Bago University
Department of Physics
First Semester Examination, March 2019

Fourth Year (BSc)
(Physics Specialization)

Phys 4109
Theoretical Physics
Time Allowed: (3) Hours

Answer any Six questions.

1 (a) Find the curvature and torsion at any point of the curve $x = a\cos 2t$, $y = a\sin 2t$ and $z = 2a\sin t$.

(b) If the tangent to a curve makes a constant angle, α, with a fixed line, then $\sigma = \pm\rho\tan\alpha$. Conversely, show that if $\frac{\sigma}{\rho}$ is constant, the tangent makes a constant angle with a fixed direction.

2 (a) State the Serret-Frenet formulae and prove that any two of them.

(b) Prove that the Serret-Frenet formulae can be written in the form $\frac{d\vec{t}}{ds} = \vec{w}\times\vec{t}$, $\frac{d\vec{n}}{ds} = \vec{w}\times\vec{n}$, $\frac{d\vec{b}}{ds} = \vec{w}\times\vec{b}$ and determine Darboux vector of the curve $\vec{w}$.

3 (a) If the tangent and binormal at a point of the curve make angles θ and ϕ respectively with a fixed direction, prove that $\frac{\sin\theta}{\sin\phi}\cdot\frac{d\theta}{d\phi} = -\frac{\kappa}{\tau}$.

(b) Prove that the radius R of the sphere of curvature is given by $R^2 = \rho^4\ \sigma^2\left(\frac{d^3\mathbf{r}}{ds^3}\right)^2 - \sigma^2$.

4 (a) Obtain the radius of curvature and torsion of the spherical indicatrices in terms of those of the given curve.

(b) Prove that the length of the common perpendicular (shortest distance) 'd' of the tangents at two nearer points distant 's' apart is approximately given by $d = \frac{1}{12}\kappa\tau s^3$.

5 Show that the normal to the surface $x = (u+v)/\sqrt{2}$, $y = (u-v)/\sqrt{2}$, $z = uv$ at any point (u, v) is described by any unit vector, $\hat{n} = \frac{x,-y,-1}{\sqrt{(1+x^2+y^2)}} = \frac{(u+v),(v-u),-\sqrt{2}}{\sqrt{\{2(1+u^2+v^2)\}}}$. Also evaluate curvature at the origin for the normal section in any direction du, dv and show that the curvature is zero for the normal sections which have the same tangents as the parametric curves through the origin.

6 (a) Find the lines of curve and asymptotic lines for the surface $x = a(u+v)$, $y = b(u-v)$ and $z = uv$.

(b) Calculate the lines of curvature and principal curvatures for the surface generated by the tangents to a skrew curve.

7 (a) Derive the radial and transversal components of velocity and acceleration for moving axes in a plane.

(b) Obtain the equation of motion of the particle at any instant time 't' under time dependent applied force.

8 (a) Show that the centre of mass of two particles must lie on the line joining them and the ratio of the distances of two particles from the centre of mass is the inverse ratio of their masses.

(b) Two particles P and Q of different masses are initially at rest. They attract each other with a constant force. No external forces act on the system. Describe the motion of the centre of mass. At what distance from the original position of P do the particles collide?