Försättsblad till skriftlig tentamen vid Linköpings Universitet

Cover page for written exam at Linköping University

Datum för tentamen Date of exam	**2010-08-16**
Sal Room	**U1**
Tid Time	**08:00-12:00**
Kurskod Course code	**TDDI11**
Provkod LADOK code	**TEN1**
Kursnamn/benämning Course name	**Programmering av inbyggda system** Embedded software
Institution Department	**IDA**
Antal uppgifter som ingår i tentamen Number of assignments	**9** 9 assignments for a total of 40 points
Antal sidor på tentamen (inkl. försättsbladet) Number of pages including cover	**3**
Jour/Kursansvarig Responsible/Examiner	**Klas Arvidsson** klaar@ida.liu.se
Telefon under skrivtid Phone during exam	**013 - 28 21 46**
Besöker salen ca kl. Time of exam visit	**Ungefär en timme efter tentans start** About one hour after exam start
Kuradministratör Course administrator	**Gunilla Mellheden** 013 - 28 22 97, 070 - 597 90 44, gunilla.mellheden@liu.se
Tillåtna hjälpmedel Allowed aids	**Ordlista och enkel miniräknare (+,-,*,/)** Dictionary and simple pocket calculator (+,-,*,/)
Övrigt Other information	*Preliminary graded: U < 50% < 3 < 67% < 4 < 84% < 5* *Grades may be raised or lowered based on overall impression.* ***Precise, explained and clearly motivated assumptions, statements and reasoning raise the impression and are required for highest score. Solve at most one assignment per sheet.*** *Results available within 10 working days.* *Read all assignments and estimate how many points you can get before you start.*
Typ av papper Paper to use	**Rutigt, linjerat eller blankt** No preference
Antal anmälda Number of exams	

1. (9p)

a) *Define an embedded system.*
What makes a system embedded? Explain each term you use. (4p)

b) When you design an embedded system certain technology can provide (technical or economical) benefits or drawbacks. List four of the metrics (technical or economical) commonly used to compare design- and IC-technology? No motivation required. (2p)

c) Give three strong reasons why you in some particular situation would burn a general purpose processor design to a PLD rather than creating a special purpose processor in a full-custom IC. (3p)

2. (1p)

State the difference between *port-based* and *memory-mapped* I/O. What is the difference from assembly point of view?

3. (5p)

N is an integer variable in the range 0-7. D is an one byte variable. Provide C-code (or comparable pseudo-code) to do each of the following bit-manipulation tasks.

a) Show how to retrieve the value of the N:th bit in D. Store the result in R. All bits of D must remain unchanged. (1p)

b) Set the N:th bit of D to logical one '1'. All other bits of D must remain unchanged. (1p)

c) Reset the N:th bit of D to logical zero '0'. All other bits of D must remain unchanged. (1p)

d) Set bits 3-5 of D to the value N. All other bits of D must remain unchanged. (2p)

4. (3p)

The 4-bit numbers -5 (decimal) and 0x7 (hexadecimal) shall be added.

a) Perform the addition in binary using three 4-bit registers (one for each operand and one for the result). (2p)

b) Explain why the operation is said to yield a *rollover.* (1p)

5. (2p)

You have the source code of an embedded application that is too slow.

a) What is the first optimization technique you should try? (1p)

b) What is the last optimization technique you should try? (1p)

6. (3p)

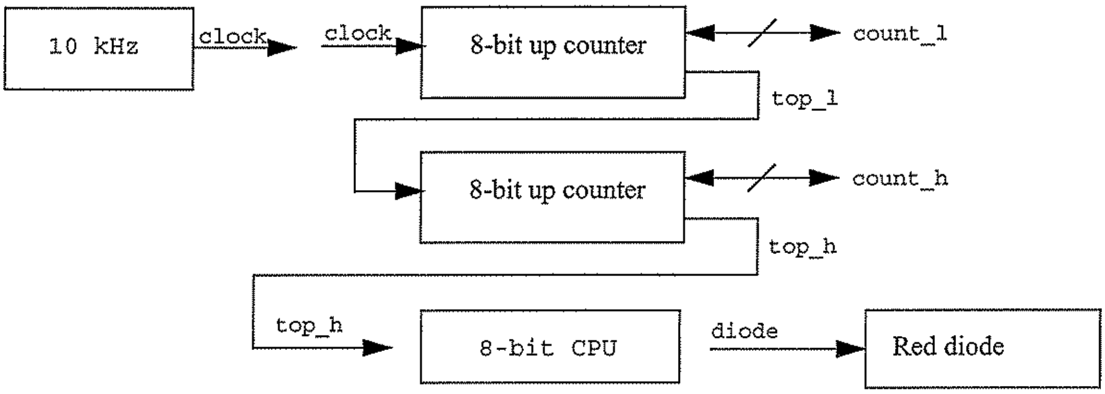
Describe the workings and organization of a foreground-background system. An explained picture is appreciated.

7. (2p)

Explain the problem(s) with the following macro implementation. The missing semicolon is supposed to be added when the macro is used (thus not a problem).

```
#define MAX(a, b) \
  if (a > b)      \
    return a;     \
  else            \
    return b
```

8. (10p)



The figure above outlines a 10kHz clock driving an 8-bit "low" counter. The "low" counter in turn increment a "high" counter every time it roll over. The "high" counter produces interrupt number 5 on the 8-bit CPU when it roll over. The interrupt service vector consists of 16-bit addresses to interrupt service routines and start at address 0x1000. Both counter registers (`count_l` and `count_h`) are memory mapped (to address 0x5000 and 0x5001). A red diode is mapped to address 0x6000 and turned off by writing a zero byte to that address. Any other value turns it on.

a) Draw a memory map of the system. Add a RAM and a ROM to your memory map and explain the purpose of your memory map. (2p)

b) Use polling and provide C-code (or comparable pseudo-code) to make the diode blink at a frequency of 2Hz (1 second on, 1 second off). Remember any initialization required. (3p)

c) Use interrupts and provide C-code (or comparable pseudo-code) to make the diode blink at a frequency of 2Hz (1 second on, 1 second off). Remember any initialization required. (3p)

d) Explain one problem or advantage of each solution. (2p)

9. (5p)

A room have a hidden safe. The safe is revealed after the door is closed and then, in any order, the door is locked and the light is turned on. The safe is hidden again whenever one of the revealing conditions is broken. Procure a finite state machine determining when to reveal or hide the safe. Any events common for all states may be omitted and described by a comment instead. The system will have three input signals (door open/closed, door locked/unlocked, light on/off) and one output signal (safe revealed/hidden). You will need 5 states.