Final Exam Information

The final exam will be held Monday December 17 from 9 am – 12 noon in the Johnson Athletic Center.

Make sure you understand how to solve all the in-class problems from W12, W13, W14, and W15, and review the problems sets.

Final Exam Topics:

Rotation and Translation in 2 and 3 dimensions:

Know that the motion of a rigid body can be regarded as a combination of translation of the center of mass and rotation about an axis through the center of mass.

Know how to determine the kinetic energy of a rigid body that is rotating and translating.

Understand the concept of moment of inertia.

**You will not have to calculate any moments of inertia using integration techniques** but you should know how to apply the parallel axis theorem to determine the moment of inertia of an object about points other than the center of mass.

Be able to apply the relation between external torque on an object, its moment of inertia and its angular acceleration for two kinds of situations:

- Objects whose motion does not involve center-of-mass acceleration such as: A disk rotating about an axis through its center.
- Objects whose motion involves acceleration of center of mass such as: A yo-yo rolling on a table, a rigid cylinder rolling down an inclined plane.

Know how to apply the rolling without slipping condition.

Be able to apply conservation of energy for problems involving rotation and translation.

Understand the concept of angular momentum and the relation between change in angular momentum and torque.

Know how to choose suitable points about which torque and angular momentum can be calculated while solving problems involving 2-dimensional rotation.
Be able to calculate angular momentum about a point: for point particles and for rigid bodies.

Be able to apply the conservation of angular momentum to solve problems involving rotation and translation of rigid objects.

Understand the vector nature of torque, angular acceleration and angular momentum.

Know how the angular momentum of a spinning object can change in time either by changing magnitude, or direction or both.

Understand how to calculate the precession angular velocity of an object that displays ‘gyroscopic behavior’.

**Central Force Motion:**

Understand how to apply energy and angular momentum conservation laws to problems involving objects orbiting under the influence of gravity. Understand how to apply Newton’s Second Law to circular orbits.

**Simple Harmonic Motion**

For a system that undergoes simple harmonic motion, understand how to derive the simple harmonic oscillator equation using energy, force, or torque methods.

Understand how to calculate the angular frequency and period of motion for a system that undergoes simple harmonic motion.

Understand how to apply the solution to the simple harmonic oscillator equation based on given initial conditions.

Understand how to calculate the angular frequency of small oscillations about a stable equilibrium point of a system.

**Kinematics:**

Understand the concepts of position, velocity and acceleration for different kinds of motion and be able to differentiate and integrate mathematical functions describing them.

Understand that two-dimensional motion of an object can be described as two independent motions based on the co-ordinate choice.

Understand how to calculate the velocity of an object in different reference frames that are moving at constant relative velocity to each other.
Circular Motion:

Understand that the direction of acceleration of an object moving at constant speed (v) in a circle is towards the center of the circle. The magnitude of this acceleration is $v^2/r$.

Understand that the tangential component of the acceleration of an object moving in a circle with changing speed is not zero.

Understand that when an object moves in a circle, there must be a net force exerted on it towards the center of the circle.

Newton’s Laws:

Understand Newton’s Third law.

Know how to represent the forces exerted on an object using free-body diagrams.

Know how to apply Newton’s Second law to objects undergoing linear and circular motion.

Work, Energy, Potential Energy, and Conservation of Energy:

Know how to calculate the work on an object (by a force exerted on it).

Know how to calculate the potential energy associated with gravity near the surface of the earth, inverse-square and spring forces.

Know how to distinguish between conservative and non-conservative forces

Know how to apply the work-mechanical energy law.

Momentum:

Understand: the concept of momentum for a single particle; the concept of impulse; the concept of center of mass of a system; how the total momentum of a system of particles is related to the velocity of the center of mass of the system; how the rate of change of momentum of a system is related to the forces exerted on the system; the difference between internal and external forces on a system;

Know how to apply the condition that the acceleration of the center of mass of a system depends only on the total external force.
Be able to apply the conservation of momentum law for 1-dimensional collisions and in component form for 2-dimensional collisions

Be able to use the conservation of momentum and conservation of energy laws to solve collisions involving two objects.

**Conservation Laws:**

Understand what is meant by a conservation law and know how to determine whether the energy, angular momentum, and momentum of a system is constant.