EXAM
(Tentamen)

TDDI11
Embedded Software

2016-10-19 14:00-18:00

On-call (jour):
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Admitted material:

- Dictionary from English to your native 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
$20 \leq p < 27$:	3
$27 \leq p < 34$:	4
$34 \leq p \leq 40$:	5

Good Luck!

Question 1, multiple choice. (10 points)
Use the answer sheet at the end of the exam. Not motivation or explanation is required for this question.

1a) What is an interrupt?

1. A signal from the processor to the bus to halt and wait for a resume signal.
2. A signal to the processor to stop executing the current set of instructions and jump to another memory address.
3. A signal to the processor to fetch data from the bus.

1b)
Which of the following statements is correct?

1. Embedded systems are often real-time systems.
2. A system cannot be both a real-time system and an embedded system.
3. A real-time system is by definition embedded.

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", b, *c);
}
```

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

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

```
#include <stdio.h>
int main() {
      printf("%d \n", ~5 && ~1);
}
```

1. 0
2. 1
3. ~5

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

```
#include <stdio.h>
int main() {
      printf("%d \n", (1 | 4)&13);
}
```

1. 8
2. 5
3. 13

1f)
Which of the following statements is not correct?

1. The foreground/background model can be implemented without extensive support from an operating system.
2. The foreground/background model is incompatible with real-time requirements.
3. The foreground/background model has problems with scalability and maintainability.

1g) What is the relationship between Mealy and Moore state machines?

1. A Mealy machine is a special kind of Moore machine where there are no loops (transitions going back to the same state).
2. A Mealy machine can be created from a Moore machine by taking the output associated with each state and put it as outputs for the transitions going in to that state.
3. A Moore machine can be created from a Mealy machine by taking the output associated with each transition from q0 to q1 and letting it be the output of q0.

1h) What is the advantage of using a message passing approach to concurrency?

1. It allows fast access to shared memory.
2. It means that no context switching is needed when changing which process that runs.
3. It avoids the critical section problem.

1i) What is the Non-Recurring Engineering (NRE) cost?

1. The one-time cost to hire one more engineer.
2. The one-time cost of designing a system.
3. The one-time cost of for an engineer to build a prototype.

1j)

What is a non-deterministic state machine?

1. A pseudo-random generator module.
2. An abstract representation of a system's behavior.
3. An unpredictable system.

Question 2. (5 points)

Consider a system intended to control the heating in a house. The system has a number of temperature sensors (outside temperature, temperature of the heating water, etc), and actuators such as circulation motors, valves and compressor. Discuss how the conversion between analog and digital signal can be done in such a system, potential problems that can occur, and what can be done to reduce these.

Question 3. (5 points)

There are three main approaches to I/O processing. Explain briefly each of them, and compare them in terms of real-time predictability and what kind of platform support which is needed.

Question 4. (5 points)
Explain the concept of macros in the C language. What is it? What happens during the compilation process? How can macros be useful in embedded programming? What are the pitfalls?

Question 5. (5 points)
Explain the foreground/background system. Draw a figure, if necessary. Mention the advantages and disadvantages of this system. Finally, describe an alternative approach that does not have the same disadvantages.

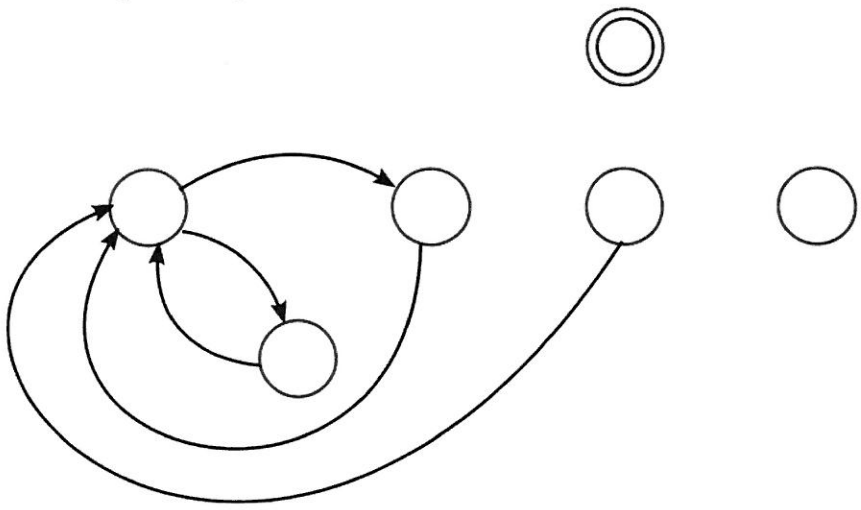
Question 6. (5 points)
Explain briefly your understanding of the design process for an embedded system. Consider aspects such as hardware/software, the main design phases, braking down in parts, and the role of standard platforms.

Question 7. (5 points)
Consider a system for entering a decimal number and decide whether the number is valid or not. The system has a keypad with the following buttons: + - . 0 1 2 3 4 5 6 7 8 9 Enter Where '.' is the decimal mark and the Enter-button is used to confirm the input.

The system has the following requirements:

- The system shall output '1' once a valid decimal number has been entered followed by Enter.
- In the event of an incorrect input, the system shall return to the initial state.
- A decimal number can begin with +, - or a digit
- A decimal number can contain a decimal mark, but must in that case be preceded and followed by a digit.

The figure below contains a partial realisation of the system as a Moore state machine with all the required states (not labeled), but only a subset of the transitions. Complete the figure with all the required transitions, and label them with the proper inputs. Also label the states with the required outputs.



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