Mittuniversitetet
MID SWEDEN UNIVERSITY

Försättsblad Prov Original

Kurskod	Provkod	Tentamensdatum
ET095G	T103	2018-10-30

Kursnamn	Elektroteknik GR (B), Introduktion till programmering av...
Provnamn	Skriftlig tentamen
Ort	Sundsvall
Termin	H18
Ämne	Elektroteknik

Exam: Introduction to Embedded System Programming (HT2018)

Course code:	ET095G
Date:	2018-10-30
Duration:	3 hours
Examiner:	Sebastian Bader
Contact:	+46 10 1428095 or +46 72 7433680
Aids (Hjälpmedel):	none
Marking:	Each question is graded on a scale from 0–5. In order to pass the exam, a minimum of 1 point per question is required. If passed, the exam will be marked with the average of the points achieved in each question.

Instructions

- Begin the answer to every question on a separate sheet of paper.
- Do not write in red color.
- For calculations, the way towards the result has to be clearly understandable.
- Direct citations from lecture slides will not be accepted as an own contribution.

Questions

Question 1: (0–5 points)

(a) List at least three properties that differ between embedded systems and general-purpose computers.

(b) An airbag in a car has the function to inflate the airbag when needed, and could easily be implemented based on an embedded system. Describe the input and output to/from the system and exemplify peripherals that could be used to generate this input and output.

(c) Provide an own example of an embedded system. Describe its function, input(s), output(s) and potential input/output peripherals.

(d) Design factors that might be taken into account for embedded systems include: size, physical format, cost, processing speed and reliability. Considering the airbag scenario previously mentioned, assign each factor a level of importance (low, medium, high).

(e) Motivate your assignment of the importance of each design factor in (d).

Question 2: (0-5 points)

(a) List the essential components of a computer system.

(b) Describe the difference between a microprocessor and a microcontroller.

(c) Describe the program execution within a computer by explaining the concept of the fetch-execute-cycle.

(d) Explain what is meant by "memory-mapped IO".

(e) Motivate why microcontrollers might be preferred for embedded systems over microprocessors.

Question 3: (0-5 points)

Consider the two code snippets in Figure 1.

```
int k = 256;
int x = 0xe3 & 2;
int i = 0;

int main() {
    while ( k > 1 ) {
        i++;
        k >>= x;
    }

    printf("%d", i);
}
```

(a)

```
uint8_t a = 15;
float b = 3.1415;
uint8_t c = a % 2;
uint8_t *p = &c;

int main() {
    printf( "%d", a );
    printf( "%d", b );
    printf( "%f", b );
    printf( "%d", *p );
}
```

(b)

Figure 1: Code snippets for Question 3.

(a) In code (a), what is the output of the printf-statement? Motivate.

(b) In code (b), provide the output of each printf-statement. Shortly motivate each answer.

(c) Describe the task of a compiler in the build system for an embedded system.

(d) Motivate why it should be more difficult to implement a compiler than to implement an assembler.

Question 4: (0-5 points)

Consider the circuit to connect a pushbutton in an embedded system, shown in Figure 2. In this circuit, *Pin X* shall be connected to a GPIO pin of a microcontroller and V_B is a voltage considerably larger than $0\,V$.

(a) In order to monitor the state of the pin, what operating mode should the GPIO pin be configured to?

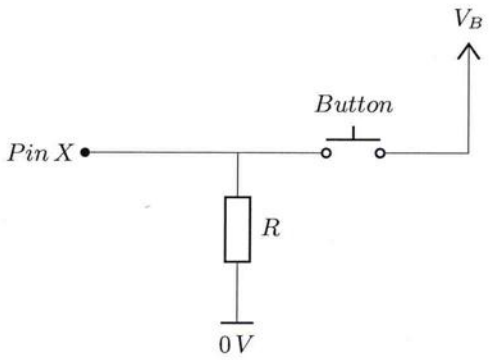

Figure 2: Circuit for Question 4.

(b) Based on the circuit above, explain how the information about the GPIO pin's state can be used to deduct if the button is pressed or not.

(c) Motivate why the resistor R is included in the circuit. What is its function and what would happen if it was not there?

(d) Assuming that your microcontroller operates with a supply voltage of $3\,V$, what is the minimally acceptable V_B, if the microcontrollers datasheet defines $V_{IH} \geq 0.7 \cdot V_{dd}$? Motivate.

Question 5: (0-5 points)

(a) An SPI interface contains (besides GND) a number of connections between the master and the slave devices. Typical names for these connections are *MISO, MOSI, CLK, CS/SS*. Describe what each line is used for.

(b) SPI is a synchronous communication protocol. Explain what the word synchronous refers to in this context.

(c) Explain what advantage a synchronous communication protocol has over an asynchronous one.

(d) Motivate why SPI would not be so well suited if your goal is to connect many devices to the same interface at the same time.

(e) What protocol would be more suited in the case of (d)? Motivate.