



- 11-31 Use the information in Problem 11-10 to find the torque needed to drive the crank at the position shown using the method of virtual work.
- 11-32 Use the information in Problem 11-10, but change the lengths of links 3 and 4 to 1.43 and 1.60 m, respectively, to make it Grashof. Then use program FOURBAR to find and plot all pin forces and the torque needed to drive the crank at a constant speed of 15 rad/sec for one revolution of the crank using the method of virtual work.
- 11-33 Use the information in Problem 11-10, but change the lengths of links 3 and 4 to 1.43 and 1.60 m, respectively, to make it Grashof. Then find and plot the torque needed to drive the crank at a constant speed of 15 rad/sec for one revolution of the crank using the method of virtual work.

### FOR REFERENCE

- 11-10 Figure P11-4b shows a fourbar linkage and its dimensions in meters. The steel crank and rocker have uniform cross sections of 50 mm wide by 25 mm thick. The aluminum coupler is 25 mm thick. In the instantaneous position shown, the crank  $O_2A$  has  $\omega = 15$  rad/sec and  $\alpha = -10$  rad/sec<sup>2</sup>. There is a horizontal force at  $P$  of  $F = 200$  N. Find all pin forces and the torque needed to drive the crank at this instant.