MASENO UNIVERSITY

UNIVERSITY EXAMINATIONS 2015/2016

FIRST YEAR FIRST SEMESTER EXAMINATIONS FOR THE DEGREE OF MASTER OF SCIENCE IN PHYSICS

MAIN CAMPUS

SPH 801: CLASSICAL MECHANICS

Date: 15th December, 2015 Time: 9.00 - 12.00noon

INSTRUCTIONS:

- Answer any THREE Questions.

Q1. Obtain the Lagrangian equations of motion for a spherical pendulum, i.e., a mass point suspended by a rigid weightless rod. **(20Mks**

Q2. a) Consider the harmonic oscillator with the coordinates p, q, the kinetic and potential energy are given by **(8Mk**

$T = \frac{p^2}{2m}$, $V = \frac{kq^2}{2} = \frac{m\omega^2 q^2}{2}$, $\omega^2 = \frac{k}{m}$

Find the

i) Lagrangian,

ii) Hamiltonian

b) The generating function for the transformation is given as **(12M**

$$F_1(q, Q) = \frac{m}{2}\omega q^2 cotQ$$

Find expressions for

i) p and P

ii) Obtain the new Hamiltonian $\mathcal{H}$

iii) Which coordinate is cyclic?

iv) Does q depend on time.

Q3. According to Yukawa's theory of nuclear forces, the attractive force between a neutron and a proton has the potential (20Mks

$$V(r) = \frac{Ke^{-ar}}{r}, \quad K < 0.$$

a) Find the force, and compare it with an inverse square law of force.

b) Discuss the types of motion which can occur if a particle of mass m moves under such a force.

c) Discuss how the motions will be expected to differ from the corresponding types of motion for an inverse square law of force.

d) Find L and E for motion in a circle of radius a.

e) Find the period of circular motion and the period of small radial oscillations.

f) Show that the nearly circular orbits are almost closed when a is very small.

Q4. a) What are the principle aims of transformation theory? (2Mks)

b) Show that the transformation (8Mks)

$$Q = ln\left(\frac{\sin p}{q}\right), P = \text{q}\cot p$$

is canonical

c) Determine the generating functions $F_1(Q, q)$ and $F_2(P, q)$. (10Mks

Q5. Let a particle of mass m move in a force field that in spherical coordinates has the form $V = -Kcos\Theta/r^2$. Write down the Hamilton-Jacobi differential equation for the particle motion. (20Mk