c) FCFS:
The processes are scheduled in the order: A B C D E

$T_{wait} = (0 + 6 + (6+4) + (6+4+1) + (6+4+1+3)) /5$
$= (0 + 6 + 10 + 11 + 14) /5$
$= 41 / 5$
$= \mathbf{8.2}$ (minutes)

d) SJF:
The processes are scheduled in the order: C D B A E

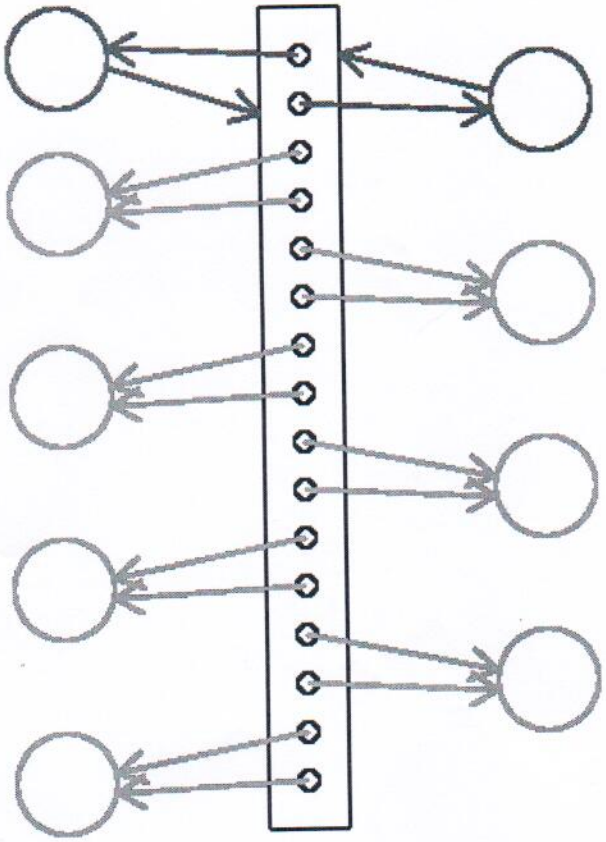
$T_{wait} = ((1+4+3) + (1+3) + 0 + (1) + (1+4+3+6))/ 5 = (8 + 4 + 0 + 1 + 14) /5$
$= 27 / 5$
$= \mathbf{5.4}$ (minutes)

2. (50 points)
a) A computer system has sixteen drives, with 9 processes competing for them. Each process may need a maximum of two drives. Is the system deadlock free? Give your reasons for the answer with the help of **resource graph diagrams**.

Solutions:

Yes, the system is deadlock **free**. This is because in the worst case, all 9 processes request two drives. As we have 16 drives, some of the processes can get two drives to finish their tasks and return the the drives. Then some of the remaining proceses can get two drives, finish and return and so on. So eventually, all processes can finish and return all drives.

The figure on the right illustrates the worst case situation. The processes colored in red are competing for a drive but when any green process has finished using and returned the two drives, they can be allocated to the red processes.



b) In general, a semaphore has two functions, **down()** which decreases the semaphore value and **up()**, which increases the semaphore value.
1. There is a special requirement for these functions in order that a semaphore works properly. What is it?