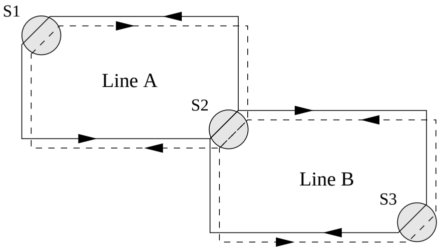
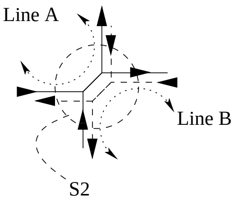
System and Device Programming

Examination Test – Programming Part
21 January 2019

Examination Time: 1h 45min. Evaluation. 18 marks.
Textbooks and/or course material allowed.

A small underground network has the following schematic representation (left-hand side picture):





where `Line A` and `Line B` indicate the two underground lines (each one with two directions, clockwise and anti-clockwise), and `S1`, `S2`, and `S3` are the three stations. Notice that in station `S2` tracks are common, in both directions, for `Line A` and `Line B` (right-hand side picture).

To control the underground network, write a Windows-32 application with the following specifications:

- At the start-up the application has to create:
  - One thread named `commuters` in charge of the commuters entering all underground stations. This thread, every $Time_1$ seconds decides the number of commuters (in the range $[0, 100]$) entering each station in each direction.
  - One thread for each station, named `station`. Stations are initially empty, but a random number of commuters enter each stations as specified by the thread `commuters`.

  When:

  - The number of commuters has been larger than 75 for a direction for 3 times at a time distance equal to $Time_1$ (i.e., at T, $(T + Time_1)$ and $(T + 2 \cdot Time_1)$ for any time T) the station must generate a new train in that direction.
  - The number of commuters has been lesss than 30 for a direction for 3 times at a time distance equal to $Time_1$ (i.e., at T, $(T + Time_1)$ and $(T + 2 \cdot Time_1)$ for any time T) the station must suppress the first train it has created.
- Each train is represented by a thread (named `train`) and it has a capacity of 100 passengers. Each train needs $Time_2$ seconds to move from one station to the following one, and it enters a station only if the tracks are empty in its direction. Each train stays in the station $Time_3$ seconds. Every time a train enters a station, a random number of passengers (at most equal to the current number of commuters in the train at that moment) leave the train, and a random number of passengers (at most equal to the capacity of the train) get on board of the train. When a train is killed (by one station) it is suppose to end its run in a secondary station (not taken in charge by the system) where all commuters on-board get out.

The application has to simulate the entire underground network, printing all main actions performed by the `commuters`, all `station` and all `train` threads. The following is a possible example of simulation:

```
commuterThread station=S1 direction=clockwise commutersIn=65
commuterThread station=S2 direction=anticlockwise commutersIn=25
commuterThread station=S3 direction=clockwise commutersIn=30
commuterThread station=S1 direction=clockwise commutersIn=25
stationThread=S1 direction=clockwise  train-Create=T1
trainThread=T1   commutersIn=63
trainThread=T1   stationIn=S2
trainThread=T1   commutersOut=45
trainThread=T1   commuterIn=27
trainThread=T1   stationOut=S2
commuterThread station=S2 direction=anticlockwise commutersIn=60
stationThread=S2 direction=anticlockwise  train-Create=T2
...
```