

## i Instructions for the exam



## DIT632, Development of Embedded and Real-time systems

This exam should be an individual work for you. You are not allowed to use any outside help.

If you are allowed to use a compiler, there is a link to an online one, which will open in a separate window. You can test the code in the online compiler, but **you must remember to copy-paste it back to the exam**, otherwise your code will disappear once you close the window.

The same is true for TinkerCad, please remember to copy-paste the code from TinkerCad to the exam.

If you access the code from your saved documents in TinkerCad, and use it in the exam, you **MUST** reference that code and describe clearly what you copied to the exam.

You are not allowed to copy code from your colleagues or any other external source.

**Remember: In programming questions, if the code does not compile, you get 0 points for the question!**

In order to pass the exam (grade G), you must get 50% of the total points.

To get VG, you must have at least 85% of the total points in the exam.

Good luck!

/Miroslaw  
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## 1 Concurrency and parallelism

Please explain the concepts of **concurrency** and **parallelism**.

Your answer should contain:

- 1) Explanation of these two concepts (2 points)
- 2) Comparison/description how they differ (2 points)
- 3) An example of both of these concepts (2 points)

**Your answer:**

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Ord: 0													

Totalpoäng: 6

## 2 Reading pointers

Please choose the right interpretation of "X" in each of the statements:

**int \*x;**

- ☐ x is a pointer to function that returns a variable of type int
- ☐ x is a pointer to a variable of type int
- ☐ x is a reference to the variable of type int
- ☐ x is a variable of type int

**int ( \* x [] ) ();**

- ☐ x is an array of pointers to functions that return int
- ☐ x is a function which takes as an argument an array of pointers to variables of type int
- ☐ x is a pointer to a function that takes as an argument an array of integers
- ☐ x is a function that takes an array as an argument and returns a pointer to int

**char \* ( \* ( \*\* x [ ] [8] ) ( ) ) [ ];**

- ☐ x is array of array of 8 pointers to pointer to function returning pointer to array of pointer to char
- ☐ x is a function that takes as input an array of 8 pointers to pointer to an array and returns a pointer to array of pointer to char
- ☐ x is array of array of 8 pointers to functions returning pointer to array of pointer to char
- ☐ x is an array of 8 pointers to pointer to function returning pointer to array of pointer to char

**int ( \* ( \* x ) [ ] ) ();**

- ☐ x is a pointer to an array of pointers to functions returning an int
- ☐ x is a function that takes as an argument a pointer to an array of pointers and returns a pointer to int
- ☐ x is a function that takes as argument an array of pointers to functions and return a pointer to int
- ☐ x is an array of pointers to functions that take no arguments and return pointers to int

**char ( \* x ( ) ) [20];**

- ☐ x is an array of pointers to functions returning pointers to functions returning pointers to char
- ☐ x is an array of 20 pointers to functions returning char
- ☐ x is a function returning a pointer to an array of 20 elements of type char
- ☐ x is a pointer to a function returning a pointer to an array of 20 elements of type char

Totalpoäng: 5

### 3 A problem with a swapping function

This function should swap two numbers, but it does not, because of a programming mistake.

Please correct the mistake and write a program, which will test that it works correctly. Please remember to comment your code!

```
void swap2( int x, int y){  
    int temp;  
    temp=x;  
    x=y;  
    y=temp;  
}
```

You can use the online C compiler for this task: [Online C compiler](#)

Your program should include:

- fix of the mistake (2 points)
- main() procedure to test this function (2 points)
- comments (2 points)

**Please write your program here**

1	
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Totalpoäng: 6

#### 4 The permuter program

Write a program in C to print all permutations of a given string using pointers. The string should be provided as an argument to your program. The limit of the number of characters in the input should be max 8.

Please remember to comment your code!

You can use the online C compiler to test your code: [Online C Compiler](#)

For the input **permuter.exe abcd**

The expected output should be:

The permutations of the string are : abcd abdc acbd acdb adcb adbc bacd badc bcad bcda  
bdca bdac cbad cbda cabd cadb cdab cdba dbca dbac dcba dcab dacb dabc

Your solution should include:

- code implementing the function (5 points)
- code to parse the program arguments (2 points)
- comments (2 points)

**Write your solution here**

1	
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Totalpoäng: 9

## 5 Find two mistakes

The following program has two mistakes in it:

```
#include<stdio.h>

void main()
{
    //declaring and defining the array variables
    int a[5] = {100,101,102,103,104};

    int b[3] = {105,106,107,108,109};

    //displaying the output
    printf("%d\n",a[100]);

    //and another element
    printf("%c\n",b[700]);
}
```

Please find these two mistakes and correct them. Your correction should include:

- source code of the corrected program (2 points)
- comments describing
  - where in the code the mistakes are (2 points),
  - what these mistakes are (2 points) and
  - explaining how your fix works (2 points)

You are allowed to use the online C Compiler: [Online C Compiler](#)

**Write your solution here**

1	
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Totalpöäng: 8

## 6 Bitpacking

The elevator controller uses one byte (8 bits) to store the status of the elevator.

The values/meaning of the bits of the byte are:

Name	Bits	Info
engine_on 7 (MSB)	1	Is engine on or off (the elevator moves or not). This is bit no
floor_pos	3	Which floor number the elevator should go to (0-7)
door_pos	2	If the door is open or closed
brake1	1	Normal brakes
brake2	1	Emergency brakes

We should store them in a byte like this:

[engine_on]	[floor_pos]	[door_pos]	[brake1]	[brake2]
1 bit	3 bits	2 bits	1 bit	1 bit

(8 bits in total)

Write a program **code.c** which takes 5 arguments (different number of arguments should result in an error message). The arguments should correspond to the values/variables above.

Example for a start of the program from command line:

**code 1 7 1 1 0**

The above should be treated as:

Name	Value
engine_on	1
floor_pos	7
door_pos	1
brake1	1
brake2	0

and the output should be 0xFE

Your task:

- Write the function to pack these values together in a byte (unsigned char), and (4 points)
- Write the main function to take the arguments from the console, pack them into a byte and print it out to the console in hexadecimal form. (3 points)
- Make the program fail-safe, i.e. if it finds anything wrong (too many/few arguments, faulty input values) your program should print out an error message and exit (2 point)
- The code should be commented (2 points)

You can use the online C compiler to test your answers: [Online C compiler](#)

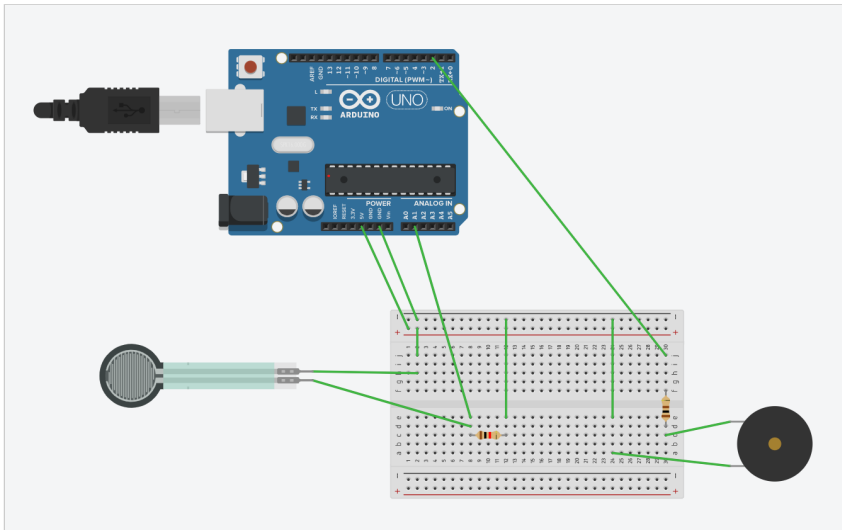
**Please write your code here**

1	
---	--

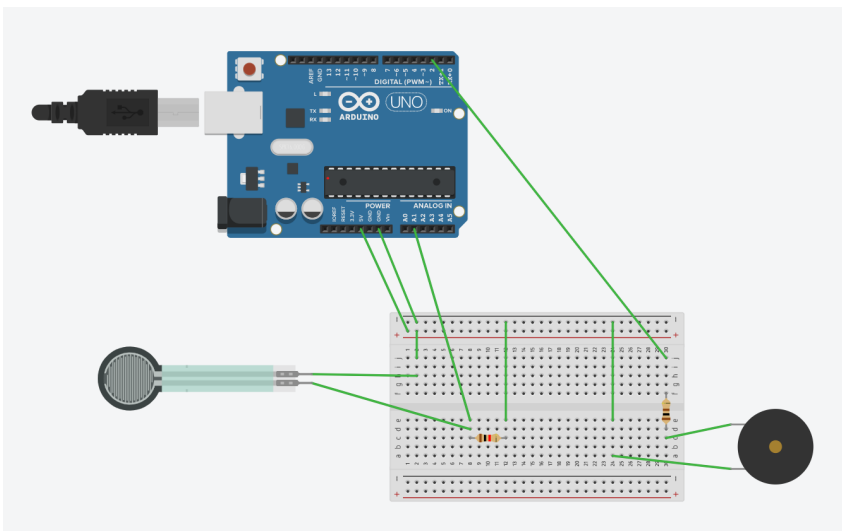
Totalpöäng: 11



## 7 Arduino board programming



Create a system with the force sensor and a buzzer as shown in the picture below.



The system should use the buzzer to make noise when a force is applied to the force sensor. The tone of buzzing should be based on the force applied to the sensor, in the following intervals:

Force
0
0.5 N
1 N
2 N
5 N
> 6 N

You can use interrupts or a loop for this exercise.

You can use the tone function with the following signature: `tone(pin, frequency, duration)`

You should use TinkerCad: <https://www.tinkercad.com>

You should deliver the following:

- Code, pasted in the box below. The code should include:
  - Code to solve the problem (3 points)
  - Where you use #define or constants to predefine the buzzer tone and the force (2 points)
  - Where you have a function that reads the force and sets the buzzer tone (3 points)
  - Comments (2 points)

Please write your code here

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Totalpoäng: 10