Asignación #1

“Breve explicación de los eslabones, juntas, y mecanismos que se describen en las secciones 1.8 y 1.12 del libro de texto”

Fecha de la asignación: 16 de marzo de 2016.

Fecha de entrega: 23 de marzo de 2016.

Lea y analice las secciones 1.8 (eslabones comúnmente usados y juntas) y 1.12 (mecanismos de propósito especial) del libro de texto y explique brevemente los eslabones, juntas, y mecanismos descritos en dichas secciones.

Se adjuntan a este documento las páginas correspondientes a las secciones de interés.

Asignación individual.

*****Debe ser entregada en páginas blancas 8½” x 11”; engrapadas en la esquina superior izquierda.***

4. ***Identify Any Points of Interest***

   The stabilizer foot is part of link 2, and a point of interest located on the bottom of the foot is labeled as point of interest *X*.

5. ***Draw the Kinematic Diagram***

   The resulting kinematic diagram is given in Figure 1.22.

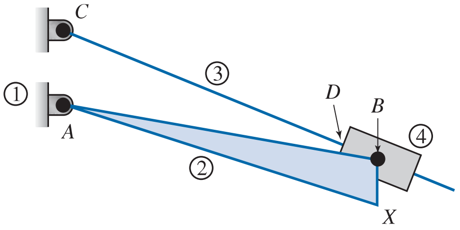


FIGURE 1.22 Kinematic diagram for Example Problem 1.6.

6. ***Calculate Mobility***

   To calculate the mobility, it was determined that there are four links in this mechanism, as well as three pin joints and one slider joint. Therefore,

$$n = 4,\ j_p = (3 \text{ pins} + 1 \text{ slider}) = 4,\ j_h = 0$$

and

$$M = 3(n - 1) - 2j_p - j_h = 3(4 - 1) - 2(4) - 0 = 1$$

With one degree of freedom, the outrigger mechanism is constrained. Moving only one link, the piston, precisely positions all other links in the outrigger, placing the stabilizing foot on the ground.

1.8 COMMONLY USED LINKS AND JOINTS

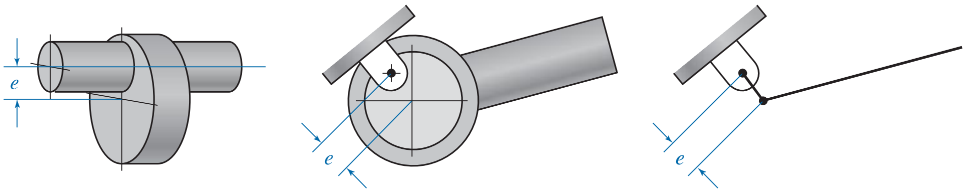
1.8.1 Eccentric Crank

On many mechanisms, the required length of a crank is so short that it is not feasible to fit suitably sized bearings at the two pin joints. A common solution is to design the link as an eccentric crankshaft, as shown in Figure 1.23a. This is the design used in most engines and compressors.

The pin, on the moving end of the link, is enlarged such that it contains the entire link. The outside circumference of the circular lobe on the crankshaft becomes the moving pin joint, as shown in Figure 1.23b. The location of the fixed bearing, or bearings, is offset from the eccentric lobe. This eccentricity of the crankshaft, *e*, is the effective length of the crank. Figure 1.23c illustrates a kinematic model of the eccentric crank. The advantage of the eccentric crank is the large surface area of the moving pin, which reduces wear.

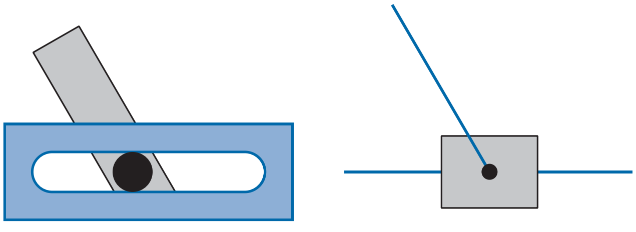
1.8.2 Pin-in-a-Slot Joint

A common connection between links is a pin-in-a-slot joint, as shown in Figure 1.24a. This is a higher-order joint because it permits the two links to rotate and slide relative to each other. To simplify the kinematic analysis, primary joints can be used to model this higher-order joint. The pin-in-a-slot joint becomes a combination of a pin joint and a sliding joint, as in Figure 1.24b. Note that this involves adding an extra link to the mechanism. In both cases, the relative motion between the links is the same. However, using a kinematic model with primary joints facilitates the analysis.



(a) Eccentric crankshaft (b) Eccentric crank (c) Eccentric crank model

FIGURE 1.23 Eccentric crank.

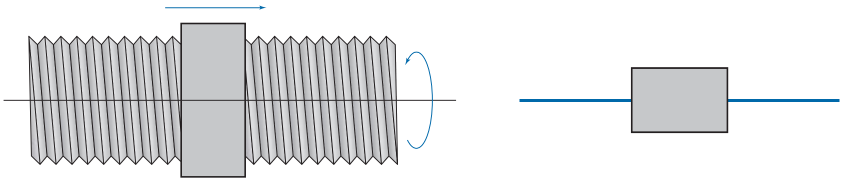


(a) Actual pin-in-a-slot joint (b) Pin-in-a-slot model

FIGURE 1.24 Pin-in-a-slot joint.

1.8.3 Screw Joint

A screw joint, as shown in Figure 1.25a, is another common connection between links. Screw mechanisms are discussed in detail in Chapter 12. To start with, a screw joint permits two relative, but dependent, motions between the links being joined. A specific rotation of one link will cause an associated relative translation between the two links. For example, turning the screw one revolution may move the nut along the screw threads a distance of 0.1 in. Thus, only one independent motion is introduced.



(a) Actual screw joint (b) Screw modeled as a slider

FIGURE 1.25 Screw joint.

A screw joint is typically modeled with a sliding joint, as shown in Figure 1.25b. It must be understood that out-of-plane rotation occurs. However, only the relative translation between the screw and nut is considered in planar kinematic analysis.

An actuator, such as a hand crank, typically produces the out-of-plane rotation. A certain amount of rotation will cause a corresponding relative translation between the links being joined by the screw joint. This relative translation is used as the "driver" in subsequent kinematic analyses.

EXAMPLE PROBLEM 1.7

Figure 1.26 presents a lift table used to adjust the working height of different objects. Draw a kinematic diagram and compute the degrees of freedom.

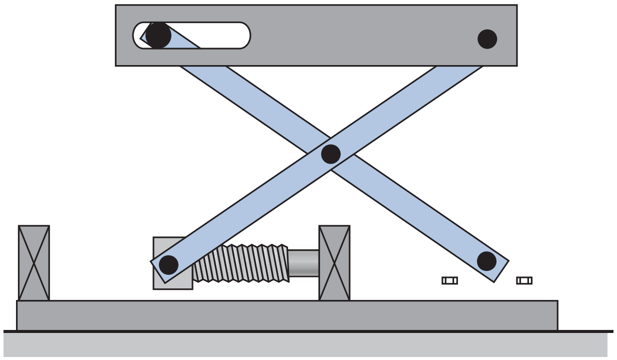


FIGURE 1.26 Lift table for Example Problem 1.7.

SOLUTION: 1. ***Identify the Frame***

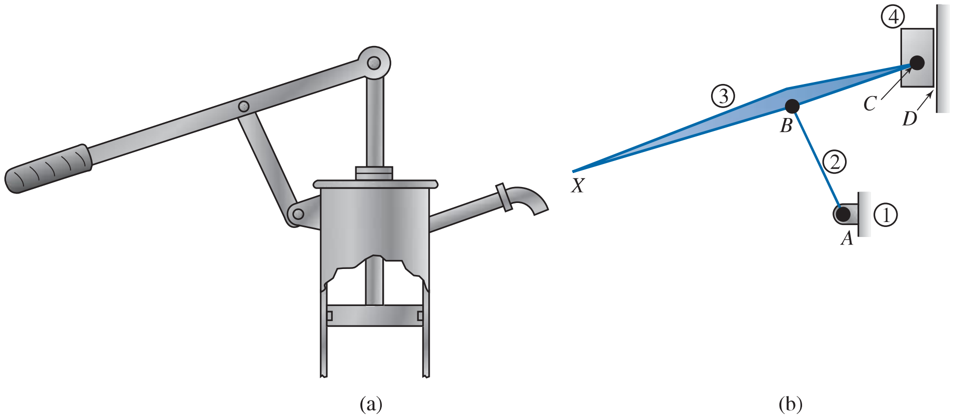
The bottom base plate rests on a fixed surface. Thus, the base plate will be designated as the frame. The bearing at the bottom right of Figure 1.26 is bolted to the base plate. Likewise, the two bearings that support the screw on the left are bolted to the base plate.

From the discussion in the previous section, the out-of-plane rotation of the screw will not be considered. Only the relative translation of the nut will be included in the kinematic model. Therefore, the screw will also be considered as part of the frame. The motion of all other links will be determined relative to this bottom base plate, which will be numbered as link 1.

1.11 SLIDER-CRANK MECHANISM

Another mechanism that is commonly encountered is a slider-crank. This mechanism also consists of a combination of four links, with one being designated as the frame. This mechanism, however, is connected by three pin joints and one sliding joint.

A mechanism that drives a manual water pump is shown in Figure 1.37a. The corresponding kinematic diagram is given in Figure 1.37b.



(a) (b)

FIGURE 1.37 Pump mechanism for a manual water pump: (a) Mechanism and (b) Kinematic diagram.

The mobility of a slider-crank mechanism is represented by the following:

$$n = 4, j_p = (3 \text{ pins} + 1 \text{ sliding}) = 4, j_h = 0$$

and

$$M = 3(n - 1) - 2j_p - j_h = 3(4 - 1) - 2(4) - 0 = 1.$$

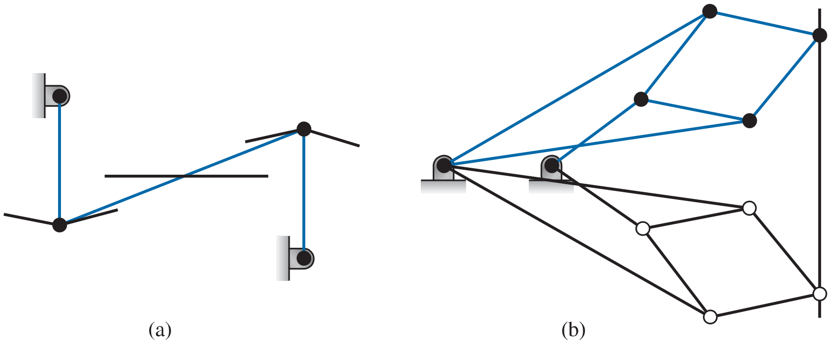
Because the slider-crank mechanism has one degree of freedom, it is constrained or fully operated with one driver. The pump in Figure 1.37 is activated manually by pushing on the handle (link 3).

In general, the pivoted link connected to the frame is called the *crank*. This link is not always capable of completing a full revolution. The link that translates is called the *slider*. This link is the piston/rod of the pump in Figure 1.37. The coupler or connecting rod "couples" the motion of the crank to the slider.

1.12 SPECIAL PURPOSE MECHANISMS

1.12.1 Straight-Line Mechanisms

Straight-line mechanisms cause a point to travel in a straight line without being guided by a flat surface. Historically, quality prismatic joints that permit straight, smooth motion without backlash have been difficult to manufacture. Several mechanisms have been conceived that create straight-line (or nearly straight-line) motion with revolute joints and rotational actuation. Figure 1.38a shows a Watt linkage and Figure. 1.38b shows a Peaucellier-Lipkin linkage.

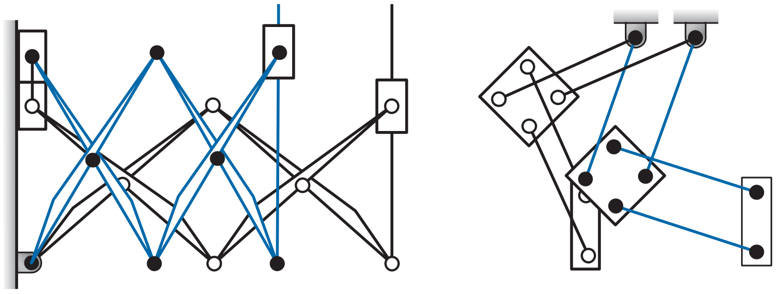


(a) (b)

FIGURE 1.38 Straight-line mechanisms

1.12.2 Parallelogram Mechanisms

Mechanisms are often comprised of links that form parallelograms to move an object without altering its pitch. These mechanisms create parallel motion for applications such as balance scales, glider swings, and jalousie windows. Two types of parallelogram linkages are given in Figure 1.39a which shows a scissor linkage and Figure1.39b which shows a drafting machine linkage.

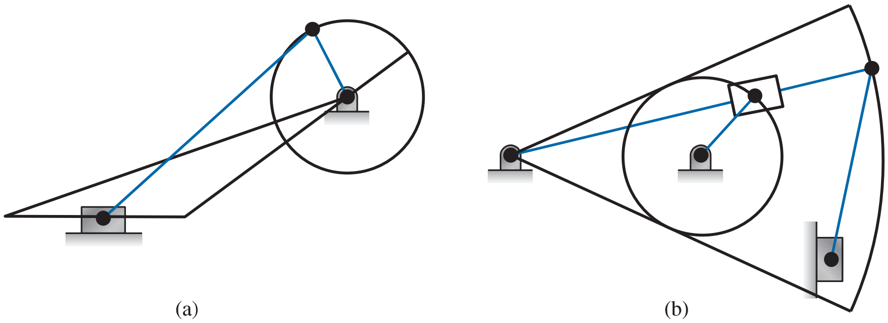


(a) (b)

FIGURE 1.39 Parallelogram mechanisms.

1.12.3 Quick-Return Mechanisms

Quick-return mechanisms exhibit a faster stroke in one direction than the other when driven at constant speed with a rotational actuator. They are commonly used on machine tools that require a slow cutting stroke and a fast return stroke. The kinematic diagrams of two different quick-return mechanisms are given in Figure 1.40a which shows an offset slider-crank linkage and Figure 1.40b which shows a crank-shaper linkage.

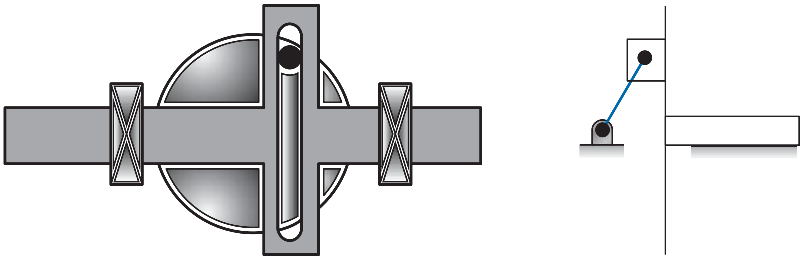


(a) (b)

FIGURE 1.40 Quick-return mechanisms.

1.12.4 Scotch Yoke Mechanism

A scotch yoke mechanism is a common mechanism that converts rotational motion to linear sliding motion, or vice versa. As shown in Figure 1.41, a pin on a rotating link is engaged in the slot of a sliding yoke. With regards to the input and output motion, the scotch yoke is similar to a slider-crank, but the linear sliding motion is pure sinusoidal. In comparison to the slider-crank, the scotch yoke has the advantage of smaller size and fewer moving parts, but can experience rapid wear in the slot.



(a) Actual mechanism (b) Kinematic diagram

FIGURE 1.41 Scotch yoke mechanism.

1.13 TECHNIQUES OF MECHANISM ANALYSIS

Most of the analysis of mechanisms involves geometry. Often, graphical methods are employed so that the motion of the mechanism can be clearly visualized. Graphical solutions involve drawing "scaled" lines at specific angles. One example is the drawing of a kinematic diagram. A graphical solution involves preparing a drawing where all links are shown at a proportional scale to the actual mechanism. The orientation of the links must also be shown at the same angles as on the actual mechanism.