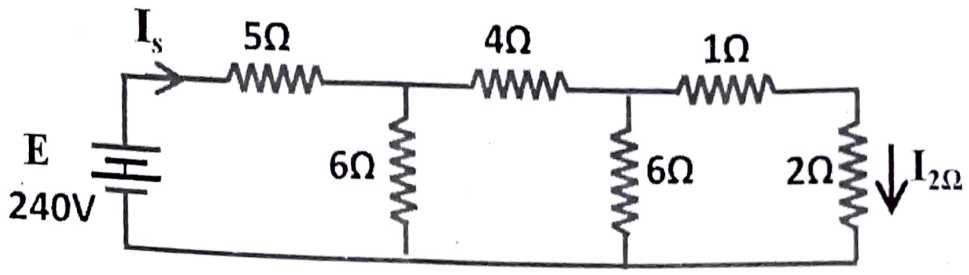
(b) A series LCR circuit with R= 6Ω, X_L=10Ω and X_c = 12 Ω is driven by a sinusoidal voltage source, v(t) = 20 cos (4000t) volts. Determine the equivalent impedance of the circuit. Also, draw its phasor diagram. (7)

3. (a) Determine the value of current I in the given diagram by using the Star-delta conversion method.



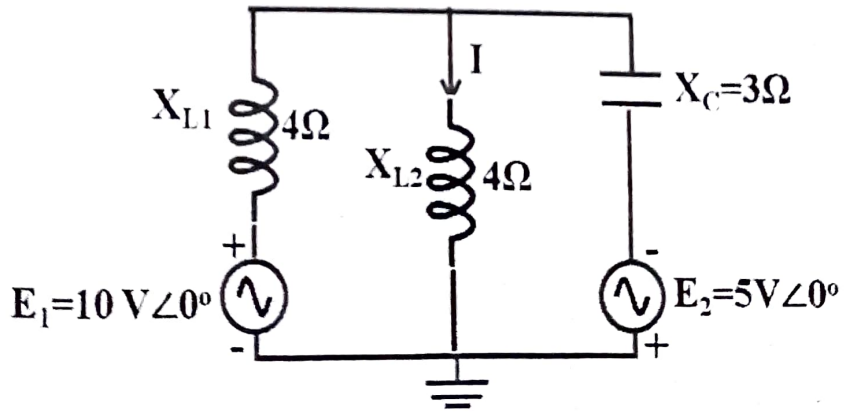
(8)

(b) Find out source current I_s and current through the resistance 2Ω ($I_{2\Omega}$) in the circuit given below.



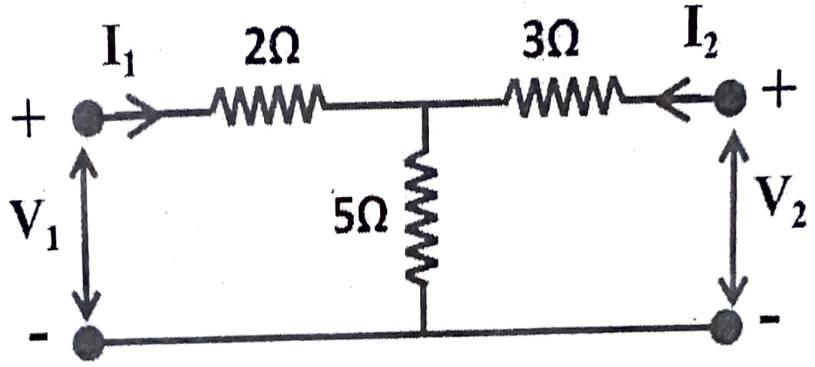
(7)

4. (a) Using the superposition theorem, find the current I through X_{L2} in the circuit given below.



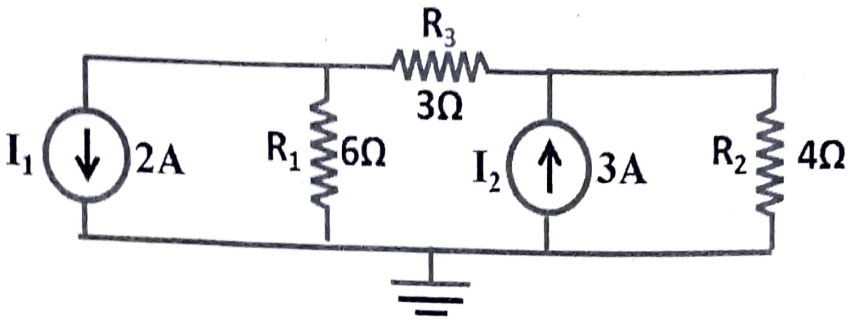
(8)

(b) Determine the transmission parameters (ABCD) of the given network.



(7)

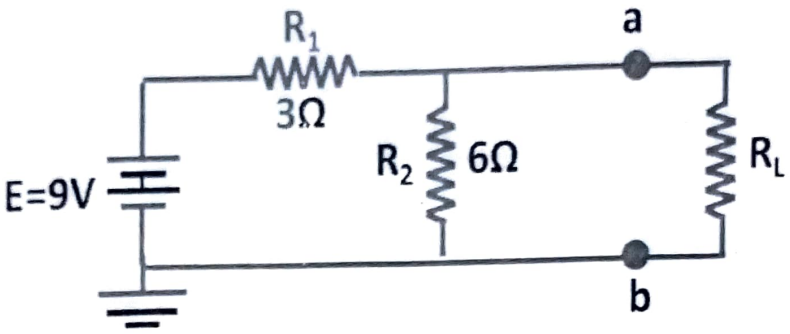
5. (a) Determine the voltage across R_3 resistor using the nodal analysis method.



(5)

(b) A series RL circuit with R = 560 Ω and L = 350 mH is driven by a sinusoidal current source, i(t)= 30 cos (ωt + 25°) ampere, where ω= 1000 rad/s. Find the voltage drop across R and L and the input voltage. (5)

(c) Find the Norton equivalent circuit at ab of the given network.



(5)

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[This question paper contains 4 printed pages.]

Your Roll No.....

E

Sr. No. of Question Paper : 4879

Unique Paper Code : 32227612

Name of the Paper : Nano Materials and Applications

Name of the Course : **B.Sc. Hons. Physics – CBCS_DSE**

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 **five** questions in all.
3. Question no. **1** is compulsory.
4. **All** questions carry equal marks.
5. Symbols have their usual meanings.

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

   (a) Name the nanostructures where an electron feels (i) 1 dimensional, (ii) 2 dimensional and (iii) 3-dimensional confinement. Give one example of each.

P.T.O.

(b) What do you understand by size effect and quantum size effect? Give one example of each.

(c) What is graphene and how is it different from C_{60} and carbon nanotubes?

(d) The XRD data of a material exhibits a peak at a 2θ angle of 30 degrees and FWHM of 0.3 degrees. Comment whether the synthesized material will be called a nanomaterial or not. (X-ray wavelength used is 0.154 nm).

(e) The bandgap of $Al_XGa_{(1-X)}N$ can vary from 3.4(x=0) to 6.2(x=l) eV. What is the range of wavelengths that can be emitted from such semiconductor?

(f) The absorption edge of ZnO thin films of thicknesses 10nm, 20nm, and 50nm are observed at 350nm, 360nm, and 375nm respectively. Plot the bandgap as a function of film thickness.

(g) How nanomaterials can be used for cancer therapy?

(h) Write the expression of the bandgap of a spherical nanoparticle. Explain the effect of excitonic contribution.

2. (a) Define density of states and its units. Drive the expression for the density of states for ID structure. Compare the results with the density of states of 3D structure using suitable energy curves. (10)

(b) An electron of mass 9.1×10^{-31} kg is trapped in a cubical box each side 1A°. Calculate the eigen energy value corresponding to 3rd energy level. Is there any degeneracy in these states, if yes, determine it? ($h = 6.626 \times 10^{-34}$ Js). (5)

3. (a) Discuss the phenomenon of quantum mechanical tunneling and hopping conductivity in solids with proper band diagrams? Give one application of each. (10)

(b) An electron with kinetic energy $E = 16$ eV is incident on a potential step of height $V = 7$ eV. Calculate the reflection coefficient. (5)

4. (a) Explain with suitable diagram the process of UV photolithography technique for patterning any structure. (8)

(b) Explain the nucleation and growth process in the synthesis of colloidal nanomaterials. (7)

5. What is the basic working principle of chemical vapor deposition (CVD) technique? Discuss any one of the CVD technique in detail. What are the various parameters that needs to be controlled during deposition? (15)

6. (a) Discuss the working of scanning electron microscope (SEM) with a neat diagram. (8)

(b) What will happen if the energy of the electron is very high, say relativistic? (2)

(c) What are the advantages and disadvantages of SEM over optical microscopes. (5)

7. (a) How an exciton is classified in the context of binding energy? Derive the expression for the binding energy of an exciton. (12)

(b) The interfacial energy for barium sulphate nanocrystals in saturated aqueous solution is 120 mJ/m^2. If the critical radius is 1 nm, calculate the value of the Gibbs free energy barrier. (3)

8. (a) How is ballistic transport different from diffusive transport? Explain with the help of diagram and give one example of each. (7)

(b) Explain the working of a single electron transfer device. (8)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1272 **F**

Unique Paper Code : 2222511201

Name of the Paper : Electricity and Magnetism

Name of the Course : **B.Sc. (Prog.)**

Semester : II

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt four questions in all. All questions carry equal marks.
3. **Question No. 1** is compulsory.
4. Non-programmable calculator is allowed.

1. Attempt all of the following : (5x3)

(a) A certain parallel plate capacitor with capacitance $C = 12\ \mu F$ is connected to a source of EMF with potential 3 V. A material of dielectric constant 4 is then inserted between the plates of capacitor.

P.T.O.

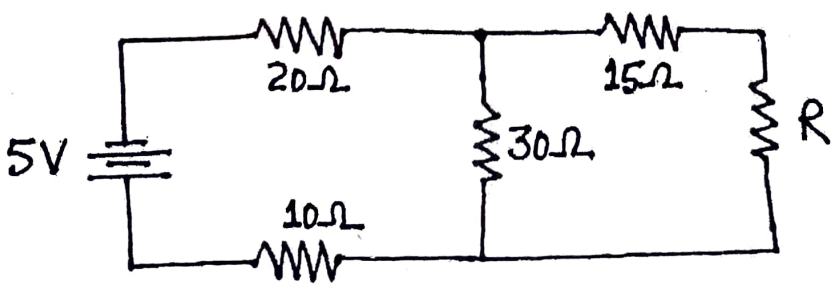
By how much does the energy stored in the capacitor change?

(b) State and deduce the Gauss's law in differential form.

(c) Define $\vec{B}, \vec{M}$ and $\vec{H}$. Establish the relation $\vec{B} = \mu_0(\vec{H} + \vec{M})$.

(d) A solenoid has a length of 50 cm and a radius of 1 cm. If the number of turns in the solenoid is 500 and relative permeability of the material on which the turns are wounded is 800, calculate the coefficient of self-inductance.

(e) Determine Thevenin's equivalent circuit for the given network across the load resistance R



2. (a) What is an electric dipole? Derive the expressions for the electric potential and electric field intensity due to an electric dipole at any point. (10)

(b) Three identical charges q = 1μC are placed in the (x,y) plane at coordinates (-1,0), (1,0) and (0, 1). How much work is needed to move the charge placed at the initial position (0, 1) to a new position (0,0), while holding the other two charges in their original positions. (all the distances are in meter) (5)

3. (a) State and explain Biot-Savart's law. Derive an expression for the magnetic field at a point on the axis ofa circular coil carrying a steady current using Biot-Savart's law. (10)

(b) A uniform solenoid 100 mm in diameter and 400 mm long has 100 turns of wire. If a current of 3 A is flowing through it, calculate the magnetic field at its center. (5)

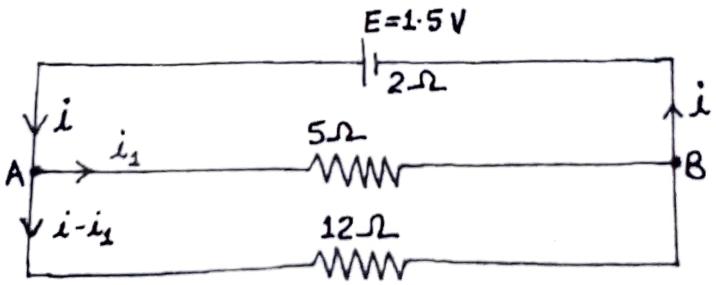
4. (a) What is electromagnetic Induction? State and explain Faraday's and Lenz's law of electromagnetic induction. Explain the fact that Lenz's law in accordance with the law of conservation of energy (10)

P.T.O.

(b) Write the Maxwell's Equations with their physical significance. (5)

5. (a) Write the statement of Superposition and Maximum Power transfer theorem for linear circuit and make necessary diagram to explain. What is the maximum power transferred to a load resistance R_L by a voltage source of 8 Volts connected in series with a resistance of 100Ω ? (10)

(b) A cell of E.M.F. 1.5 volt has internal resistance 2 Ω. Find the current given by the cell and the current through each resistance in given figure by using Kirchhoff s law. (5)



Constants:

$\mu_0 = 4\pi \times 10^{-7}$ henry/metre (free space)

$\epsilon_0 = 8.85 \times 10^{-12}$ $C^2/N.m^2$ (free space)

(1000)

[This question paper contains 8 printed pages.]

Your Roll No.....

E

Sr. No. of Question Paper : 5714

Unique Paper Code : 42221201

Name of the Paper : Electricity, Magnetism and EMT

Name of the Course : **B.Sc. Prog. – CBCS Core**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Five** questions in all.
3. Question No. **1** is compulsory.
4. Attempt **four** questions from the rest of the paper.
5. Use of non-programmable calculator is allowed.

P.T.O.

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

(a) Given a vector $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. Show that $\oiint_S \vec{r}.d\vec{S} = 3V$, where V is volume enclosed by surface S.

(b) Prove that the electric field at any point can be expressed as the negative gradient of potential at that point.

(c) Two concentric spheres of diameters 10 cm and 12 cm where medium between the spheres is air and the outer sphere is earthed make a spherical capacitor. Find the charge on the inner sphere if the potential difference between the spheres is 10,000 volt.

(d) Differentiate between diamagnetic and paramagnetic material (mention any two points). Give one example of each.

(e) In a coil an emf of 6 V is induced when the current in the coil changes at the rate of 100 Amp per second. Find coefficient of self-inductance of the coil.

(f) What is Lenz's law? Show that it is in accordance with the law of conservation of energy.

(g) How does the electric field produced by the varying magnetic field differ from the electric field of stationary charges?

2. (a) Find the directional derivative of $\phi = 4xz^3 - 3x^2y^2z$ at $(2, -1, 2)$ in the direction $2\hat{i} - 3\hat{j} + 6\hat{k}$. (5)

(b) Prove that $\nabla^2 r^n = n(n + 1)r^{n-2}$ where n is constant. (5)

P.T.O.

(c) Given $\vec{A} = \left(3x^2 + 6y\right)\hat{i} - 14yz\hat{j} + 20xz^2\hat{k}$. Evaluate the line integral from (0, 0, 0) to (1, 1, 1) along the following paths c: $x = t$, $y = t^2$, $z = t^3$. (5)

3. (a) Using Gauss's theorem, find an expression for the electric field due to an infinite line charge of uniform charge density X at a perpendicular distance 'a' from it. (5)

(b) Derive expressions for the electric potential due to a uniformly charged spherical shell at points inside and outside the shell. Show that the electric potential due to the shell at any point inside is equal to the value of the potential on its surface. (7)

(c) Show that the potential function $V = a(x^2 + y^2 + z^2)^{1/2}$ does not satisfy Laplace's equation. (3)

4. (a) What do you understand by polarization of a dielectric? Define three electric vectors $\vec{D}$, $\vec{E}$ and $\vec{P}$. Establish the relation between them. (7)

(b) How does the capacitance of a parallel plate capacitor change when a dielectric slab of dielectric constant K is inserted between the plates and it completely fills the space between the plates? (4)

(c) A parallel plate capacitor with plate area 1 m^2 is completely filled with a dielectric material of dielectric constant 5. The capacitor is charged to a potential of 200 volt. If the distance between the plates is 0.01 cm, find the energy stored in the capacitor. (4)

5. (a) Starting from Biot Savart's law, derive an expression for the magnetic vector potential at a distance $\vec{r}$ from the current element. (5)

(b) Derive an expression for magnetic field of a small current loop. (5)

(c) Using Biot Savart's law calculate the magnetic field due to a finite current element. (5)

6. (a) Explain Faraday's law and Lenz's law of Electromagnetic induction. (4)

(b) Define coefficient of self-inductance. Derive an expression for self-inductance of a solenoid. (2+3=5)

(c) A solenoid of 80 cm length has 550 turns and 2 cm diameter. Calculate :

(i) the self-inductance of the solenoid.

(ii) the magnetic flux linked with coil when the current in the solenoid is 2 A.

(iii) the rate of change of current in the solenoid that will produce a self- induced emf of 0.3 volts. (6)

7. (a) Write Maxwell's equations for electromagnetic field in integral and differential form in free space. Obtain the wave equations for the electric and magnetic field vectors in vacuum. (7)

(b) An electromagnetic wave propagates along the x direction, the magnetic field oscillates at a frequency of 10^{10} Hz and has an amplitude of 10^{-5} T, acting along the y-direction. Write down the expression of the electric field and compute the wavelength of the wave. (4)

(c) Derive the equation of continuity using Maxwell's equation and give its significance. (4)

Physical Constants :

$\varepsilon_0 = 8.854 \times 10^{-12}$ C/N-m^2:

$\mu_0 = 4\pi \times 10^{-7}$ Wb/A-m;

$c = 3 \times 10^8$ m/s.

$e = 1.6 \times 10^{-1}$ m/s

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5652 **E**

Unique Paper Code : 42174404

Name of the Paper : Chemistry of s and p block elements, States of matter and Chemical Kinetics

Name of the Course : **B.Sc. Physical Science/Life 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 **six** questions in all, **three** questions from **SECTION A** and **three** questions from **SECTION B**.
3. Use separate answer sheets for **Section A** and **Section B** and indicate the section you are attempting by putting a heading of Section.
4. The questions should be numbered in accordance to the number in the question paper.
5. Use of Scientific Calculator is permitted.

P.T.O.

SECTION – A

(Inorganic Chemistry)

Attempt any **three** *questions from this section.*

1. (a) What is Ellingham's diagram? CO is better reducing agent than carbon below 710°C but above this temperature reverse is true. Explain. (4.5)

(b) Discuss the cyanide process of purification w.r.t silver metal. (4)

(c) What is diagonal relationship? Give reasons why it arises in Beryllium and Aluminium. (4)

2. (a) How NH_2OH is used in the preparation of nylon-6. Give the chemical reaction involved. (4.5)

(b) Compare the reducing power of H_3PO_4, H_3PO_3 and H_3PO_2. Give reason for your answer. (4)

(c) Graphite cleaves readily between layers. Explain. (4)

3. (a) What is inert pair effect? PbO_2 is an oxidizing agent. Explain. (4.5)

(b) Why excessive use of Phosphates as water softener is criticized by the environmentalists? (4)

(c) Complete any **four** reactions : (4)

(i) $H_2S_2O_7 + H_2O \rightarrow$

(ii) $N_2H_4 + O_2 \rightarrow$

(iii) $2ClO_2 + 2NaOH \rightarrow$

(iv) $CaC_2 + 2H_2O \rightarrow$

4. (a) Why the second ionization enthalpy of alkali metals is extremely high? Name the factors that influence the ionization energy. (4.5)

(b) Sulphur when heated melts to a mobile liquid, but on further heating the viscosity increases sharply and then decreases again. Explain. (4)

(c) Draw the structures/Shapes of the following compounds :

N_2H_4, SO_2Cl_2, NH_3, PCl_5 (4)

SECTION – B

(Physical Chemistry)

Attempt **three** *questions from this section.*

$R = 8.314 \text{ J K}^{-1}\text{mol}^{-1}$

$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$

$$N_A = 6.023 \times 10^{23}$$

5. (a) Roughly sketch the Maxwell distribution curve for the gas molecules in terms of molecular speeds. Label both axes and explain the effect of temperature on the distribution curve. (3.5)

(b) What are Miller indices? Calculate miller indices for planes having Weiss indices : (3)

(a) 2a, 3b, c (b) 2a, –3b, –3c

(c) Explain the dependence of surface tension on temperature and why the surface tension of a liquid becomes zero at its critical temperature. (3)

(d) Differentiate between order and molecularity of a reaction giving examples. (3)

6. (a) Describe the reasons for deviation of gases from ideal behaviour. Derive van der Waals equation of state for a real gas. (4)

(b) Calculate the collision number, Z_1 and mean free path, λ, of oxygen gas at 1 atm pressure and 27°C. The collision cross-section is 0.27 $(nm)^2$.

(4)

(c) What do you understand by the term viscosity? What are its units? Describe the Ostwald viscometer method for the measurement of viscosity of a liquid giving expression. (4.5)

7. (a) Explain the concept of activation energy of reaction. Derive expression for its calculation from Arrhenius equation. (4)

(b) The density of Li metal is 0.53 g cm^{-3} and the separation of (100) planes is 350 pm. 4 Determine whether the lattice is f.c.c. or b.c.c. M(Li) = 6.941 g mol^{-1}. (4)

(c) Derive expression for Bragg's Law sketching labeled diagram and explain the significance of n in the equation. (4.5)

8. (a) Describe any two methods for determination of order of a reaction. (4)

(b) The rate constant for a second order reaction is 5.7×10^{-5} dm^3 mol^{-1} s^{-1} at 25°C and 1.64×10^{-4} dm^3 mol^{-1} s^{-1} at 40°C. Calculate the activation energy of the reaction. (4)

(c) The half-life of the homogeneous gaseous reaction: $SO_2Cl_2 \rightarrow SO_2 + Cl_2$, which obeys first-order kinetics, is 8 minutes. How long will it take for the concentration of SO_2Cl_2 to be reduced to 1% of the initial value? (4.5)

13

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5778 **E**

Unique Paper Code : 42224412

Name of the Paper : Waves and Optics

Name of the Course : **B.Sc. (Prog.) 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. **Question no. 1** is compulsory.
3. Attempt **any five** questions in all.
4. **All** questions carry equal marks.

1. (a) State the principle of superposition in the context of two collinear harmonic oscillations of same frequency.

P.T.O.

(b) What are beats? Writean expression for the frequency of beats.

(c) Compare the intensity pattern obtained by Young's double slit interference experiment and Fraunhofer diffraction due to a double slit.

(d) Write two differences between travelling and stationary waves.

(e) Distinguish between Fizeau and Haidinger Fringes? Give examples.

(f) Distinguish between Fraunhofer and Fresnel's class of diffraction.

(g) Calculate the change in intensity level when the intensity of sound increases 100 times its original intensity.

2. (a) What do you understand by Lissajous figures? (3)

(b) Find the resultant of two perpendicular simple harmonic motions whose amplitude are in the ratio 1:2 and the phase difference is 90°. (12)

3 (a) What are normal modes of vibration in a stretched string?Discuss the possible modes of vibration of a stretched string of finite length fixed at both ends. (8)

(b) What do you mean by wave velocity and group velocity? Derive the relation between them in a dispersive medium. (7)

4. (a) Explain how sound waves are produced. What do you understand by intensity and loudness of sound? (7)

(b) How does a noise is different from musical notes? Discuss in detail how musical scales are made? (8)

5. (a) Explain the phenomenon of interference of light due to thin films and find the condition for maxima and minima. (10)

(b) An oil film (μ=1.47) of thickness t=0.12 μm rests on a pool of water. If light strikes the film at an angle of 60°, what is the wavelength reflected in the first order? (5)

6. (a) Describe the construction and working of Michelson's interferometer. Explain how it is used to determine wavelength of monochromatic light. (10)

(b) When the movable mirror of Michelson interferometer is moved through 0.06854 mm, a shiftof 220 fringes is observed. Find the wavelength of light used. (5)

7. (a) Explain with theory, Fresnel type of diffraction due to straight edge. (7)

(b) Explain the theory of plane transmission grating. How it can be used to find the wavelength of light? (8)

8. (a) What do you mean by plane polarised light? What are the various ways to produce it? (7)

(b) Describe how one can produce and detect circularly-polarised and elliptically-polarised light with the help of Nicol prism and quarter-wave plate. (8)

[This question paper contains 4 printed pages.]

Your Roll No.....

F

Sr. No. of Question Paper : 1225

Unique Paper Code : 2222011202

Name of the Paper : Electricity and Magnetism

Type of the Paper : DSC

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

Semester : II

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Question 1** is compulsory.
3. Attempt **any four** questions from question numbers 2-6.
4. All questions carry equal marks.

1. Attempt **all** parts of this question: (6×3=18)

   (a) Find the electric field at the centre due to a uniformly charged semi-circular arc.

P.T.O.

(b) Find the potential for the region between two concentric right circular cylinders when $V_1 = 0$ at V at r = 1 mm and V_2 =150 V at r = 20 mm.

(c) What is the interpretation of Gauss's law in the case of static charge and steady current, respectively.

(d) An infinite solenoid (**N** turns per unit length, current **I**) is filled with linear material of susceptibility χ_m. Find the magnetic field inside the solenoid.

(e) A dielectric cube of side '*a*' centered at the origin carries a polarization $\vec{P}=k\vec{r}$ where **k** is a constant. Find the bound charges densities σ_b and ρ_b ?

(f) Why the nature of magnetic susceptibilities in paramagnet, diamagnet and ferromagnet are different?

2. (a) A uniformly charged disc of radius **R** having surface charge density c is placed in the **x-y** plane with its center at the origin. Find the electric field intensity along the **z**-axis at a distance **Z** from origin. (9)

(b) Verify that the differential version of Ampere's Law implies the integral version, using Stokes' Theorem. (6)

(c) Is the choice of the vector potential corresponding to a given magnetic field unique? Justify. (3)

3. (a) Obtain the boundary conditions for the electric field and displacement vector at the interface of two dielectric media having dielectric constants ε_1 and ε_2 respectively. (6)

(b) Which one of these is an impossible electrostatic field? Justify.

(i) $\vec{E}=k[xy\hat{i}+2yz\hat{j}+3xyz\hat{k}]$

(ii) $\vec{E}=k[y^2\hat{i}+(2xy+z^2)\hat{j}+2yz\hat{k}]$ (6)

(c) A solenoid of length 30 cm and area of cross-section 10 cm^2 has 1000 turns wound over a core of constant mu = 600. Another coil of 500 turns is wound over the same coil at its middle. Calculate the mutual inductance between them. (6)

4. (a) Calculate the divergence of electrostatic field due to a point charge **q** located at **r'** from the origin. Give the physical interpretation of your result. (9)

(b) A current distribution generates a vector potential $\vec{A}=xy\hat{i}+yz\hat{j}-4xyz\hat{k}$ Wb/m. Calculate the flux of magnetic field through the surface defined by $z = 1$, $0 \leq x \leq 1$ and $-1 \leq y \leq 4$ (6)

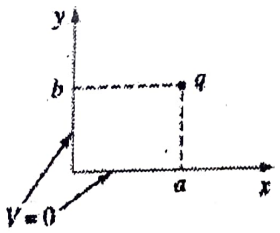
P.T.O.

(c) Moist soil has a conductivity of 10^{-3} S/m and relative permittivity 2.5. Find J_c and J_D where $E = 6 \times 10^{-6} \sin(9 \times 10^9 t)$ V/m (3)

5. (a) Two infinitely long grounded metal plates at y=0 and y=π are connected at x=+a and x=-a by a metal strip maintained at potential V_0. Find the potential inside the rectangular pipe for V=0 when y=0 & y = π and $V=V_0$ at x = +a & x=-a. (12)

(b) What is the significance of Maxwell's displacement current, and how is it different from conduction current? (3+3)

6. (a) Two semi-infinite grounded conducting planes meet at right angles. In the region between them there is a point charge q. Find the location and magnitude of all image charges. (9)



(b) An infinitely long circular cylinder carries a uniform magnetization M parallel to its axis. Find the magnetic field inside and outside the cylinder. (9)

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[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5883 **E**

Unique Paper Code : 42227637

Name of the Paper : Solid State Physics

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

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 **five** questions in all.
3. Question No. **1** is compulsory.

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

(a) Find the reciprocal lattice vectors for

$a = 3i, \quad b = 3j, \quad c = i+j+k$

P.T.O.

(b) Define the Mobility, Drift velocity, and conductivity of a semiconductor.

(c) Derive the relationship between displacement vector D, polarization vector P, and electric field intensity E through diagram.

(d) Give one experimental evidence that led to the phenomenon of Superconductivity.

(e) Differentiate between conductors, semiconductors, and insulators on the basis of energy level diagram.

(f) What is the difference between Ferroelectricity and Piezoelectricity?

(g) Calculate the Flail coefficient of sodium based on the free electron model. Given that sodium has BCC structure and the side of the cube is 4.28Å.

2. (a) What is the reciprocal lattice to FCC lattice? (4)

(b) Show the following : (122), (111), (201), and [101] in a simple cubic lattice. (4)

(c) What is the difference between Atomic and Geometrical structure factors? Derive the relation for the intensity of the diffracted beams. (7)

3. (a) Find the expression for the dispersion relation of a monoatomic lattice. Flow is it different from that of a continuous string? (7)

(b) Discuss Flail effect and derive the formula for the Hall coefficient. (4)

(c) Explain how the measurement of the Hall coefficient helps one to determine the mobility of electrons in metals. (4)

4. (a) Discuss the Kronig-Penny model for the motion of electrons in a periodic potential. Show from E-K graph that the materials can be classified into conductors, insulators, and semiconductors. (10)

(b) Define the effective mass of an electron. Give its physical significance. (5)

5. (a) Obtain the Lorentz relation for the local electric field at an atom. Outline the difference between E, Maxwell's field, and E_{loc}, the Lorentz field. (10)

(b) Differentiate between Normal and Anomalous dispersion. (5)

6. (a) What is ferromagnetism? Describe classical Weiss's theory of ferromagnetism and give the significance of Curie's temperature. (10)

(b) A paramagnetic salt contains 10^{28} ions/m^3 with magnetic moment of one Bohr magneton. Calculate the paramagnetic susceptibility and the magnetization produced in a uniform magnetic field of 10^6 A/m at room temperature. (5)

7. (a) Describe the significance of critical temperature, critical magnetic field and critical current for superconductors. (10)

(b) Write short notes (i) Hard superconductors (ii) High temperature superconductors. (5)