FINAL EXAM (Serial #2)

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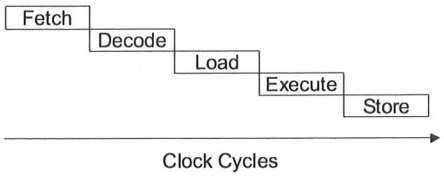
The exam has totally 70 points. Scientific calculator can be used if needed. There are 6 questions in this exam.

1. Are the following claims true (T) or false (F)? Every correct answer gives you +2 p, every incorrect –2 p, and an empty answer is worth 0 p. The minimum amount of total points is 0 p and maximum 10 p.
   a) In a hard real-time system, the sampling frequency should be at least 100 Hz or more.
   b) In cost-effective and robust real-time systems, a pragmatic rule of thumb could be: process everything as slow as possible and repeat tasks as slow as possible.
   c) Speculative execution works well with instruction pipelines if the instructions only involves memory access.
   d) A task is still scheduled by the real-time operating system if it is suspended.
   e) EEPROM may lose its data due to ambient light.

2. a) If you consider the following instruction cycle and the basic von Neumann architecture, which of those five phases use the System Bus? (5 p)




   You have a CPU with the instruction set given below. The following assembly-language program is written using that instruction set. b) What is the content of register R1 after the program is executed? Please explain your answer briefly. (10 p)

| Assembly Instruction | First byte | | Second byte | | Operation |
|---|---|---|---|---|---|
| MOV Rn, direct | 0000 | Rn | direct | | Rn = M(direct) |
| MOV direct, Rn | 0001 | Rn | direct | | M(direct) = Rn |
| MOV @Rn, Rm | 0010 | Rn | Rm | | M(Rn) = Rm |
| MOV Rn, #immediate | 0011 | Rn | immediate | | Rn = immediate |
| MOV Rn, Rm | 0100 | Rn | Rm | | Rn = Rm |
| ADD Rn, Rm | 0101 | Rn | Rm | | Rn = Rn + Rm |
| SUB Rn, Rm | 0110 | Rn | Rm | | Rn = Rn – Rm |
| JZ Rn, relative | 0111 | Rn | relative | | PCR = PCR + relative (only if Rn is 0) |

*Instruction set*

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0       MOV R0, #0;
1       MOV R1, R0;
2       MOV R2, #2;
3       MOV R3, #100;
4       MOV R4, R0;
5       MOV R5, R0;
Loop:   MOV R0, R4;
7       ADD R0, R2;
8       MOV R4, R0;
9       ADD R1, R2;
10      SUB R0, R3;
11      JZ R0, Next;
12      JZ R5, Loop
Next:   MOV R5, #10000
14      MOV @R5, R1
```

*Program*

*Note: #n represents decimal number n*

3. Is it possible to directly write 1 over 0 in a flash memory? And why? (10 p)

4. Construct a cyclic code structure with four tasks, communicate, destination, drive&door, and supervision. Task communicate runs twice as frequently as destination and drive&door, and task communicate runs four times as frequently as supervision. (10 p)

5. A preemptive priority system has three periodically executed tasks, $\tau_1$, $\tau_2$ and $\tau_3$, with required execution periods of $p_1$ = 40 ms, $p_2$ = 20 ms and $p_3$ = 100 ms, respectively. The corresponding worst-case execution times of those tasks are $e_1$ = 10 ms, $e_2$ = 10 ms and $e_3$ =20 ms.
   a) How would you prioritize the tasks according to the Rate-Monotonic (RM) principle? (5 p)
   b) Do you see any problem with the given requirements? (5 p)

6. Consider a real-time operating system with preemptive-priority scheduling. Draw a representative state diagram that shows the possible task states and allowed transitions between them. (5 p)
   In addition, define all the states and transitions. (10 p)