In this laboratory experiment you will build a multi-threaded solution for the dining philosopher's problem. This solution will prevent deadlock and avoid indefinite postponement while sharing resources among five interacting threads.

The original dining philosopher's problem was suggested by Dijkstra as a demonstration of resource sharing. In this sample problem, five philosophers are sitting around a table, eating and talking. There are five forks (or chopsticks) shared by the five philosophers, one between each pair of philosophers. When a philosopher is eating he or she must use two forks. This means that the philosophers sitting on either side of the eating philosopher must wait to eat. The goal is to

- enforce mutual exclusion (i.e. two philosophers are not permitted to use the same fork at the same time),
- prevent deadlock (i.e. a philosopher is not permitted to hold a fork indefinitely while waiting for another fork),
- avoid lockstep synchronization (i.e. a philosopher is permitted to eat twice if the philosophers on either side have not been waiting to eat),
- avoid starvation (i.e. avoid a situation where a philosopher is indefinitely delayed from eating).

The difference between deadlock and starvation may not be clear at first. The situation of deadlock occurs when processes (philosophers) are waiting for an event that will never occur. An example of deadlock in this model would be if all the philosophers were holding the fork on their left while waiting for the fork on their right to become available. On the other hand, starvation occurs after a philosopher fails to get both forks after a maximum number of attempts. The possibility exists that the philosopher could eat but the situation simply did not occur. The forks are shared resources and since each fork is accessible by a unique pair of philosophers the forks should be considered as five different types of resources. Otherwise any philosopher would be able to use any two forks that were laying anywhere on the table. In the figure above philosopher P0 may use forks R0 and R4, philosopher P1 may use forks R0 and R1, and so on. Since a
philosopher must use two forks to eat, the philosophers on either side of an eating philosopher must wait (i.e. talk) while their neighbor eats. The goal of each philosopher is to eat a while and talk a while. The problem is to develop a set of rules (the same for each philosopher) that permits each philosopher to accomplish their goals of eating and talking without starvation due to deadlock or indefinite postponement.

Use the sample code provided dinner45.zip to test a multi-threaded simulation of the dining philosopher's problem.

1. How does this program simulate the picking up and putting down of fork? 
   __________________________________________________________________________
   __________________________________________________________________________

2. How does this program force each philosopher to wait until the forks are available? ______
   __________________________________________________________________________
   __________________________________________________________________________

3. What method of preventing deadlock is being implemented in this code?
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________

4. Choose a philosopher (say P2) and make their talking time larger by changing the appropriate sleep time,
   Thread.Sleep(rnd.Next(500) + 500);
   How does this affect the other philosophers? ________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________

5. Now make a philosopher's eat time longer and describe how this affects the other philosophers.
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________

6. How many philosophers can eat at the same time? ________________________________

7. Do the percentages of Eating, Waiting and Talking seem reasonable? ________________
   Explain _________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________