U.G. 5th Semester Examination-2021

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) What is a non-holonomic constraint? Give an example.

b) What is the equation of constraint of the motion of a body on an inclined plane under gravity?

c) What are the advantages of Lagrangian formulation over Newtonian formulation?

d) What is the significance of rotational cyclic co-ordinates?

e) State the postulates of special theory of relativity?

f) Show that 1 atomic mass unit is equal to 931 MeV?

g) What is the principle of equivalence of mass and energy?

h) Prove that a particle of zero rest mass travels with the speed of light.

i) What is a four vector? Give an example of four vector.

j) An electron and a positron practically at rest come together and annihilate each other. Calculate the energy released.

k) Define Larmor's formula.

l) What are world point and world line?

m) What is Hamilton's principle?

n) What is canonical momentum?

o) What are the fundamental Poisson's brackets?

GROUP-B

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

a) A small bead of mass M is initially at rest on a horizontal wire and is attached to a point on the wire by a massless spring of spring constant k and unstretched length a. A mass(m) is freely

suspended from the bead at the end of a wire of length b. Determine the degrees of freedom, generalised coordinates and Lagrangian of the system. 1+1+3

b) Determine the degrees of freedom, generalised coordinates and Lagrangian of a pendulum made of a spring (spring pendulum) with a mass on the end. Assume L_0 is the equilibrium length of the spring. 1+1+3

c) What is relativistic length contraction of bodies? Show that the circle $x^2+y^2=r^2$ in frame S, appears to be ellipse in a frame S' which is moving with a velocity $v\hat{i}$ relative to S. 2+3

d) Calculate the rest mass of a particle whose momentum is 130MeV/c when its kinetic energy is 50MeV? Calculate the relativistic mass of the photon of wavelength 5000 Å. 3+2

e) Define Lorentz gauge. If $\vec{E}$ and $\vec{B}$ are respectively electric and magnetic field vectors, then show that $\vec{E}.\vec{B}$ are invariant under Lorentz transformation. 1+4

f) Prove that the relativistic Hamiltonian is equal to the total energy of the system. Explain the Twin Paradox in Special relativity. 3+2

GROUP-C

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

a) Prove that if the Lagrangian of a system is invariant under translation along a direction the corresponding linear momentum is conserved. Calculate the Lagrangian for a charged particle moving in an electromagnetic field. Prove the Poisson bracket relation $[J_x , J_y]= J_z$ 3+5+2

b) A particle of mass m can move in a frictionless thin circular tube of radius r. If the tube rotates with an angular velocity ω about a vertical diameter. Deduce the differential equation of motion of the particle? Prove that $E^2-p^2c^2$ is invariant under Lorentz transformation? Two electrons, each of velocity 0.8c, move towards each other. Find the relative velocity of one electron with respect to the other? 5+3+2

c) Write the components of velocity, momentum four vector and hence calculate the Four-force or Minkowski force? State the conservation of four-momentum? Calculate the percentage contraction of a rod moving with a velocity

0.8c in a direction inclined at 60° to its own length? 2+2+2+2+2

d) Calculate the Lienard-Wiechert potentials of a point charge moving with constant velocity. Show that Maxwell's equations are covariant under Lorentz transformations. 5+5

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