BASICS OF KINEMATICS AND DYNAMICS

Introduction:

The objective of *kinematics* is to develop *various means of transforming motion* to achieve a specific kind needed in applications. For example, an object is to be moved from point *A* to point *B* along some path. The first question in solving this problem is usually: What kind of a mechanism (if any) can be used to perform this function? And the second question is: How does one design such a mechanism?

- The objective of *dynamics* is analysis of the behavior of a given machine or
- mechanism when subjected to dynamic forces. For the above example, when the mechanism is already known, then external forces are applied and its motion is studied. The determination of forces induced in machine components by the motion is part of this analysis.
- As a subject, the kinematics and dynamics of machines and mechanisms is
- disconnected from other subjects (except statics and dynamics) in the Mechanical Engineering curriculum. This absence of links to other subjects may create the false impression that there are no constraints, apart from the kinematic ones, imposed on the design of mechanisms. Look again at the problem of moving an object from *A* to *B*. In designing a mechanism, the size, shape, and weight of the object all constitute input into the design process.
- All of these will affect the size of the mechanism. There are other considerations as well, such as, for example, what the allowable speed of approaching point *B* should be. The outcome of this inquiry may affect
- either the configuration or the type of the mechanism. Within the subject of kinematics and dynamics of machines and mechanisms such requirements cannot be justifiably formulated; they can, however, be posed as a learning exercise.

KINEMATICS AND DYNAMICS AS PART OF THE DESIGN PROCESS

- The role of kinematics is to ensure the functionality of the mechanism, while the role of dynamics is to verify the acceptability of induced forces in parts. The functionality and induced forces are subject to various constraints (specifications) imposed on the design. Look at the example of a cam operating a valve
- Fundamentals of Kinematics and Dynamics of Machines and Mechanisms
- The *design process* starts with meeting the *functional requirements* of the product.
- The basic one in this case is the proper *opening*, *dwelling*, and *closing* of the
- valve as a function of *time*. To achieve this objective, a corresponding cam profile producing the needed follower motion should be found. The rocker arm, being a lever, serves as a displacement amplifier/reducer. The timing of opening, dwelling, and closing is controlled by the speed of the camshaft. The function of the spring is to keep the roller always in contact with the cam. To meet this requirement the inertial forces developed during the follower–valve system motion should be known, since the spring force must be larger than these forces at any time. Thus, it follows that the determination of component accelerations needed to find inertial forces is important for the choice of the proper spring stiffness. Kinematical analysis allows one to satisfy the functional requirements for valve displacements. Dynamic analysis allows one to find forces in the system as a function of time. These forces are needed to continue the design process. The *design process* continues with meeting the *constraints requirements*, which in this case are:
- 1. Sizes of all parts;
- 2. Sealing between the valve and its seat;
- 3. Lubrication;
- 4. Selection of materials;
- 5. Manufacturing and maintenance;
- 6. Safety;
- 7. Assembly, etc.
- The forces transmitted through the system during cam rotation allow one to

- determine the proper sizes of components, and thus to find the overall assembly dimension. The spring force affects the reliability of the valve sealing. If any of the requirements cannot be met with the given assembly design, then another set of parameters should be chosen, and the kinematic and dynamic analysis repeated for the new version.
- Thus, kinematic and dynamic analysis is an *integral part* of the machine design process, which means it *uses input* from this process and *produces output* for its continuation.

Source : http://nprcet.org/e%20content/mech/KM.pdf