1) (34/40) Consider the following fragment of code which is executing on a VLIW processor. Initially R1=600, R2=0x1000, R3=0x3000:

```
lab:    LW      R4, 0(R2)
        LW      R5, 0(R3)
        ADD     R4, R4, R4
        ADD     R4, R4, R5
        MUL     R4, R4          ; R4=R4*R4
        SW      R4, 0(R2)
        SW      R4, 0(R3)
        ADDI    R2, R2, 4
        ADDI    R3, R3, 4
        SUBI    R1, R1, 1
        BNE     R1, R0, lab
```

Working hypothesis:
- Fetch and decode stage have a 6-instruction width
- There are three functional units for the Arithmetic-Logic operations and Branches (ALBUs)
- Branches have 1 delay slot
- There are two Load/Store Units with three stages (effective address calculation, addressing, eventual read); the eventual read requires 1 clock cycle
- Write-backs can be overlapped to the decode stage
- There is one Multiplication Unit (MU) with four stages
- The register file has 24 registers R0-R23 (R0 is hardwired to the value 'zero')
- The register file has 6 independent input ports and 6 independent output ports
- The compiler unrolls the iterations in order to use all available registers (the number of iterations is known by the compiler – initially written in R1)

By compiling the following tables, calculate:
   i) the CIT (Cycles per Iteration) of the optimally unrolled loop so that the CIT is minimized;
   ii) the IPC (Instructions Per Cycle) at the end of the iterations
   iii) the Utilization factor U=available_slots/total_slots

Ciclo	ALBU1	ALBU2	ALBU3	LSU1	LSU2	MULU	Commenti
1	...	...	...	LW R4,0(R2)	LW R5,0(R3)	NOP	...
2	...	...	...	...	...	...	...
3	...	...	...	...	...	...	...

2) (6/40) On a Linux system, write the SINGLE command line to perform at the BASH shell prompt the following operation (please note that no intermediate files should be used:
   - The file 'data1.txt' contains an unsorted list of numerical values to be used as input
   - The file 'data2.txt' should contain a sorted list of the values contained in data1.txt
   - The sorted list should also be parsed to extract the lines which contain a "1"
   - The extracted list should be directed to the printer