EXAM
(Tentamen)

TDDI11
Embedded Software

2016-08-17 08:00-12:00

On-call (jour):
Mikael Asplund, 013-282668

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 are correct?

1. Real-time systems must be predictable.
2. Real-time systems must be fast.
3. Real-time systems must be exact.

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;
      a = 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 || 0);
}
```

1. 0
2. 1
3. 5

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

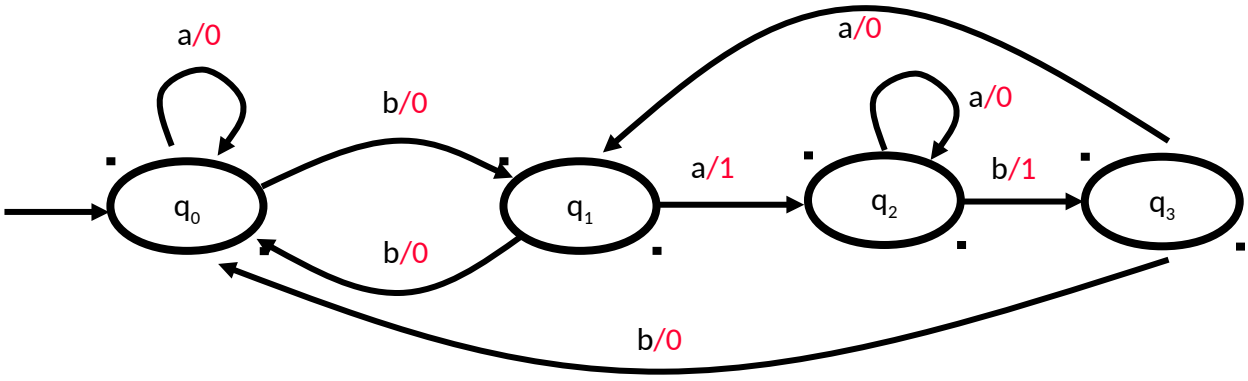
```
#include <stdio.h>
int main() {
      printf("%d \n", (1 | 4)^13);
}
```

1. 8
2. 5
3. 13

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

1. Direct memory access gives the programmer direct access to the memory.
2. Execution time of the interrupt service routine is a concern in real-time systems.
3. An *interrupt vector* is an address to an interrupt service routine.

1g)
Consider the statemachine below:



Which of the following outputs will be produced by the input string aaabbabab?

1. 000110101
2. 000101000
3. 000000011

1h)
Consider a system that is composed of three components. The three components can each be described with state machines that have 3, 7 and 10 reachable states respectively. How many reachable states are there in the full system?

1. Exactly 20.
2. Somewhere between 20 and 210 (including 20 and 2010).
3. Exactly 210.

1i)
Context switching refers to:

1. Storing and restoring the process state (i.e., program counter, registers, etc) when switching between processes in a multitasking system.
2. Changing the context of a process by moving it from one core to another in multi-core system.
3. Moving the data and program memory of a process from one location in memory to another in order to reduce fragmentation.

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 that periodically reads the input from an accelerometer unit. The data from the accelerometer comes in the following format: X acceleration (2 bytes), Y acceleration (2 bytes), Z acceleration (2 bytes). The data is provided in big-endian order whereas the processor uses little-endian. Provide C-like pseudocode for a program that prints out the acceleration of the three dimensions, read from a 6-byte array *buffer*.

Question 3. (5 points)
Most embedded systems must interact with the environment. However, embedded systems understand digital signals whereas the environment deals with analog signals. How is this problem addressed for input and output signals? Give at least two examples of two different methods for converting between these two representations.

Question 4. (5 points)
Consider the following task set for small robot system:

Task	**Period**	**Worst-case execution time (WCET)**
Control task	50ms	30ms
Planning task	100ms	20ms
Communication task	500ms	60ms

4a) What is the utilisation of the task set? (1p)

4b) What would the priorities of the tasks be if the RMS policy is used? (1p)

4c) Can the tasks be scheduled with RMS without any deadline misses? (3p)

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)
Give one example of an embedded system and describe what you consider to be the five most important design metrics for this system. Remember to motivate your answers.

Question 7. (5 points)

A Mealy Finite State Machine produces an output of 1 if in the input sequence it detects either 110 or 101 patterns. Overlapping sequences should be detected.

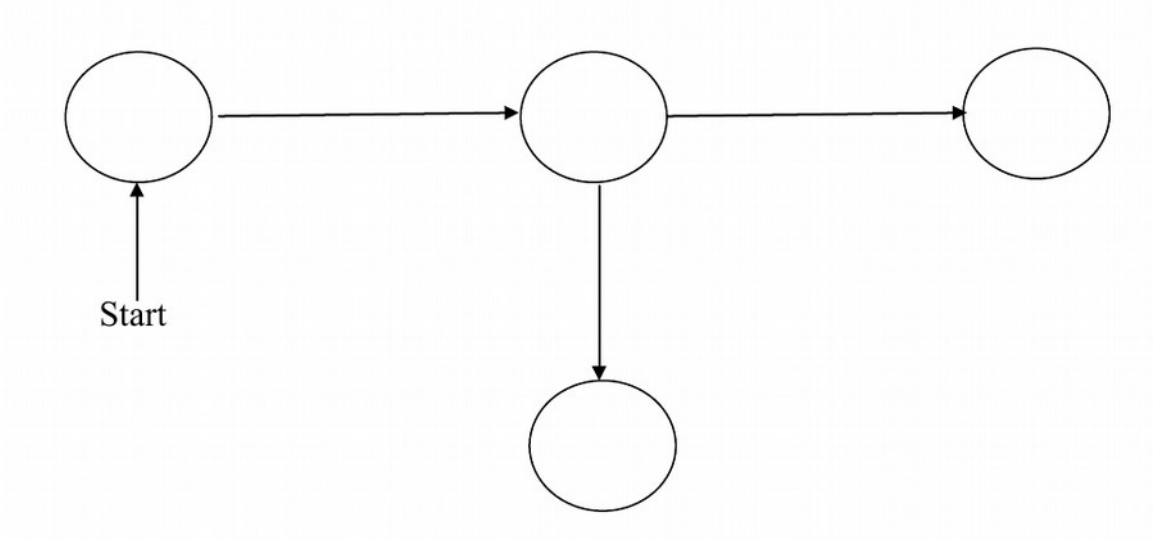
An example sequence is given below.

Input	0	1	1	0	0	1	0	1	1	0	0
Output	0	0	0	1	0	0	0	1	0	1	0

A partial Mealy Finite State Machine is shown in the figure below. It shows all the states but only some of the transitions. You should complete the FSM.

7a) Draw all the transitions and label them with the proper inputs. (3p)

7b) Write the output in each transition. (2p)



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