Bago University
Department of Physics
Second Semester Examination, September 2019

Third Year (BSc)
(Physics Specialization)

Phys 3106
Classical Mechanics
Time Allowed: (3) Hours

Answer any Six questions.

1 (a) Derive the Hamilton's equations of motion (or) the canonical equations of motion from Hamiltonian.

(b) If $Q = \sqrt{2q}\, e^{\alpha} \cos p$ and $P = \sqrt{2q}\, e^{-\alpha} \sin p$, where α is a constant, show that the transformation is canonical.

2 (a) Distinguish between configuration space and phase space.

(b) Prove that the transformation $p = m\omega q \cot Q$ and $P = \frac{m\omega q^2}{2\sin^2 Q}$ are canonical and obtain the generator of the transformation.

3 (a) Discuss the action and angle variables.

(b) Use action angle variables to obtain the energy levels of the hydrogen atom.

4 (a) Discuss the motion of a particle in one dimension by H-J method.

(b) Derive the equation $H\left[q_1, \ldots, q_n, \frac{\partial F_2}{\partial q_1}, \ldots, \frac{\partial F_2}{\partial q_n}, t\right] + \frac{\partial F_2}{\partial t} = 0$. Do you know the name of equation?

5 (a) What are the moments of inertia and products of inertia? Write down the components of angular momentum in a compact form.

(b) Find the moments and products of inertia of a homogenous cube of side 'a' for an origin at one corner, with axes directed along the edges.

6 (a) State and explain Euler's geometrical equations.

(b) Find the principal axis from the angular momentum in the matrix form.

7 (a) What is Minkowski four-space? Write down the momentum components of a single particle acted upon by conservative forces for relativistic mechanics and explain the terms.

(b) A π^0 meson of rest mass m_0, velocity u decays in flight into two photons of same energy. If one of the photons is emitted at an angle θ to the direction of motion of the π^o meson in the laboratory system, show that its energy $h\nu$ is given by

$$h\nu = \frac{m_0 c^2}{2\gamma(1 - u\cos\theta/c)} \quad \text{and} \quad \gamma = 1/\sqrt{1 - u^2/c^2}.$$

8 (a) Obtain the transformations for the components of the momentum-energy four-vector.

(b) The average lifetime of μ-mesons at rest is 2.3×10^{-6} s. A laboratory- measurement on μ-meson gives an average lifetime of 6.9×10^{-6} s.

(i) What is the speed of the mesons in the laboratory?

(ii) What is the effective mass of a μ-meson when moving at this seed, if its rest mass is $207m_e$?

(iii) What is its kinetic energy?