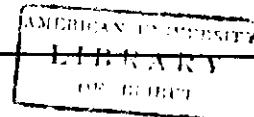


NAME: \_\_\_\_\_

I.D. # \_\_\_\_\_



- 10% 1. A turntable rotates with a constant angular velocity ( $\omega$ ) about a perpendicular axis through its center O. The position of a point P which is moving relative 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.

- 25% 2. A mass ( $m_1$ ) hangs from a spring with a constant (k). The point of support of 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 ( $\theta$ ) 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.

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

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

- 20% 5. A. For a central force given by  $F(r) = K \frac{e^{-br}}{r^2} \hat{r}$ ,  $K < 0$   
What values of r are necessary for stable  $r^2$  circular orbits ?

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

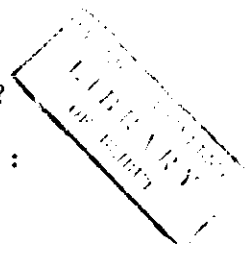
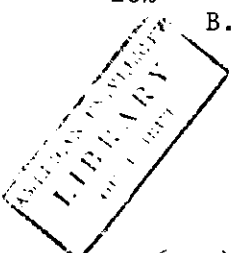
$$V(x) = -V_1 e^{-ax^4} \quad \text{where (a) is a constant}$$

a) Find the force

b) Discuss the motion qualitatively

- 10% 6. a) Using appropriate symmetries, find the moments of inertia at the center 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