Seat No:______________ **Enrollment No:______________**

PARUL UNIVERSITY

FACULTY OF APPLIED SCIENCE

M.Sc., Summer 2017-18 Examination

Semester: 2 **Date: 16/05/2018**
Subject Code: 11206155 **Time: 10:30 am to 1:00 pm**
Subject Name: Mechanics **Total Marks: 60**

Instructions:
1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

Q.1. A) Answer the following questions. **(08)**

(a) Find the expression for kinetic energy in terms of angular velocity $\vec{\omega}$ and principle moment of inertia at O.

(b) Show that a $a_{ij}A^{kj} = \Delta\delta_i^k$, where Δ is a determinant of order three and A^{ij} are cofactor of a^{ij} .

Q.1. B) Answer the following questions (Any two) **(08)**

(a) Show that for a single particle with constant mass, the equation of motion implies that the following differential equation for kinetic energy $\frac{dT}{dt} = \vec{F} \bullet \vec{v}$, while if mass varies with time corresponding equation is $\frac{d}{dt}(mT) = \vec{F} \bullet \vec{p}$

(b) A particle of mass m moves in one dimensional such that it has lagrangian;

$L = \frac{m^2\dot{x}^4}{12} + m\dot{x}^2 - v^2$ where *v* is differentiable function of *x*. Find the equation of motion for *x(t)*.

(c) If x^i and $\overline{x}^i$ are independent co-ordinates of point, show that $\frac{\partial x^j}{\partial \overline{x}^k}\frac{\partial \overline{x}^k}{\partial x^i} = \delta_i^j$

Q.2. A) Answer the following questions.

(a) Define force. Derive sufficient condition that system is to be in equilibrium. **(06)**

(b) If u and v are initial and final velocity, prove that V = u + at. **(02)**

Q.2. B) Answer the following questions (Any one)

(a) Find the components of the first and second fundamental tensors in spherical co-ordinates **(06)**

(b) If force acting on a particle is conservative then Show that total energy of particle T+V is conserved.

Q.3. A) Explain in brief D' Alembert principle. Using it derive Lagrange equation of motion and hence derive Lagrange equation of motion in Cartesian co-ordinate system. **(08)**

Q.3. B) Answer the following questions (Any two)

(a) If L is a Lagrangian for the system of n degree of freedom satisfying Lagrangian equation show by direct substitution $L' = L + \frac{d}{dt}F(q_1, q_2, ...q_n, t)$ also satisfies Lagrangian equation. **(04)**

(b) Show that any inner product of tensors A_r^p and B_t^{qs} is a tensor of rank three. **(04)**

(c) Define Christopher's symbols of first kind and second kind. **(04)**

If $(ds)^2 = (dr)^2 + r^2 (d\theta)^2 + r^2 \sin^2 \theta (ds)^2$, find the values of $[13,3]$ and $\left\{ \begin{matrix} 3 \\ 13 \end{matrix} \right\}$.

Q.4. A) Answer the following questions.

(a) A vector with components (1,2,3) acts at the point (3,2,1). What is its moments about the co-ordinate axis. **(04)**

(b) Define moment of inertia. Find moment of inertia of rectangle having length *l* and width *w*. **(04)**

Q.4. B) Answer the following questions (Any two)

(a) Define : Rigid body, Mass, Frame of reference. **(03)**

(b) At what points in space in R^3; a vector grad V parallel to z-axis for **(03)**

$v(x, y, z) = x^2 + y^2 + z^2 + xyz.$

(c) Write in brief Product of Inertia of a rigid body. **(03)**