EXAM

(Tentamen)

TDDI11

Embedded Software

2017-05-30 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 question.

1a) Which of the following statements is / are correct? Compared to interrupt based programming,

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

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

1. Embedded systems are used in safety-critical systems.
2. A safety-critical system cannot be an embedded system.
3. A safety-critical 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;
      a = 7;
      printf("%lu %lu \n", b, *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", (5 || 0) && 2);
}
```

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", (9 | 4) & 10);
}
```

1. 8
2. 1
3. 9

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

1. The foreground/background model can be implemented without extensive support from an operating system.
2. The foreground/background model is suitable for improving response time in complex and large systems.
3. The foreground/background model has problems with scalability and maintainability.

1g) Which of the following statements is/are correct. A Moore state machine can be used to model an embedded system, and

1. is a finite state machine without loops (transitions going back to the same state).
2. is a finite state machine that associates outputs to states.
3. is a finite state machine that assiciates outputs to transitions.

1h) Which of the following statements is/are correct. A critical section is a section of code

1. That should be executed by at most a thread at a time.
2. That is very difficult to get right and is therefore never used in concurrent embedded software.
3. That is not needed in shared memory based concurrent applicatoins.

1i) Which of the following statements is/are correct. An over-the-wall design process

1. Improves communication and the interaction between the different teams
2. Cuts on product costs and time to market by isolating the different teams.
3. Does not promote cross-functional teams like concurrent engineering does.

1j) Which of the following statements is / are correct. An OR-group is used in a state machine

1. To simplify representing the fact that all states in the group have similar outgoing or incoming transitions.
2. To describe a non-deterministic choices between two outgoing transitions.
3. To describe a non-deterministic choices between two incoming transitions.

Question 2. (5 points)

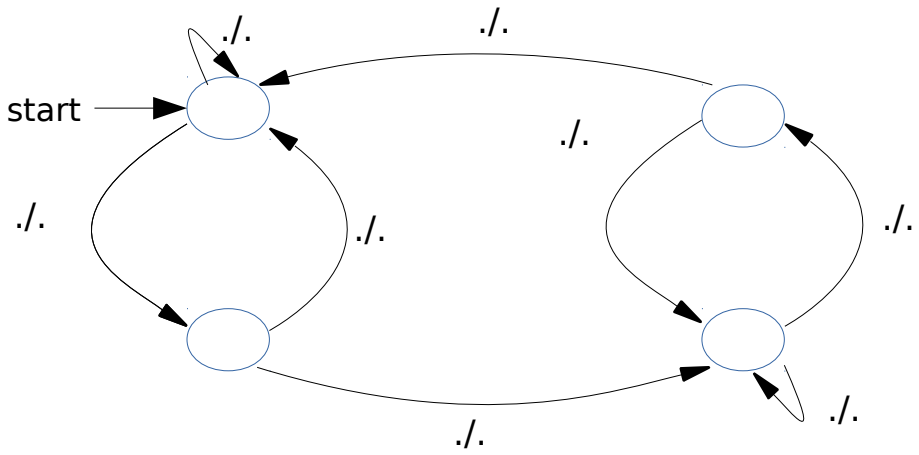
Consider a system that periodically reads 128 bytes representing 32 consecutive unsigned 4-bytes integers. The 128 bytes are read from a buffer "char in_buffer[128]". The 32 4-bytes integers are stored one after the other. Each 4-bytes integer is stored in big-endian order. The processor uses little-endian order. Provide a C-like pseudocode for a program that fills a 128 bytes buffer "char out_buffer[128]" with the same content as the one in in_buffer (i.e., 32 integers of 4 bytes each) but where each integer is now stored in little-endian order.

Question 3. (5 points)
There are three main approaches to I/O processing. Explain briefly each of them and compare them in terms of what kind of platform support is needed for each one of them.

Question 4. (5 points)
Consider a task set with three periodic tasks: Task 1 with period T1= 12 and execution time C1= 2, Task 2 with period T2= 4 and execution time C2= 1 and Task 3 with period T3= 6 and execution time C3= 3. The three tasks are to be run on the same processor using some scheduling algorithm.

1. Give the processor utilization ratio in case the three 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)
Branch predictors can be modelled as Mealy machines that have a number of states (to remember some part of the previous inputs), take as input whether the current branch has been taken or not (1 or 0) and output their prediction for the next branch. The branch predictor we consider behaves as follows. At each state, the predictor bases its prediction for the next branch (i.e., current output) on whether the current branch and the one before it have been taken or not (i.e., value of the current input and the one before it). For example, a transition labeled 0/1 means the predictor witnessed the current branch was not taken (input 0) and predicts the next branch will be taken (output 1). Of course predictions may turn out to not hold. We give the skeleton of the Mealy machine below. You should complete it (i.e., fill in all input/ouptut labels for all transitions) in order to satisfy the following. Initially, the predictor acts as if the last two branches were not taken (i.e. as if the last two consecutive inputs were 0). The predictor changes its output from 0 to 1 (respectively from 1 to 0) if both the current input and the input exactly before it are 1 (respectively both the current input and the one exactly before it are 0). It otherwise maintains its previous prediction.



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

Question 7. (2 points)
The following macros is meant to compute the square of a number. Would you recommend using this definition? what may become wrong with it? be concret.

```
#define POW(x) x*x
```

Question 8. (3 points)
Write a C-like pseudocode method “swap” that takes as input a 16 bits unsigned int and returns the result of swaping each even bit with the odd bit following it. For example, the argument 1001100110011001 would result in swap returning 0110011001100110.

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