• The design of mechanisms and their components requires information about forces acting on these components. Kinematics and Dynamics of Machines Some mechanisms are designed to perform a specific kinematic function (like the windshield wiper mechanism). others to transfer energy (like the internal combustion engine). 4. Force Analysis of Mechanisms · However, in any mechanism, identification of forces is needed to determine the proper dimensions of components. 1 2 · The objective of the force analysis of mechanisms is to find Static and Inertial Forces the transformation of forces from the input to the output links. • This transformation of forces depends on the position of the · In the force analysis of Machines, we frequently refer to two mechanism; in other words, it is a function of time.

Introduction

- Thus, it is important to find out how these forces change during one cycle in order to find their maxima.
- One should differentiate between two types of forces: *external* and internal. The former are forces that are applied to the links from external sources — driving forces, resistance forces - whereas the latter are forces acting between the joints (they are called constraint or reaction forces).

- kind of forces: static forces and inertial forces
- Inertial forces or d'Alembert's forces are those equivalent to system inertia
- Static forces refer to all forces except inertia forces.
- d'Alembert's Principle: The external forces acting on a rigid body are equivalent to the effective forces of the various particles forming the body.

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Free-body Diagram For A Link

• A diagram of a link with all forces (external and internal) applied to it is called a *free-body diagram*. Under the action of all forces (static and inertial), the link must be in equilibrium.

$$\sum_{i=0}^{n} F_{i} = 0, \qquad \sum_{j=0}^{m} M_{j} = 0$$

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• This requirement results in relationships between the known and unknown forces for a single link.

- The internal forces originate in joints since joints constrain the relative motion between the connected links.
- In the case of a revolute joint, in general, both the magnitude and the direction of the constraint force are unknown, whereas in the case of a prismatic joint only the magnitude of the constraint force is unknown.

Example 1. Negligible inertia forces



Example 2. Considerable inertia forces



Impact Center

- If the mass of a combined pendulum is concentrated in a point so that its oscillation period remain the same, the new point is named *Impact center*.
- If an impact force is implied to impact center, the reaction of pendulum axes will be zero
- Location of impact center depends upon location of axes point with respect to the center of gravity

Locating Impact Center

For a Lamped Mass Pendulum:



For a distributed Mass Pendulum:





Axes Reaction

In case of zero axes reaction, the sole acting forces are inertia forces which can be replaced with a single force at distance h from centroide:



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