U.G. 5th Semester Examination-2020

PHYSICS

[HONOURS]

Discipline Specific Elective (DSE)

Course Code : PHY-H-DSE-T-01

(Classical Dynamics)

Full Marks : 60 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.

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

GROUP-A

1. Answer any **ten** questions : 2×10=20

a) Define the term 'constraint'. Classify the constraints.

b) What are the difficulties introduced by constraints in the solution of a mechanical problem?

c) Define degrees of freedom. Determine the degrees of freedom of two particles connected by a rigid rod moving freely in a plane.

d) What is generalized momentum? Define cyclic coordinate.

e) State the postulates of the special theory of relativity.

f) What is Minkowski space? Define world line.

g) Write the Lorentz transformation equations. How do you get the Galilean transformations from the Lorentz transformations?

h) What is proper length and proper time interval?

i) Write the relation between relativistic energy and relativistic momentum. Plot the variation of mass with velocity.

j) What is the difference between relativistic and non-relativistic Doppler's effect?

k) What is retarded time and retarded potential?

l) Define power of radiation. What is the Larmor formula?

m) What is electromagnetic field tensor?

n) Define space-like intervals and time-like intervals.

o) What is the significance of the Hamiltonian function?

GROUP-B

2. Answer any **four** questions : 5×4=20

a) What are generalized coordinates? Determine the generalized coordinates for a simple pendulum. Set up the Lagrangian for a simple pendulum. 2+1+2

b) A cylinder of radius a and mass m rolls down an inclined plane making an angle θ with the horizontal. Set up the Lagrangian and find the equation of motion. 2+3

c) What is relativistic length contraction of bodies? Explain Einstein's formula for addition of velocities? 2½ + 2½

d) Write down the relativistic Lagrangian of a charged particle in an electromagnetic field and hence find the Hamiltonian. 1+4

e) Prove that the three dimensional volume element dxdydz is not invariant under Lorentz transformations while the four dimensional volume element dxdydzdt is invariant. Give two examples of four-vector. 4+1

f) Establish the covariant form of Maxwell's electromagnetic field equations by four vectors. 5

GROUP-C

3. Answer any **two** questions : 10×2=20

a) Calculate the Hamilton's equations in spherical polar coordinates. Write the Hamiltonian for a simple harmonic oscillator and deduce its equation of motion. 5+2+3

b) What do you understand by time dilation? If E and B are respectively electric field and magnetic field vectors, then show that $E^2-B^2c^2$ and E.B are invariant under Lorentz transformations. 2+4+4

c) Prove that a particle of zero rest mass travels with the speed of light. Show that the rest mass of a particle of momentum p and kinetic energy T given by $m_o = p^2c^2-T^2/2Tc^2$. Calculate the Lienard-Wiechert potentials of a point charge moving with constant velocity. 3+3+4

d) Calculate the electric and magnetic fields of a point charge moving with constant velocity. Calculate the Lagrangian, Hamiltonian and using the Hamiltonian calculate the equation of motion of a particle moving in a central force field. 5+1+1+3

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