SH-V/PHS/503/DSE-1/19

B.Sc. 5th Semester (Honours) Examination, 2019-20

PHYSICS

Course ID : 52416 **Course Code : SHPHS/503/DSE-1**

Course Title : Advanced Mathematical Physics

Time: 2 Hours **Full Marks: 40**

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer *any five* of the following: 2×5=10

(a) What do you mean by Direction Cosines?

(b) What do you mean by Invariant tensor?

(c) What is the Quotient law of Tensors?

(d) What is antisymmetric tensor?

(e) Write down the condition for two lines to be coplanar.

(f) Find the probability of drawing 2 aces in succession from a pack of 52 cards.

(g) Give an example of a finite ordered element in an infinite group.

(h) Define normal subgroup of a group.

2. Answer *any four* of the following: 5×4=20

(a) What do you mean by Gradient, Divergence and curl of Tensor fields?

(b) Define Covariant, Contra variant and mixed tensors.

(c) Write down moment of Inertia tensor, stress and strain tensors.

(d) If the probability of a bad reaction from a medicine is 0·001, determine the change that out of 2000 individuals more than two will get a bad reaction.

(e) Prove that for any group G, $G/Z(G)$ is cyclic if and only if G is abelian, where $Z(G)$ is the centre of G.

(f) Prove that for any group homomorphism $f : G_1 \to G_2$, ker f is a normal subgroup.

3. Answer *any one* question: 10×1=10

(a) (i) Let G be a group prove that G is cyclic if and only if there exists an element a $\in G$ such that $O(a) = (G)$

(ii) Give an example of a non-commutative group whose all the subgroup are normal.

(iii) Are the groups $(\mathbb{C}^*, \cdot)$ and $(\mathbb{R}^*, \cdot)$ isomorphic to each other? Justify your answer.

(iv) State Schur's lemma. 5+2+2+1=10

(b) (i) Write down generalized Hooke's law.

(ii) What do you mean by Minkowski space?

(iii) What do you mean by Kroneker Delta? Discuss its property.

(iv) Define permutation Tenser.

(v) Discuss with an example product of two tensors. 2+2+2+2+2=10

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B.Sc. 5th Semester (Honours) Examination, 2019-20

PHYSICS

Course ID : 52416 **Course Code : SHPHS-503-DSE-1**

Course Title : Classical dynamics

Time: 2 Hours **Full Marks: 40**

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Candidates are required to give their answers in their own words as far as practicable.

Section–I

1. Answer *any five* of the following: 2×5=10

(a) Find the Lagrangian for simple pendulum.

(b) An electron of rest mass $9{\cdot}2\times10^{-31}$ kg is moving with a speed 0·99C. What is total energy, where C = $3\times10^{+8}$m/s.

(c) Two photons approach each other. What is their relative velocity.

(d) Show that kinetic energy remain constant when a charge particle move in uniform magnetic field.

(e) The potential energy of a particle is a given by the expression $V(x) = x^4 - 4x^3 - 8x^2 + 48x$. Find the points of unstable equilibrium.

(f) Explain turbulance in fluid dynamics with examples.

(g) Show that if a given co-ordinate is cyclic in Lagrangian, it will be cyclic in Hamiltonian.

(h) An electron emitted from a hot filament is accelerated through a potential difference of 18kVand entrrs a region of a uniform magnetic field 0.1T with certain initial velocity. What is the trajectory of the electron if the magnetic field is transverse to the initial velocity?

Section–II

Answer *any four* of the following: 2×5=5

2. What is light cone? What is world line? Draw typical space-time diagram. 1+2+2=5

3. (a) Established the relation $E^2 = p^2 c^2 + m_o^2 c^4$, symbols have their usual meaning. 3

(b) A pion at rest decays in to a muon and neutrino. Show that the momentum of the muon is given by $\left|\overline{P}_M\right| = \frac{c(m_\Pi^2 - m_\mu^2)}{2m_\Pi}$, Symbols have their usual meaning. 2

4. A charge particle initially moving in the *x*-direction with a velocity V_{ox} be subjected to a uniform electric field *E* in the *K* direction and a uniform magnetic field *B* in the *z* direction. Find the velocity of charge particle at any instant of time *t*. 5

5. (a) Derive an expression for Laplace-Runge-Lenz Vector.

(b) Prove that the speed of a particle moving in an elliptic path in an inverse square field $f(r) = -\frac{K}{r^2}$ is given by $V^2 = \frac{K}{m}\left(\frac{2}{r} - \frac{1}{a}\right)$, where *a* is the semi-major axis, *m* is the mass of particle. 3+2=5

6. Explained

(i) Minkowski space

(ii) Invariant interval

(iii) Space like

(iv) Time-like

(v) Light like 1+1+1+1+1=5

7. (a) What are the characteristics of ideal fluid?

(b) Write the general form of Navier-Stokes equation and state one application of it. 2+2+1=5

Section–III

Answer *any one* question. 10×1=10

8. Two masses each equal *m*, are connected by massless springs of spring constant *k* such that they can freely slide on a smooth horizontal surface. The ends of springs are fixed to vertical walls. Determine

(i) the normal frequency.

(ii) the normal modes vibration.

(iii) the normal coordinate 3+4+3=10

9. (a) Given the Lagrangian $L = \frac{1}{Z}m\left(\dot{r}^2 + r^2\,\dot{\theta}^2\right) - V(r)$. Find the Hamiltonian and hence the equation of motion. (Symbols have their usual meaning)

(b) Show that the total energy will remain constant for a particle motion in central force field. 6+4=10

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