PHYSICS
(Nuclear and Particle Physics)
(DSE–1B)
Paper : PHYS 304 TH

Time Allowed : 3 Hours **Maximum Marks : 70**

Note : *Attempt* ***five*** *questions in all, selecting one question from each Section. Question No.* ***1*** *is compulsory.*

SECTION–A
(Compulsory Question)

1. (*i*) Magnetic moment of neutron is :

(*a*) Positive (*b*) Negative

(*c*) Zero (*d*) Infinite.

(*ii*) Which has the highest penetrating power ?

(*a*) α particle (*b*) β particle

(*c*) γ rays (*d*) All have the same penetrating power.

(*iii*) The decay constant of the end product of natural radioactive series is :

(*a*) Zero (*b*) One

(*c*) Infinite (*d*) π.

(*iv*) A meson is a bound state of :

(*a*) 3 quarks (*b*) 2 quarks

(*c*) 1 quark and 1 anti-quark (*d*) 3 anti-quarks.

(*v*) The values of Baryon number, Lepton number, Iso-spin, Strangeness number of neutron are :

(*a*) $1, 0, \frac{1}{2}, 0$ (*b*) $1, 1, \frac{1}{2}, 0$

(*c*) $0, 1, \frac{1}{2}, 1$ (*d*) 1, 0, 0, 1.

(*vi*) Nuclear forces are saturated forces. Explain.

(*vii*) What are Thermal Neutrons ?

(*viii*) What are the processes by which a γ-ray may lose its energy ?

(*ix*) What are Cerenkov radiations ?

(*x*) What is Cyclotron ? How does it differ from a betatron ?

(*xi*) Give an example of each : Fermion, Boson, Baryon, Lepton. $11 \times 2 = 22$

SECTION–B

2. (*a*) Why electron cannot be a constituent part of the nucleus ? Explain in detail.

(*b*) What is Binding Energy (BE) per nucleon ? What inferences can be drawn from BE per nucleon curve ?

(c) Assuming that average mass of a nucleon is 1.67×10^{-2}, kg and radius of nucleus to be given $R = R_0 A^{1/3}$, calculate the density of the nucleus ($R_0 = 1.5 \times 10^{-15}$m). 6,3,3

3. Describe the nuclear shell model. Show how 'magic numbers' are obtained in nuclear shell model. Describe limitations of nuclear shell model. 12

SECTION–C

4. Discuss Gamow's theory of α-decay and derive the expression for transmission coefficient for α-decay. 12

5. (a) Derive the expression for half life and mean life time of radioactive substance. What is the relation between these two ?
   (b) Explain neutrino hypothesis of β-decay.
   (c) Explain inverse β-decay. 6, 3,3

SECTION–D

6. (a) What is Compton Effect ? Derive an expression for the change in wavelength of a scattered photon.
   (b) Why a photon cannot transfer its entire energy to the electron in Compton process ?
   (c) Explain why visible light cannot demonstrate Compton effect ? 6, 3,3

7. Describe the construction and working of Geiger-Muller (GM) counter. What do you mean by dead time and recovery time of GM counter ? Explain the differences between GM counter and proportional counter. 12

SECTION–E

8. What are Quarks ? Discuss qualitative aspects of quark model. On the basis of quark model discuss quark content of mesons and baryons. 12

9. (a) For each of the following decays state the conservation law that forbids it :
   (i) $n \rightarrow p + e^-$
   (ii) $n \rightarrow p + \gamma$
   (iii) $n \rightarrow \pi^+ + e^-$
   (b) Write a short note on composition of cosmic rays.
   (c) Write a short note on variation of cosmic rays intensity with latitude and altitude. 6, 3, 3

PHYSICS
(Solid State Physics and Electronics)
(DSE–1A)
Paper : PHYS 302 TH

Time Allowed : 3 Hours **Maximum Marks : 50**

Note : *Attempt* ***five*** *questions in all, selecting one question from each Sections–B, C, D and E. Section–A is compulsory. Use of log table and non-programmable calculator is allowed.*

SECTION–A
(Compulsory Question)

1. (*i*) At very low temperature the specific heat of a solid is directly proportional to (where T is temperature) :

(*a*) T^2 (*b*) T^3

(*c*) $\frac{1}{T^2}$ (*d*) $\frac{1}{T^3}$.

(*ii*) The co-ordination number for *fcc* lattice is :

(*a*) 6 (*b*) 8

(*c*) 12 (*d*) 16.

(*iii*) At 0 K all the levels, above the fermi level are :

(*a*) Empty (*b*) Filled

(*c*) Partially filled (*d*) None of these.

(*iv*) Draw the characteristic curve (V–I) of an ideal diode.

(*v*) Draw the circuit diagram of full-wave rectifier with π section filter.

(*vi*) Are emitter and collector interchangeable in a transistor ? Why ?

(*vii*) What is the Barkhausen criterion for sustained oscillations ? $2 \times 7 = 14$

SECTION–B

2. (*a*) Define Atomic Scattering Factor. Derive an expression for it. 6,3

(*b*) Show that the reciprocal lattice of SC lattice is also SC lattice.

3. (*a*) Discuss Einstein's theory of lattice heat capacity and explain the discrepancy between the theory and low temperature experimental results. 7,2

(*b*) Differentiate between Photons and Phonons.

SECTION–C

4. (*a*) Derive the expression for Fermi energy and density of states for a free electron gas in three dimensions. 7,2

(*b*) How is the Fermi gas different from the ordinary gas ?

5. (*a*) Discuss the Kronig-Penney model and explain the forbidden gap using this model.
   (*b*) What do you mean by effective mass of electron ? Explain its significance. 6,3

SECTION–D

6. (*a*) What is a Tunnel Diode ? Discuss its V-I characteristics. Can this diode be used to convert ac into dc ?
   (*b*) What is Ripple Factor ? Calculate its value for full-wave rectifier. 5,4
7. (*a*) In a common base circuit transistor $\alpha = 0.96$. If the base current is 60 μA, calculate :
   (*i*) Emitter Current
   (*ii*) Collector Current.
   (*b*) Explain the working of an N channel FET and discuss about the main parameters of FET. 4,5

SECTION–E

8. What do you mean by Multistage Amplifiers ? Draw the circuit diagram of an RC coupled amplifier and find voltage gain and current gain for middle frequency range by drawing equivalent circuits. 9
9. (*a*) What is an Oscillator ? Explain the Hartley oscillator by drawing a circuit diagram in details.
   (*b*) If L = 50 μH and C = 300 pF, calculate the frequency of oscillations. 7,2

B.Sc. Physics

STATISTICAL AND THERMAL PHYSICS

(DSC 1C) / Core

PAPER : PHYS 201 TH

Time : 3 Hours **Maximum Marks : 50**

Note : Attempt five questions in all, selecting *one* question each from Section-B, C, D and E. Question No. 1 of Section A is compulsory.

Section-A

(Compulsory Question)

1. Attempt all the seven sub-questions :

(*a*) What is the probability of a random event, an event and an impossible event ?

(*b*) What is phase space and what is a small volume element in it ?

(*c*) What are fermions ? State the statistics followed by them.

(*d*) State Kelvin-Planck statement of second law of thermodynamics.

(*e*) The thermodynamic probability of a system in perfect order is :

(*i*) 1

(*ii*) 0

(*iii*) – 1

(*iv*) ∞

(*f*) Define temperature of Inversion.

(*g*) For indistinguishable particles, the number of microstates is ..... the number of macrostates.

(*i*) Equal to

(*ii*) More than

(*iii*) Less than

$(2 \times 7 = 14)$

Section-B

2. Derive an expression for the probability of a microstate corresponding to the distribution of N distinguishable particle in K compartments of unequal sizes which are further divided into cells of equal a priori probability. (9)

3. (*a*) Explain macrostate, microstate and thermodynamic probability of microstate. Obtain relationship between thermodynamic probability and the probability of a microstate.

   (*b*) Differentiate between static and dynamic system. (7, 2)

Section-C

4. (*a*) Obtain basic equation for distribution law in all the three statistics.

   (*b*) Derive Maxwell-Boltzmann relation :

$$n_i = \frac{g_i}{e^{\alpha + \beta u_i}}$$

   where symbols have their usual meaning. (4, 5)

5. What is Bose-Einstein statistics ? What are its assumptions ? Derive its distribution law. (9)

Section-D

6. A thermocouple acts like a reversible heat engine. Obtain expression for thermoelectric e.n.f., Peltier coefficient and Thomson coefficient. (9)

7. (*a*) Give the statistical definition of entropy. Show that the process of diffusion of one gas into another is accompanied by increase in entropy.

   (*b*) Entropy is the measure of disorder. Comment. (6, 3)

Section-E

8. What are thermodynamic potentials and their significance ? Obtain thermodynamic relations from U, F, H and G. (9)

9. (*a*) A wire is stretched adiabatically. Show that the change in temperature is given by :

$$\Delta T = \frac{-l \eta T}{C_p} \Delta F$$

   where T, η, l and ΔF are temperature, coefficient of linear expansion, length of wire and change in force respectively.

   (*b*) Calculate the pressure under which water will boil at 125° C, if the change in specific volume is 1.676 m^3. Given the latent heat of steam = 22.68×10^5 J/kg. (6, 3)

(Waves and Optics)

Paper : PHYS 202 TH

Time : 3 Hours] **[Maximum Marks : 50**

Note : Attempt *five* questions in all. The question paper consists of five Sections. Section A is compulsory. Sections B, C, D and E consist of *two* questions each. Select *one* question from each Section.

Section—A

1. Compulsory question :
   (*i*) What are the factors on which the natural frequency of an oscillator depend ?
   (*ii*) What is the difference between positive and negative crystals ?
   (*iii*) What is relaxation time and how is it related to damping coefficient ?
   (*iv*) What do you mean by induction coupling ?
   (*v*) What is a figure of merit of vibration ?
   (*vi*) Show that $y = x^2 + c^2t^2$ is a solution of one dimensional wave equation.
   (*vii*) What is the difference between normal dispersion and anomalous dispersion ?

$2 \times 7 = 14$

Section—B

2. (a) Write the equation of motion of a damped simple harmonic system. What are the solutions of the equation ?
   (b) Deduce the frequency and quality factor of a circuit with :
   $L = 10\,\mu H$, $C = 5\,\mu F$ and $R = 2\,\Omega$.

5, 4

3. (a) Derive the expression for the time period of oscillation of two springs connected in :
   (*i*) Parallel combination
   (*ii*) Series combination.
   (b) If the displacement equation of SHM be
   $x = A \sin(\omega t + \phi)$,
   show that the velocity v and acceleration a satisfy the equation $\omega^2 v^2 + a^2 = A^2\omega^4$.

5, 4

Section—C

4. (a) Show that the maximum displacement of a forced damped oscillator by a force $F = F_0 \cos \omega t$ and having damping constant r is given by :

$$A_{max} = \frac{F_0}{\omega' r}, \text{ where } \omega' = \sqrt{\frac{s}{m} - \frac{r^2}{4m^2}}$$

(b) The voltage of 200 V is applied to a series LCR circuit, having $R = 20\ \Omega$, $L = 10\ \mu H$ and $C = 0.01\ \mu F$. Calculate :

(*i*) Natural frequency

(*ii*) Q value of circuit at resonance

(*iii*) Bandwidth of the circuit.

5, 4

5. (a) Define and explain normal co-ordinates and normal modes of vibration in coupled oscillators.

(a) What is the difference between in phase and out of phase modes ?

5, 4

Section—D

6. (a) Discuss how transverse waves are reflected and transmitted at the boundary. Find refraction and transmission coefficients.

(b) Define phase and group velocity. Find the relation between them.

7. (a) Derive law of refraction from Huygen's principle.

(b) A soap film 6×10^{-5} cm thick is viewed at an angle of 30° to the normal. Find the wavelengths of the light in the visible spectrum which will be absent from the reflected light ($n = 1.33$).

5, 4

5, 4

Section—E

8. (a) Distinguish between Fresnel and Fraunhoffer type diffraction. Discuss Fraunhoffer diffraction at a double slit and the position of maxima and minima.

(b) A narrow slit illuminated by light of wavelength 6.4×10^{-5} cm is placed at a distance 3 metres from a straight edge. If the distance between the straight edge and screen is 5 m, calculate the distance between first and fourth dark band.

9. (a) Describe the construction and working of a Nicol prism. How is it used as a polarizer and analyser ?

5, 4

(b) What is double refraction ? How will you get circularly and elliptically polarized light ?

5, 4

B.Sc. PHYSICS

(Electrical Circuits and Network Skills)

(SEC2)

Paper : PHYS 205 TH

Time : 3 Hours] **[Maximum Marks : 50**

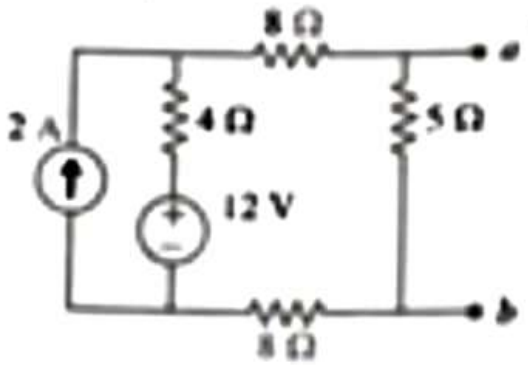
Note :- Attempt any *five* questions.

1. (a) Prove that the power consumed in a purely Inductive circuit is zero.

   (b) What is Ohm's law ? Write the limitations of Ohm's law. 6,4

2. (a) Draw the symbolic representation of a practical current source. Explain that why impedance is used in this symbolic representation.

(b) State Norton Theorem and apply it to find the Norton equivalent circuit shown below at terminal $a - b$:



4,6

3. (a) Differentiate between star and delta connections in three phase systems.

(b) A stove element draws 15 A when connected to a 240 V line. How long does it take to consume 60 kJ ? 6,4

4. (a) What are drawing symbols ? Draw the electrical symbols for Zener diode, Fuse, OP-AMP, LED, DPDT switch.

(b) Draw a two rung ladder diagram of a electrical circuit. 6,4

5. (a) Explain different types of DC power sources. Write their advantages and disadvantages.

(b) What is Self-induction ? Derive an expression for self-inductance of a coil. 6,4

6. (a) Describe the principle, construction and working of a DC generator. Support with relevant diagrams.

(b) Why a bridge rectifier is preferred over a centre-tap rectifier ? Explain. Is there any application where center-tap rectifier is preferred over a bridge rectifier ? 6,4

7. (a) Explain different types of electrical conduits with their characteristics. 4

(b) Write short notes on any *two* of the following :

(i) Phase reversal

(ii) MCB

(iii) SPD 6

B.Sc. PHYSICS

(MECHANICS)

(Core)

PAPER : PHYS 101 TH

Time : 3 Hours] [Maximum Marks : 50

Note : Attempt **five** questions in all, selecting **one** question each from Sections B, C, D and E respectively. Question No. 1 (Section A) is compulsory.

SECTION-A

(Compulsory Question)

1. (*i*) Differentiate between linear and non-linear differential equations.

   (*ii*) What are left handed and right handed co-ordinate systems ?

   (*iii*) What do you mean by homogeneity of space ?

   (*iv*) What is non-inertial frame of reference ?

   (*v*) What is a turning point of a body moving under central force field ?

   (*vi*) What is angular momentum ? Give its S.I. unit.

   (*vii*) What is the final result of Michelson-Morley experiment ?

$2 \times 7 = 14$

SECTION-B

2. (*a*) Derive an expression for the velocity of a particle moving in a plane in polar co-ordinates.

   (*b*) Motion of a particle is described by the equation $x = 4 \sin 2t$, $y = 4 \cos 2t$, $z = 6t$. Find velocity and acceleration of the particle. 5, 4

3. (*a*) What is Coriolis Force ? Derive an expression for it.

   (*b*) Prove that homogeneity of time leads to law of conservation of energy. 5, 4

SECTION-C

4. (*a*) Obtain equation of motion for equivalent one body problem for two masses. Also explain the concept of reduced mass.

   (*b*) State and explain Kepler's first law of planetary motion. 5, 4

5. (*a*) What do you understand by central and non-central forces ? Establish the differential equation of motion under central force and deduce its solution.

   (*b*) Show that the angular momentum of a particle moving under a central force is constant. 5, 4

SECTION-D

6. (*a*) What do you mean by Torque ? Derive its expression along three axes. What is the physical meaning of torque ?

   (*b*) Derive the relation between torque and angular momentum. 5, 4

7. (*a*) Explain the laboratory and centre of mass system. Discuss the elastic collision between two particles in the lab system.

   (*b*) Prove that the kinetic energy of the system in centre of mass frame is always less than kinetic energy in the laboratory frame. 5, 4

SECTION-E

8. (*a*) What was the essential aim of Michelson-Morley experiment ? Discuss the significance of the result obtained.

   (*b*) Discuss the postulates of Einstein's special theory of relativity. 5, 4

9. (*a*) Derive the formula for relativistic variation of mass with velocity.

   (*b*) At what speed a particle is moving, if its mass is equal to four times its rest mass ? 5, 4

B.Sc. PART–I (H.P.U.)

PHYSICS

(Electricity, Magnetism and EMT)

(Core)

Paper–PHYS-102

Time Allowed : 3 Hours] **[Maximum Marks : 50**

Note : Attempt ***five*** questions in all, selecting ***one*** question each from Sections B, C, D and E and ***seven*** sub-questions from Section A. Question No. **1** (Section A) is compulsory.

SECTION–A

(Compulsory Question)

1. Explain the following :

(*i*) What is displacement current ? Give its unit in SI.

(*ii*) Why light waves travel through vacuum whereas sound waves cannot ?

(*iii*) Why is ferromagnetism not found in liquids and gases ?

(*iv*) What are Ferrites ? To what use are they put ?

(*v*) Is volume charge density in variant under Lorentz transformation ?

(*vi*) A current is sent through a hanging coiled spring why does the spring contract in length ?

(*vii*) Why no current flows through a conductor in absence of electric field ?

(*viii*) What is the physical interpretation of gradient of a scalar function ?

(*ix*) What is an irrotational fields ? Give two examples. **7×2=14**

SECTION–B

2. (*a*) What is meant by curl of a vector ? State and prove Stoke's theorem.

(*b*) Show that :

$$\vec{\nabla}.(\vec{A}\times\vec{B}) = \vec{B}.(\vec{\nabla}\times\vec{A}) - \vec{A}.(\vec{\nabla}\times\vec{B})$$ **5,4**

3. (*a*) Prove that electric potential due to quadrupole varies inversely as cube of the distance.

(*b*) Drive the equation of continuity :

$$\vec{\nabla}.\vec{J} + \frac{\partial\rho}{\partial t} = 0,$$

what form will it take for steady currents ? **5,4**

SECTION–C

4. (*a*) What is Hall effect ? Drive an expression for Hall constant and mention the application of this effect.

(*b*) What is Vector Potential ? Show that :

$$\vec{\nabla}.\vec{A} = \frac{\mu_0}{4\pi} \iint \frac{\vec{J}}{r}.\vec{ds}$$

under what condition $\vec{\nabla}.\vec{A} = 0$? 5,4

5. (*a*) Show that transformation laws of transforming electric field from one inertial frame of reference to another are given by $E'_{11} = E_{11}$ and $E'_{\perp} = rE_{\perp}$, where symbols have their usual meanings.

(*b*) Deduce the Clausius-Mossotti relation for a polarisation of a medium. 5,4

SECTION–D

6. (*a*) Show that for non-uniform polarisation :

$$\vec{\nabla}.\vec{P} = -\rho_p.$$

(*b*) The dielectric constant of helium is 1.00074. Find the dipole moment of each atom when a gas is subjected to an electric field of intensity 150 volt/cm. 5,4

7. (*a*) Explain ferromagnetism on the basis of domain theory.

(*b*) Define free and bound currents. Show that :

$$\vec{\nabla} \times \vec{H} = \vec{J}_{free}.$$

4,5

SECTION–E

8. (*a*) Show that the impedance of free space for *e.m.* wave is 377 Ω.

(*b*) Drive the equations of plane em-wave in a medium having finite permittivity E, permeability *u* and conductivity σ.

9. (*a*) Discuss the propagation of a plane *e.m.* wave incident normally at a boundary separating two media of different impedances and show that a perfect conductor is a perfect reflector of *e.m.* waves. 4,5

(*b*) Define Poynting Vector. What does it represent ? Give its unit in SI. 6,3