Physics 217 — Feb. 20, 1991
Final Exam — Time : 2hrs

NAME: _____

I.D. # _____

1. A turntable rotates with a constant angular velocity (ω) about a perpendicular axis through its center O. The position of a point P which is moving relative
10% to the turntable is given by: $r = x\hat{i} + y\hat{j}$ where the unit vectors $\hat{i}$ and $\hat{j}$ are fixed in the turntable.

Find : a) The absolute velocity and

b) The acceleration of P in terms of its motion relative to the turntable.

2. A mass (m_1) hangs from a spring with a constant (k). The point of support of
25% the spring moves with a horizontal displacement

$$x_1 = A \sin\omega t$$

From (m_1) hangs a massless rod of length (L) at the end of which is a second mass (m_2) . The spring moves vertically and the rod is constrained to a vertical plane.

a) Write the Lagrangian

b) Determine the equations of motion

c) If (θ) is the angle that the rod makes with the vertical, check the equations from part (b) if it is assumed that $\theta = \dot{\theta} = \ddot{\theta} = 0$ at all times.

3. Find the Hamiltonian equations of motion for a particle in a central field.
15% Are there any constants of the motion ?

4. Find the principal axes and their associated moments of inertia for a cube of
20% mass M and sides a, for an origin at one corner with axes directed along the edges of the cube.

5. A. For a central force given by $F(r) = K \dfrac{e^{-br}}{r^2} \hat{r}$, $K < 0$

What values of r are necessary for stable circular orbits ?

20%

B. The potential energy of a particle moving in one dimension is :

$$V(x) = - V_1 e^{-ax^4}$$ where (a) is a constant

a) Find the force

b) Discuss the motion qualitatively

6. a) Using appropriate symmetries, find the moments of inertia at the center
10% of a uniform rectangular plate ABCD of sides (L_1) and (L_2).

b) Also, find the moments of inertia about axes AB and AD and the line perpendicular to the plate at B.

GOOD LUCK