(1)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 3007 **H**

Unique Paper Code : 32221402

Name of the Paper : Elements of Modern Physics

Name of the Course : **B.Sc. Hons Physics Core Repeat Paper**

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. **Q1** is compulsory.
4. **All** questions carry equal marks.
5. Use of non-programmable scientific calculator is allowed.

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

(a) Find the minimum energy of an electron confined in a one-dimensional box of size 10 nm.

(b) What is the number of photons that strike a surface of $1cm^3$ in one second if the incoming light of 650nm wavelength has an intensity of 100 watts/ m^2?

(c) What are spontaneous and stimulated emissions? Why stimulated emission is necessary for lasing action?

(d) The wavefunction associated with a particle is given as $\psi(x) = A \cos\left(\frac{n\pi x}{L}\right)$ in region $0 \leq x \leq L$. Find the value of normalization constant A.

(e) The position and momentum of a 1 KeV electron are simultaneously measured, if the position is located within 0.1 nm, what is the percentage of uncertainty in momentum?

(f) The binding energy of $^{24}Mg_{12}$ is 198.28 MeV. Find its atomic mass, (take mass of neutron to be 1.674×10^{-27}kg and mass of proton to be 1.672×10^{-27}kg)

(g) The half-life of ^{24}Na is 15 hours. How long will it take for 70% of sample of this nuclide to decay?

2. (a) What is photoelectric effect? Discuss the observations of the experiment illustrating photoelectric effect. How does the classical electromagnetic theory fail to explain these results?

(b) If blue light of wavelength 460 nm impinges on a metal surface, a stopping potential of 1.1 eV is obtained. What will be the work function of the given metal? (10,5)

3. (a) State Heisenberg's uncertainty principle for position and momentum and illustrate it using gamma ray microscope thought experiment.

(b) A photon is emitted in a process characterized by a time interval of 1.0 millisecond. What will be the inherent uncertainty in the energy and frequency of the emitted photon. (7,8)

4. (a) Obtain the time independent Schrodinger's wave equation from the time dependent Schrodinger equation.

(b) Prove the relation $\partial P/\partial t + \nabla.J = 0$, where J is the probability current density and P is the probability density. Give the physical interpretation of the equation. What are the states called for which $\nabla.J = 0$. (5,10)

5. (a) A particle of mass m is confined in a one dimensional infinitely rigid box having potential

$$V(x)=\begin{cases}\infty & x<-a/2\\ 0 & -a/2\le x\le a/2\\ \infty & x>a/2\end{cases}$$

Find the wave function associated with the particle and its energy E.

(b) What are quantum dot particles? How are they related with quantum mechanics? (10,5)

6. (a) On the basis of the liquid drop model of a nucleus, explain the various terms of semi-empirical mass formula for calculation of binding energy of a nucleus.

(b) Gold $^{197}_{79}Au$ is the most ductile metal. Calculate is average radius, nuclear volume and nuclear density. (10,5)

7. (a) Discuss the variation of binding energy per nucleon with mass number, A, and hence explain the concept of (i) nuclear stability, (ii) nuclear fission, and (iii) nuclear fusion.

(b) Consider the following decay process:

$$^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He + Q$$

Determine the kinetic energies of the α-particles and the daughter nuclei. (10,5)

(2)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4123 **H**

Unique Paper Code : 2222011202

Name of the Paper : Electricity and Magnetism

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

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) Two uniform infinite sheets of electric charge densities $+\sigma$ and $-\sigma$ intersect at an angle of 45°. Find the magnitude and direction of the resultant electric field.

   (b) Calculate the charge density in an enclosed region due to the potential

   $$V = x^2 + y^2 + z^2.$$

P.T.O.

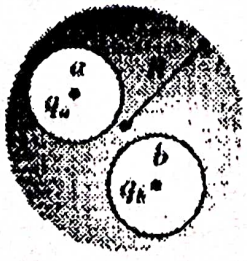
(c) Show that equation of continuity is a consequence of Maxwell's equations.

(d) Given that $\vec{E}_1 = 2\hat{i} - 3\hat{j} + 5\hat{k}$ (V/m) at the charge-free dielectric interface between two different dielectric materials of 2 and 5, respectively. Find $\vec{E}_2$ and $\vec{D}_2$.

(e) Determine whether the following elements are paramagnetic or diamagnetic (i) Chlorine Atoms (Atomic No. = 17, Atomic Mass = 35.43 u), and (ii) Copper atoms (Atomic No. = 29, Atomic mass = 63.55 u)

(f) A current sheet of width 4 m lies in the $z = 0$ plane and contains a total current of 10 A in a direction from the origin to (1, 3, 0) m. Find an expression for $\vec{K}$.

2. (a) Two spherical cavities, of radii a and b, are hollowed out from the interior of a (neutral) conducting sphere of radius R. At the center of each cavity a point charge placed q_a and q_b. Find the surface charge densities on the walls of both the cavities and the surface of the conductor. What is the force experienced by q_a and q_b? (9)



(b) A block of iron ($\mu = 5000\ \mu_0$) is placed in a uniform magnetic field with 1.5 Wb/m^2. If iron consists of 8.5×10^{28} atoms/m^3, calculate (i) the magnetization M (ii) the average dipole moment. (9)

3. (a) A point charge q is located at a from the center of a grounded conducting sphere of radius R along y axis such that (a > R). What is the potential outside the grounded conducting sphere? (9)

(b) In spherical coordinates, V = 0 for r = 0.10 m and V = 100 V for r = 2.0 m. Assuming free space between these concentric spherical shells, find E and D. (9)

4. (a) Calculate the Laplacian of electrostatic potential at any arbitrary point P due to a point charge q located at r' from the origin. (9)

(b) Is it true that in a uniform material with magnetic susceptibility χ_m and electric conductivity 0, the bound current distribution can only be a surface current (assume no time dependence). Justify. (3)

(c) Using Ampere's law obtain magnetic flux density B inside and outside the toroid. (6)

5. (a) A very long cylinder of linear dielectric material is placed in an uniform electric field E_0. Find the resulting field within the cylinder. (The radius is R, the susceptibility χ_r and the axis is perpendicular to E_0.) (9)

(b) State the second uniqueness theorem and under what condition(s) it will reduce to the first one. (3)

(c) In a material for which $\sigma = 5.0$ S/m, $\varepsilon_r = 1$ and electric field intensity is $E = 250\sin 10^{10}t$ V/m. Find the conduction and displacement current densities and the frequency at which they have equal magnitudes. (6)

6. (a) An infinitely long cylinder, of radius R, carries a "frozen-in" magnetization, parallel to the axis, $\vec{M} = kr\hat{r}$ where k is a constant and r is the distance from the axis (there is no free current anywhere). Find the magnetic field inside and outside the cylinder

(i) Locate all the bound currents, and calculate the field they produce.

(ii) Use Ampere's law to find $\vec{H}$, and then get $\vec{B}$. (3+3+3+3)

(b) Two coaxial solenoids each carrying current I, but in opposite directions. The inner solenoid of radius a has N_1 turns per unit length and the outer of radius b has N_2 turns per unit length. Find $\vec{B}$ in each of the three regions : (i) inside the inner solenoid, (ii) between them and (iii) outside the outer solenoid. (2+2+2)

(3)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4161 **H**

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. (3×5=15)

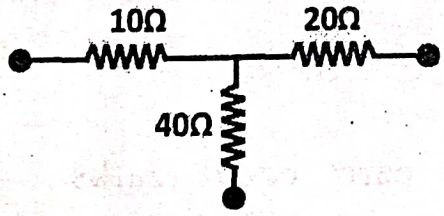
(a) Define an ideal and a real voltage source with the help of a diagram. Draw their V-I characteristic curves.

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

(c) State superposition theorem and give one of its limitations.

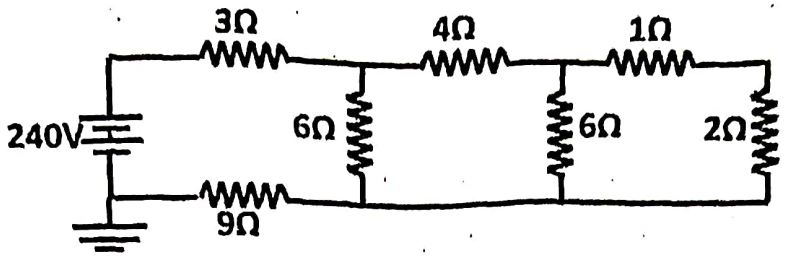
(d) What is the difference between transient and steady state response in a dc network? How does the time constant affect the transient state response?

(e) Convert Y (star) configuration into its equivalent Δ (delta) configuration.



2. (a) Derive an expression to calculate voltage across the capacitor at any given time during charging and discharging process for a RC network. (8)

(b) Find the voltage across the 2Ω resistor using nodal analysis for the given network. (7)

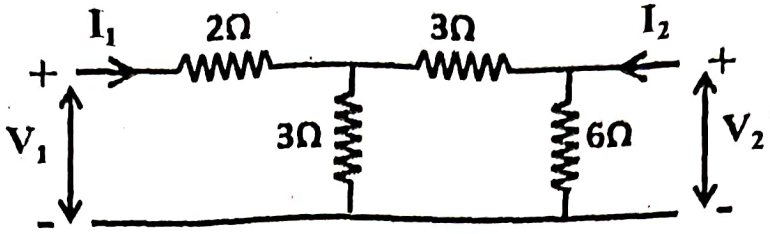


3. (a) A circuit with components L, C and R are connected parallel to each other and with an ac voltage source. Given, R = 10 Ω, L = 300 mH and v(t) = 10 cos 5000t. Find the value of C at resonance, when the value of resonant frequency is 460 Hz. Determine the voltage across C and the current i(t) in the circuit using phasor notation. (8)

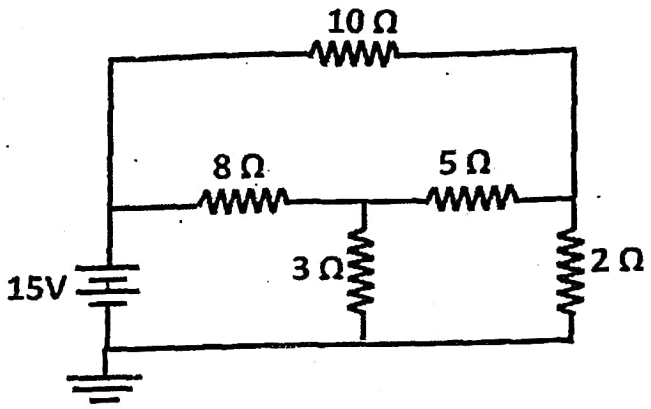
(b) A series RL circuit with R = 560 Ω and L = 350 mH is driven by a sinusoidal voltage source with angular frequency (ω) = 1000 rad/s. Determine the equivalent impedance to the series RL circuit. Draw its impedance diagram. (7)

4. (a) State and prove Maximum Power Transfer theorem for an ac network. (8)

(b) Determine z-parameters of the given two-port network. (7)

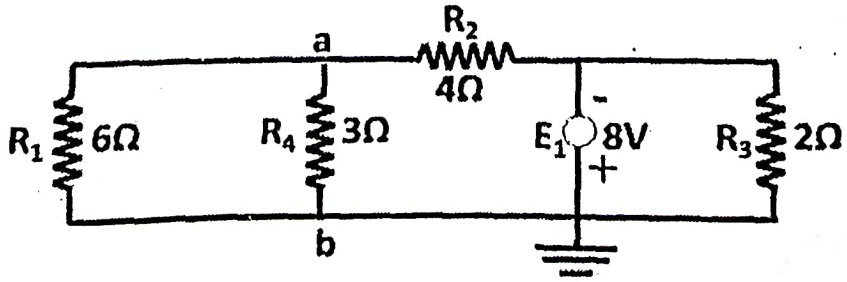


5. (a) Find the value of current through the 10-Ω resistor using Mesh analysis. (5)



(b) Derive an expression for sharpness of resonance of a series LCR circuit, driven by a sinusoidal source. (5)

(c) Draw the Thevenin's equivalent circuit at terminals ab (R_4) for the given network. (5)



(4)

Roll No. .....

Sl No of QP	:	4142A
Name of the Department	:	Department of Physics and Astrophysics
Name of Course	:	B.Sc. Hons. - (Physics)_NEP: UGCF-2022__DSCC-12
Name of the Paper:	:	Analog Electronics
Semester	:	IV - Semester
Unique Paper Code	:	2222012403
Duration	:	2 hours
Max. Marks	:	60 marks

Instructions for Candidates:

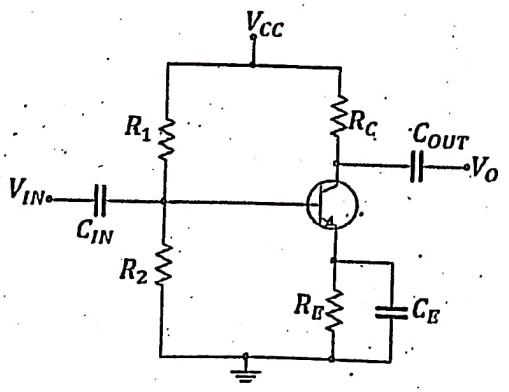
a) *Write your Roll No. on the top immediately on receipt of this question paper.*
b) *Attempt any Four questions in all. Question No. 1 is compulsory.*
c) *Simple non-programmable calculators are allowed.*

1. Attempt all parts of the following: (3X5=15)

a) In a common emitter transistor configuration, the current amplification factor is 0.9. If the emitter current is 1mA and leakage current is assumed zero, determine the value of the base current for the common base configuration.
b) For what voltage will the reverse current in a Germanium pn junction diode reach 80% of its saturation value at room temperature?
(Given $\eta = 1$, $k = 1.38 \times 10^{-23}\ J/K$; $q = 1.6 \times 10^{-19}$C)
c) Why do we need positive feedback in designing oscillator ciruits.
d) Explain the role of coupling capacitor (C_C) and Emitter capacitor in (C_E) based transistor amplifier circuits.
e) An Op-Amp in open loop inverting configuration is driven by a 1kHz triangular wave of 100 mV peak signal value. Draw the output waveform of the circuit with respect to this input.

2. (10,5)

a) A transistor amplifier with voltage divider biasing circuit has the following specifications ; $V_{CC} = 22V$, $R_1 = 39k\Omega$, $R_2 = 3.9k\Omega$, $R_C = 10k\Omega$, $R_E = 1.5k\Omega$, $C_{IN} = C_{OUT} = 10\mu F$, $C_E = 50\mu F$ and $\beta = 140$. Determine the dc bias voltages and the quiescent point parameters. Also show the quiescent point on the dc load line for the circuit.



b) Define the four h-parameters with reference to a CE transistor configuration. Explain how these parameters can be determined from the static characteristic curves of the configuration.

3.

a) A sinusoidal peak-to-peak voltage of 60 sin $100\pi t$ is applied to a full wave rectifier with load resistance of 500 Ω and forward diode resistance of 50 Ω. Find the maximum DC current component, rms current component, PIV of the semiconductor diode, ripple factor and rectification efficiency. (5,10)

b) Define line regulation and load regulation for a Zener diode based voltage regulator. Explain with help of a circuit diagram the working of Zener diode as a voltage regulator. Derive the relations for the minimum value of load resistance, the minimum and the maximum value of the supply voltage that can be regulated by a given Zener diode.

4.

a) Derive the expresson for the oscillation frequency of a transistor based Hartley Oscillator. (9,3,3)

b) A transistor based Colpitts oscillator has a frequency of oscillation $f = 100kHz$. If the value of two of the frequency determining components is $L = 100mH$ and $C_1 = 0.01\mu F$. Determine the value of the third component.

c) Calculate the frequency of oscillation for the transistor based RC phase shift oscillator having $R_C = 2k\Omega, R = 5k\Omega$ and $C = 0.01\mu F$.

5.

a) Explain the working of a basic differentiator circuit designed using Op-amp. Explain the problems associated with the basic circuit and how they are rectified in a practical differentiator. Explain the response curve for the circuit. (8,4,3)

b) Design an practical Op-amp integrator for the frequency range from 1 to 10 kHz. Choose the capacitor value as 0.1 μf.

c) Calculate the output voltage for an op-amp based inverting summing amplifier for the following sets of voltages and resistors:
(i) $V_1 = 1V, V_2 = 2V, V_3 = 3V, R_1 = 500k\Omega\ R_2 = 1M\Omega\ R_3 = 1M\Omega$ and $R_F = 1M\Omega$
(ii) $V_1 = -2V, V_2 = 3V, V_3 = 1V,\ R_1 = 200k\Omega\ R_2 = 500k\Omega\ R_3 = 1M\Omega$ and $R_F = 1M\Omega$

(5)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 3078 **H**

Unique Paper Code : 32227613

Name of the Paper : Communication System

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

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. **All** questions carry equal marks.
4. Question No. **1** is compulsory.
5. Use of scientific calculator is allowed.

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

(a) What are the different ways to increase the capacity of a cell in a cellular network?

(b) A carrier wave is given by $V_c = 5.0 \times \text{Cos}\ (6 \times 10^6 \times t)$. This carrier is amplitude modulated by a base band signal given by $V_m = 3.0 \times \text{Cos}\ (100t)$. Find the value of modulation index.

(c) How PM signal is derived from FM?

(d) A broadcast radio transmitter radiates 5 kW power when the modulation percentage is 60 percent. How much is the carrier power?

(e) The noise level available at the output of a communication receiver is -10 dBm. What is the noise level in the absolute scale?

(f) What do you mean by bandwidth? Explain Shannon's limit for information capacity.

2. (a) Define the term SSB in amplitude modulation. Explain any one method of SSB signal generation using suitable block diagram. How much power is saved in SSB transmission over DSB-SC transmission?

(b) Explain amplitude demodulation using diode detector. What type of distortions can occur in the detection of AM signal using this method of detection? (8,7)

3. (a) Define Pulse amplitude modulation (PAM) and explain its generation with suitable diagrams.

(b) For the following bit sequence, draw the timing diagram for Unipolar Return to Zero (UPRZ), Unipolar Non Return to Zero (UPNRZ), Bipolar Return to Zero (BPRZ), Bipolar Non Return to Zero (BPNRZ) and Split Phase (Manchester) encoding :

Bit stream: 1 0 1 0 1 1 0 1 0 1 1 0 0 (10,5)

4. (a) Write the requirements of a FM detector circuit. Draw and explain the circuit diagram of slope detector for the demodulation of FM signal.

(b) An angle modulated signal has the form $s(t) = 100 \text{Cos}[2\times10^{7}\pi t + 4\text{Sin}(2\times10^{3}7\pi t)]$

(i) Determine the average transmitted power for a load resistance of 1kΩ.

(ii) Determine the peak phase deviation.

(iii) Determine the peak frequency deviation. (10,5)

5. (a) Draw the block diagram for a pulse code modulation (PCM) system and explain it's working.

(b) Determine (i) the peak frequency deviation, (ii) minimum bandwidth for a binary FSK signal with a mark frequency of 49 kHz, a space frequency of 51 kHz and an input bit rate of 2 kbps. (10,5)

6. (a) Explain Global System for Mobile Communication with the help of a block diagram. Describe in detail about its different components and the interfaces between them.

(b) What do you understand by handoff and roaming?

(c) Determine the following :

(i) Channel capacity for a cellular telephone area comprised of seven macrocells with 16 channels per cell.

(ii) Channel capacity if each macrocell is split into four minicells. (8,4,3)

7. (a) What do you understand by satellite communication? Give a comparison between LEO (Low Earth Orbit), MEO (Medium Earth Orbit) and GSO (Geosynchronous Orbit). Explain why geostationary satellites are preferentially used for worldwide communications.

(b) Draw the block diagram of a satellite transponder and explain it's working. (8,7)

(6)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 3188 **H**

Unique Paper Code : 32227612

Name of the Paper : Nano Materials and Applications

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

Semester : VI

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **five** questions in all.
3. Question No. **1** is compulsory.
4. Symbols have their usual meanings.

P.T.O.

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

(a) What do you understand by nanomaterials? Give one example each of 2D and 1D nanomaterials.

(b) Determine the surface area to volume ratio of spherical particles of radii 1 nm, 10 nm, 1 μm, and plot the variation of the ratio with radii.

(c) How do electrons interact with matter in electron microscopy?

(d) Draw the typical XRD curves obtained for crystalline, polycrystalline and amorphous materials.

(e) Sketch and label a schematic diagram of a single electron transfer device.

(f) How do optical properties of a material change with the size of nanoparticle?

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

(h) What are organic (dye synthesized) solar cells?

2. (a) Explain briefly the physical and chemical vapour deposition techniques. (8)

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

3. (a) Considering the free electron gas model, determine the density of state expression [ρ(E)] for a 3D material. Draw the corresponding E vs. K and E vs. ρ (E) diagram of 3D and 2D material for comparison and explain briefly the important features of the two. (12)

(b) Explain why the confinement results in the appearance of the zero-pointa energy in the E vs. K diagram. What is the physical significance of the zero-point energy? (3)

4. (a) Discuss the absorption, emission and luminescence radiative processes. (10)

(b) Why is vacuum required in all thin film deposition techniques? How is it achieved? (5)

5. Discuss the principle and fabrication technique of any two of the following used for the synthesis of nanomaterials?

(i) Sol-gel

(ii) Sputtering

(iii) Hydrothermal method

(iv) Molecular Beam Epitaxy (7.5×2=15)

6. (s) How is ballistic transport different from diffusive transport? (5)

(b) Obtain an expression for the variation in electrostatic energy of a system for single electron charging. Name the effect associated with it. (10)

7. (a) What are silicon nanowires? Give its various applications. (8)

(b) What are quantum LASER devices? How are they formed? (7)

(7)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4026 **H**

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 : (5×3)

(a) Define the electric flux. A square frame of edge 10 cm is placed with a positive normal making an angle of 60° with a uniform electric field of 20 V/m, find the flux of the electric field through the surface bounded by the frame.

(b) What is Displacement Current?

(c) Define Magnetic permeability and susceptibility. Establish the relation $\mu = \mu_0(1 + \chi)$.

(d) Calculate the coefficient of self-induction of a coil of 1000 turns when a current of 2.5 Ampere produces a magnetic flux of 0.5 micro-Weber.

(e) State Kirchhoff's Current and Voltage law.

2. (a) State and prove Gauss's theorem in electrostatics. (7)

(b) What is the potential at the center of the square, if the four charges are placed at the corner of the square : $q_1 = +1.0 \times 10^{-8}$ C, $q_2 = -2.0 \times 10^{-8}$ C, $q_3 = +3.0 \times 10^{-8}$ C, $q_4 = +2.0 \times 10^{-8}$ C and side of square is 1.0 meter. (5)

(c) The voltage between parallel plates of a capacitor is V_1. The plates are isolated electrically. A dielectric slab of dielectric constant k is inserted between the plates and completely fills the volume between them. Find the new potential V_2. (3)

3. (a) State and explain Biot-Savart's law. Derive an expression for the magnetic field at a point due to an infinitely long straight current carrying conductor using Biot-Savart's law. (7)

(b) What are the characteristics of diamagnetic, paramagnetic and ferromagnetic substances. Illustrate by simple experiment. (5)

(c) A 10 cm long wire carrying a current of 10 ampere is held at an angle 30° with the direction of a uniform magnetic field strength of 1 weber/metre^2. Calculate the force acting on wire. (3)

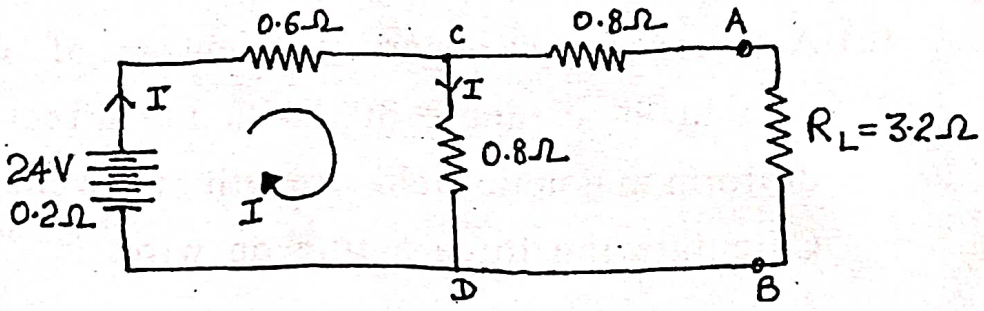
4. (a) Explain the phenomenon of self-induction. Derive an expression for the coefficient of self-inductance of a long uniformly wound solenoid. Hence find the self-inductance of a toroidal coil of circular cross-section of radius r. (7)

(b) Calculate the mutual-inductance of a solenoid of 1 metre length having 500 turns in primary and 100 turns in secondary coil and the area of cross-section of solenoid is 5 cm^2. (5)

(c) Write the equation of continuity and explain its physical significance. (3)

5. (a) State the maximum power transfer theorem. Show that power lost in the internal generator is equal to the power delivered to the load and the power efficiency is only 50%. (7)

(b) Draw the Thevenin's equivalent for the following circuit. Calculate the current through the load resistance. (5)



(c) State and explain Norton's Theorem with example. (3)

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)

(8)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 3538 **H**

Unique Paper Code : 42227637

Name of the Paper : Solid State physics

Name of the Course : **B.Sc. Prog.-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. **All** questions carry equal marks.
3. Attempt **any Five** questions in total.
4. **Question No. 1** is compulsory.

1. Attempt **any five** of the following:- (3x5=15)

   (a) Show that the reciprocal lattice vector $\vec{G}_{hkl}$ is perpendicular to the plane (*hkl*).

P.T.O.

(b) What are phonons? Mention any one experimental fact which indicates the existence of phonons in solids.

(c) At optical frequencies how does the dielectric constant of a polar dielectric depend on the index of refraction? Explain which polarizibility component contributes to the dielectric constant at optical frequencies.

(d) Distinguish between dia-, para-, ferro- magnetic materials

(e) The critical field and critical temperature of lead (Pb) are $6.5\times10^4\ A/m$ and 7.18 K, respectively. To what temperature it must be cooled to become a superconductor in a magnetic field of $2\times10^4 A/m$.

(f) Distinguish between conductors, semiconductors and insulators on the basis of band theory of solids.

(g) How does a superconductor differ from a perfect conductor?

2. (a) Show that the reciprocal lattice of a face centered cubic lattice is a body centered cubic lattice

(6)

(b) X-ray of wavelength 1.54 Å are used to calculate the spacing between (200) planes in aluminium. The first order Bragg's angle corresponding to this reflection is 22.4°. Determine the value of lattice parameter of the aluminium crystal. (4)

(c) Construct first, second and third Brillouin Zones for a 2D square lattice. (5)

3. (a) Draw and discuss the dispersion relation for a linear chain of diatomic crystal. How it is different than the linear chain of monoatomic crystal. Discuss the characteristics of the various branches and why they are names acoustic and optical ones. (7)

(b) What is Dulong-Petit's law for heat capacity of solids? How it is different than the observed heat capacity of solids. Draw the necessary plots to explain the difference. Explain what is wrong in the classical theory of crystal heat capacity that it fails miserably at low temperatures. What modifications are required in the model to explain the experimentally observed behavior? (8)

4. (a) What are the main assumptions of the Debye's theory of specific heat of solid? Obtain its high and low temperature limits of the specific heat and show how far it agrees with the experimental results. (12)

(b) Calculate the Debye specific heat of copper at 10 K, given that the Debye characteristic frequency is 6.55×10^{12} *Hz*. (3)

5. (a) What is meant by local field in a dielectric? Obtain an expression for the local field for an atom in a dielectric medium. (8)

(b) Explain Meissner Effect in superconductors with suitable diagram. (7)

6. (a) Obtain an expression for paramagnetic susceptibility on the basis of Classical Langevin's theory. (10)

(b) Discuss difference between Type-I and Type-II superconductors (5)

7. (a) State all the assumptions of the Kronig-Penney model for an electron in a crystal. Draw the E-K relation of an electron for this model and explain the origin of the observation of forbidden gap in solids. (9)

(b) What is Hall Effect? Explain with the help of a suitable diagram the generation of hall voltage in n-type semiconductor. Mention two uses of Hall Effect. (6)

(9)

Sr. No. of Question Paper : 3430 Your Roll No .....

Unique Paper Code : 42224412

Name of the Course : B.Sc. (Prog.) Physical Science

Name of the Paper : Waves and Optics

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 any Five questions in all. Question No. 1 is compulsory.
3. Simple non-programmable calculators are allowed.
4. All questions carry equal marks.

1. Attempt all of the following: (3x5=15)
   (a) What are coherent sources? Give examples.
   (b) How will you test the flatness of surface by interference of light?
   (c) Compare the action of zone plate and convex lens.
   (d) Refractive index of water is 1.33. Calculate the angle of polarization of light reflected by the surface of pond.
   (e) What do you understand by half and quarter wave plates?

2 (a) Two colinear simple harmonic motions are acting simultaneously on a particle. Show that the resultant motion of particle is simple harmonic motion. Also, obtain the expression for amplitude and phase constant of the resultant motion in term of their amplitudes and phase difference. (8)

(b) Two colinear simple harmonic motions acting simultaneously on a particle are given by $x_1=0.3 \cos 2\omega t$ and $x_2=0.2 \sin(2\omega t-\pi/3)$. where x is expressed in cm and t in seconds. Write down the expression for the resultant displacement as a function of time. (7)

3 (a) State the principle of superposition and prove that it holds only for linear differential equations. (8)

(b) Deduce the expression for the velocity of transverse waves on a long-stretched string. (7)

4 (a) Give the theory of formation of Newton's rings by reflected monochromatic light and prove that radii of these rings are proportional to the square root of natural numbers. (10)

(b) The diameter of the tenth bright ring in Newton's rings experiment is 0.5 cm in reflected system. Calculate the thickness of air film corresponding to this ring and the radius of curvature of the lens. (Given λ= 5890 Å). (5)

5 (a) How thickness of thin glass or mica strip is measured using Fresnel's biprism. Derive the necessary formula used. (10)

(b) A thin mica sheet (refractive index =1.6) of 7 micron thickness introduced in path of the interfering beams in the biprism arrangement shifts the central fringe to the position normally occupied by 7th bright fringe from the centre. Find the Wavelength of light used. (5)

6 (a) Give the theory of Fraunhofer diffraction due to single slit. (10)

(b) In the Fraunhofer diffraction due to a narrow slit, a screen is placed 2 metres away from the lens to obtain the pattern in its focal plane. Find the slit width if the first minima lie 5 mm on the either side of the central maxima when the plane waves of wavelength 6×10^{-5} cm are incident on the slit. (5)

(10)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4022 **H**

Unique Paper Code : 2222512401

Name of the Paper : Waves and Optics

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

Semester : IV

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. **All** questions carry equal marks.
4. Question No. **1** is compulsory.
5. Use of non-programmable scientific calculator is allowed.

P.T.O.

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

(a) Show that superposition principle is true only in case of homogeneous linear equations.

(b) What are stationary waves? How are they formed?

(c) In Young's double slit experiment, the separation of four bright fringes is 2.5 mm and the distance from the slit to the screen is 80.0 cm. Calculate the separation between two slits when the wavelength of the light used is 5896 Å.

(d) Distinguish between Division of amplitude and Division of wavefront categories of interference.

(e) What is the highest order spectrum which may be seen with a monochromatic light of wavelength 5000 Å with a diffraction grating having 5000 lines/cm?

2. (a) What are Lissajous figures? Give a mathematical analysis to trace graphically the motion of a particle subjected to two perpendicular simple harmonic motions of equal frequencies, different amplitudes and phase differing by (i) zero and (ii) Π/4. (10)

(b) All simple harmonic motions are periodic but all periodic motions are not simple harmonic. Explain. (5)

3. (a) Explain the theory of formation of Newton's rings and derive an expression for the diameter of dark rings formed by reflected light. (10)

(b) Newton's rings are observed in reflected light of wavelength 5900 Å. The diameter of the 10^{th} dark ring is 0.5 cm. Find the radius of curvature of the lens. (5)

4. (a) Give the theory of Fraunhofer diffraction due to a single slit. Discuss the intensity distribution pattern obtained in it. (10)

(b) For Fraunhoffer diffraction with a single slit of width 0.2 mm and screen placed at a distance of 3.0 m from the slit, find the total width of the central maximum, wavelength of light used is 5000 Å. (5)

5. (a) A set of 8 tuning forks is arranged in a series of increasing frequencies. If each fork gives 4 beats per second with the preceding one and the frequency of the last fork is an octave of the first, find the frequencies of the first and the last fork. (5)

(b) Give Stokes treatment of reflection and refraction. (5)

(c) A parallel beam of light of wavelength 5890 Å in incident on a glass plate (μ=1.5) such that the angle of refraction into the plate is 60°. Calculate the smallest thickness of the plate which will make it dark by reflection. (5)