EXAM
(Tentamen)

TDDI11
Embedded Software

2018-08-22 08:00-12:00

On-call (jour):
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Admitted material:
- Dictionary from English to another language

General instructions:
- The assignments are **not ordered** according to difficulty.
- You may answer in either English or Swedish.
- Read all assignments carefully and completely before you begin.
- Use a new sheet for each assignment and use only one side.
- Before you hand in, order the sheets according to assignment, number each sheet, and fill in AID-number, date, course code and exam code at the top of the page.
- Write clearly. Unreadable text will be ignored.
- Be precise in your statements.
- **Motivate** clearly all statements and reasoning.
- **Explain** calculations and solution procedures.
- If in doubt about the question, write down your interpretation and assumptions.
- Grading: U, 3, 4, 5. The **preliminary** grading thresholds for p points are:

$0 \leq p < 20$:	U
$20 \leq p < 30$:	3
$30 \leq p < 35$:	4
$35 \leq p \leq 40$:	5

Good Luck!

Question 1, multiple choice. (10 points)

- Use the answer sheet at the end of the exam.
- No motivation or explanation is required for this 10 points question.
- **Zero or more statements may be correct for each question.**
- Tick each statement if and only if it is correct. Ticking a wrong statement or missing to tick a correct statement gives 0 points for that question.

1a) Compared to interrupt-based programming:

1. Polling-based programming requires simpler hardware support.
2. Polling-based programming wastes more CPU cycles to monitor the status of I/O device controllers.
3. Polling-based programming is easier to scale to complex and large software.

1b) A hard real time system...

1. Cannot be embedded.
2. May be embedded.
3. Must be embedded.

1c) What will be the output from the following C program?

```
#include <stdio.h>
int main() {
        unsigned long int a = 2;
        unsigned long int b = a;
        unsigned long int *c = &a;
        b = 0;
        printf("%lu %lu \n", a, *c);
}
```

1. 0 0
2. 2 0
3. 2 2

1d) What will be the output of the following C program?

```
#include <stdio.h>
int main() {
        printf("%d \n", (1 && 2) || 4);
}
```

1. 0
2. 1
3. 4

1e) What will be the output of the following C program?

```
#include <stdio.h>
int main() {
        printf("%d \n", (3 & 2) | 1);
}
```

1. 0
2. 1
3. 3

1f) The foreground/background model...
1. requires an operating system with task scheduling and virtual memory.
2. does not allow for interrupt-based programming.
3. is suitable for less sophisticated embedded systems.

1g) A finite state machine capturing the program controlling an embedded system...
1. should have an initial state
2. should be deterministic
3. should have a final state

1h) Concurrent software ...
1. is not used in embedded systems using mono-core chips
2. can simplify capturing solutions in embedded applications
3. is easy to get wrong but still used in embedded systems

1i) A unit cost ...
1. is the non-recurring cost of the first produced unit
2. is always negligible for newly designed satellites
3. is a cost for a work that is not necessary but that engineers like to do.

1j) Specification of embedded software ...
1. is usually efficiently and sufficiently carried with a natural language (e.g. English)
2. does not profit from using state machines
3. might include errors and deficiencies

Question 2. (4 points)
- Explain the difference between little and big-endian representations
- Include clean and simple figures in your explanation.
- Describe, in a sentence or two, a situation where translating from one representation to the other is needed.

Question 3. (5 points)
What is the difference between I/O programming using DMA and interrupt in terms of required CPU cycles and hardware support. Explain.

Question 4. (6 points)
Consider a task set with two periodic tasks: Task 1 with period T1= 12 and execution time C1= 3 and Task 2 with period T2= 3 and execution time C2= 2. Both tasks are to be run on the same processor using some scheduling algorithm.
1. Give the processor utilization ratio in case the two tasks are scheduled (1pt)
2. Which task would get the highest priority if Rate Monotonic Scheduling (RMS) is used (1pt)

3. Assume non-pre-emptive RMS is used. Can the tasks be scheduled? Explain using a diagram (2 pt).
4. Can pre-emptive RMS schedule the tasks? Explain using a diagrams (2pt).

Question 5. (5 points)
Give a Mealy machine (outputs associated to transitions, not states) that takes sequences of 0s and 1s as input. The machine should output 1 when it finished reading a non empty sequence of ones that is of a length that is divisible by 3 (i.e. exactly 3,6,9,12,.. of consecutive ones). It should output 0 otherwise. Possible runs of your solution:

Input sequence	Output sequence
0111000...	0000100...
1101110...	0000001...
0000000...	0000000...
1111110...	0000001...

Question 6. (5 points)
Describe the sequence of events that occur when a sensor sends a byte via a serial port and interrupt-driven I/O is used to copy the byte to a given address. Recall a serial port uses a control register to inform on whether new data arrived and a data register to contain the data (you can keep the interaction with the serial port at this level of details: namely read status, read data, etc). Describe how does the microcontroller know what to do and how can it resume what it was doing.

Question 7. (2 points)
The following macros is meant to compute the sum of two numbers. This macro is not well written. We still want to use a macro for computing sums of two numbers. Explain what problems may occur if used as currently written and rewrite it to solve these problems.

```
#define sum(x,y) x*y
```

Question 8. (3 points)
In this question, you are allowed to use bit-level operators (i.e. some of "and", "or", "shift left", "shift right", and "inversion"), no loops, no additions, no divisions, no subtractions and no multiplications. Write a C program that checks if a 16 bits unsinged int is a multiple of 16.

Answer sheet for question 1. Please hand this paper in together with the answers for the other questions (numbered and with AID number).

1a)	( ) 1	( ) 2	( ) 3
1b)	( ) 1	( ) 2	( ) 3
1c)	( ) 1	( ) 2	( ) 3
1d)	( ) 1	( ) 2	( ) 3
1e)	( ) 1	( ) 2	( ) 3
1f)	( ) 1	( ) 2	( ) 3
1g)	( ) 1	( ) 2	( ) 3
1h)	( ) 1	( ) 2	( ) 3
1i)	( ) 1	( ) 2	( ) 3
1j)	( ) 1	( ) 2	( ) 3