EXAM
(Tentamen)

TDDI11
Embedded Software

2017-10-27 14:00-18:00

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 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) Which of the following statements is / are correct?
Compared to interrupt based programming:

1. polling requires simpler hardware support.
2. polling wastes more CPU cycles to monitor the status of I/O device controllers.
3. polling based is harder to maintain and to scale.

1b) Which of the following statements is / are correct?

1. Embedded systems may be real time systems.
2. Real time systems are too complex to be embedded.
3. Embedded systems are by definition real time systems.

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

```
#include <stdio.h>
int main() {
      unsigned long int a = 5;
      unsigned long int *b = &a;
      unsigned long int c = *b;
      *b = 7;
      printf("%lu %lu \n", a, c);
}
```

1. 5 5
2. 7 5
3. 7 7

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

```
#include <stdio.h>
int main() {
      printf("%d \n", (0 || 2) && 3);
}
```

1. 0
2. 1
3. 2

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

```
#include <stdio.h>
int main() {
      printf("%d \n", (0 | 2) & 3);
}
```

1. 0
2. 1
3. 2

1f) Which of the following statements is / are correct?
1. The foreground/background model is suitable for high volume low cost microcontroller-based applications.
2. The foreground/background model requires support from a multitasking operating system with premptive scheduling.
3. The foreground/background model is easy to scale and to maintain.

1g) Which of the following statements is/are correct.
When used to model an embedded system, a Moore state machine:
1. Associates outputs to states.
2. Associates outputs to transitions.
3. Cannot represent outputs.

1h) Which of the following statements is/are correct:
1. Concurrent software is only used on multicore machines for computationally intensive applications such as scientific computing.
2. Concurrent software is very difficult to get right and is therefore never used in embedded software.
3. Concurrent software helps organize applications in loosely coupled entities.

1i) Which of the following statements is/are correct. Non-recurring engineering cost:
1. Is a design metric
2. Is a cost that is not to be taken into account
3. Is a cost for a work that is not necessary but that engineers like to do.

1j) Which of the following statements is/are correct. Specification of embedded software:
1. Is usually efficiently and sufficiently carried with a natural language (e.g. English)
2. Might profit from using Moore state machines
3. Is usually simple enough that it is difficult to introduce faults in it.

Question 2. (5 points)
Explain the difference between little and big endian representations of a 4 bytes-integer:
- 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.
- Give a C code snippet that explains how to perform such a translation assuming a "char buffer[4]" containing the 4-bytes integer.

Question 3. (5 points)

What is the difference between I/O programming using DMA and polling in terms of required CPU cycles and hardware support. Explain.

Question 4. (5 points)
Consider a task set with two periodic tasks: Task 1 with period T1= 5 and execution time C1= 2 and Task 2 with period T2= 7 and execution time C2= 4. 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. What would the priority of the tasks be if RMS is used (1pt)
3. Assume pre-emptive RMS is used. Can the tasks be scheduled? Explain using a diagram (1 pt).
4. Can pre-emptive EDF schedule the tasks? Explain using a diagram (2pt).

Question 5. (5 points)
Give a Mealy machine that takes sequences of 0s and 1s as input. The machine should output 0 unless it witnesses three consecutive inputs with the same value (i.e., three consecutive 0s or two consecutive 1s), in which case it outputs 1. Possible runs of your solution:

Input sequence	Output sequence
`000000...`	`001111...`
`111111...`	`001111...`
`110000...`	`000011...`
`000111...`	`001001...`

Question 6. (5 points)
Describe the sequence of events that occur when a mouse key is pressed when using interrupt-driven I/O

Question 7. (2 points)
The following macros is meant to compute the third power of a number. This macros is not well written. Explain what problems may occur if used as currently written and rewrite it to solve these problems.

```
#define Cube(x) (x*x*x)
```

Question 8. (3 points)
Using bit-level operators (no additions, divisions, substractions or multiplications), write a C program that checks if a 16 bits unsinged int is a multiple of 512.

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