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PG/IS/MTM-105/13

M.Sc. 1st Semester Examination, 2013

**APPLIED MATHEMATICS WITH OCEANOLOGY
AND COMPUTER PROGRAMMING**

(Classical Mechanics and Non-linear Dynamics)

PAPER—MTM-105

Full Marks : 50

Time : 2 hours

**Answer Q. No. 1 and any four
questions from the rest**

The figures in the right-hand margin indicate marks

- 1. Answer any four questions : 2 × 4**
- (a) State and prove conservation law of energy.**
 - (b) Define non-holonomic constraints. Give an example of such constraint.**
 - (c) State Noether's theorem.**

(Turn Over)

- (d) What do you mean by Hamilton principle function ? What is its physical significance ?
- (e) Show that the expression $x^2 + y^2 + z^2 - c^2t^2$ is invariant under Lorentz transformation.
- (f) What are the advantages of Hamiltonian over Lagrangian ?

2. Deduce the Euler's dynamical equations

$$A\dot{w}_1 - (B - C) w_2 w_3 = 0$$

$$B\dot{w}_2 - (C - A) w_3 w_1 = 0$$

$$C\dot{w}_3 - (A - B) w_1 w_2 = 0$$

when a rigid body rotates about a fixed point, where the symbols have their usual meanings. 8

3. Define Routhian. Deduce Routhian equations of motion. 8
4. Define poisson bracket. Show that Poisson bracket is invariant under canonical transformation. 8
5. Consider the equilibrium configuration of the molecule such that two of its atoms of each of

(3)

mass M are symmetrically placed on each side of the third atom of mass m . All three atoms are collinear. Assume the motion along the line of molecules and there is no interaction between the ends atoms. Compute the kinetic energy and potential energy of the system and discuss the motion of the atoms. 8

6. In relativistic mechanics, show that the mass of a particle increases with velocity. 8

7. Prove that

$$J = \int_{x_0}^{x_1} F(y_1, y_2, \dots, y_n, y'_1, y'_2, \dots, y'_n, x) dx$$

will be stationary only if

$$\frac{d}{dx} \left(\frac{\partial F}{\partial y'_j} \right) - \frac{\partial F}{\partial y_j} = 0, j = 1, 2, \dots, n \text{ where } y'_j = \frac{\partial y_j}{\partial x}.$$

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[*Internal Assessment* : 10 Marks]