Seat No. : _____

JF-111

June-2022

M.Sc., Sem.-II

408 : Physics

(Classical Mechanics-II and Solid State Properties)

Time : 2 Hours] **[Max. Marks : 50**

Instructions : (1) **All** questions in Section – I carry equal marks.

(2) Attempt any **three** questions in Section –I.

(3) Questions in Section – II is COMPULSORY.

Section – I

1. (A) Write the differential equation for harmonic oscillator. Hence obtain parametric equations for the harmonic oscillator. Draw the corresponding phase trajectories. **7**

   (B) Write the differential equation for damped harmonic oscillator. Hence obtain parametric equations for the damped harmonic oscillator for $b^2 < \omega_0^2$, and $b^2 > \omega_0^2$. Draw the corresponding phase trajectories. **7**

2. (A) Obtain an expression for the phase trajectory of a Simple pendulum. Hence discuss the three cases of phase trajectories for (a) $E_1 < 2mgl$, (b) $E_1 = 2mgl$, (c) $E_1 > 2mgl$. **7**

   (B) Obtain an expression for the time period of simple pendulum in terms of its amplitude (θ_0), i.e. obtain $T = \frac{4}{\omega_0} K(k)$, where $k = \sin(\theta_0/2)$. **7**

3. (A) Using the transition from a discrete to a continuous system, obtain an expression for the Lagrangian density for an infinitely long elastic rod that can undergo small longitudinal vibrations. **7**

   (B) Write transformation equations for the components of electric field and magnetic field. Hence show that $\overline{E}.\overline{B}$ and $\overline{E}^2 - c^2\ \overline{B}^2$ are relativistically invariant. **7**

4. (A) A pion at rest decays into a muon and a neutrino. Find the energy of the outgoing muon in terms of the two masses, m_π and m_μ (assuming $m_\nu = 0$). **7**

(B) Obtain an expression for the Compton wavelength of an electron in terms of scattering angle. **7**

5. (A) Write a short note on electron spin resonance. **7**

(B) Explain concept of Bloch Walls and magnetic domains. **7**

6. (A) Explain exchange interaction and the Heisenberg model for magnetism. **7**

(B) Explain in detail the Neel model of Ferrimagnetism. **7**

7. (A) What is superconductivity ? How superconductors are different in magnetic properties than its normal conducting state ? **7**

(B) Obtain equation of current for ac Josephson effect. **7**

8. (A) Discuss in detail the thermodynamics of superconducting state and show that superconducting state is more stable than its normal state of the material. **7**

(B) What is flux quantization ? Obtain condition for flux quantization in a superconducting ring. **7**

Section – II

9. MCQs : **8**

(1) For the stability of fixed point attractor the required condition is $| f'_\mu (x^*) |$ should be _____.

(A) > 0 (B) < 0

(C) > 1 (D) < 1

(2) The time associated with the moving object is called _____ time.

(A) Proper time (B) Object time

(C) Associated time (D) Image time

(3) When an object of mass m is at rest, its relativistic energy is _____.

(A) mc^2 (B) Infinite

(C) 0 (D) 1

(4) In chaotic map a nonchaotic window occurs at _____ value of μ.

(A) 3.5699 (B) 3.82

(C) 2.5029 (D) 3.6692

(5) Air is an example of

(A) Paramagnetic material (B) Ferromagnetic material

(C) Diamagnetic material (D) Antiferromagnetic material

(6) Curie-Wiess law is used to calculate

(A) Permittivity (B) Susceptibility

(C) Permeability (D) Magnetization

(7) The penetration depth for a superconductor is assumed by

(A) $\lambda(T) = \dfrac{\lambda_0}{\sqrt{1 - (T / T_C)^4}}$ (B) $\lambda(T) = \dfrac{\lambda_0}{\sqrt{1 - (T / T_C)}}$

(C) $\lambda(T) = \lambda_0 \sqrt{1 - (T / T_C)^4}$ (D) $\lambda(T) = \lambda_0 [1 - (T/T_C)^4]$

(8) Type-II superconductor observe

(A) Partial Meissner-Ochsenfield effect

(B) Breakdown of Silsbee effect

(C) High critical field (HC) and high temperature

(D) All of the above

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