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
031 772 1081

1 Paging and addressing

Please explain the concepts of **paging** and **addressing** of memory**.**

Your answer should contain:
1) Explanation of these two concepts (2 points)
3) An example of how a physical address is calculated from a virtual address (2 points)

Your answer:

Teckenf…

Ord: 0

Totalpoäng: 4

2 Reading pointers

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

int *x();

- x is a pointer to a function that returns an int
- x is a function that returns a pointer to an int
- x is a variable of type int
- x is a pointer to a pointer to a function that returns a variable of type int

int (* x []) ();

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

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

- 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 a function 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
- x is array of array of 8 pointers to a pointer to functions returning pointer to array of pointer to char

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

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

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

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

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){
   x = x + y;
   y = x - y;
   x = x - y;
}
```

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
```

Totalpoäng: 6

4 The fraction calculation program

Write a program that does calculations on fractions.

Just as a reminder, to add fractions:

$$\frac{a}{b} + \frac{c}{d} = \frac{ad+bc}{cd}$$

and to multiply them:

$$\frac{a}{b} * \frac{c}{d} = \frac{ac}{bd}$$

Your solution should include the following functions, which take fractions as input, returns the approximated value (as double) and print the nominator and denominator. It shuold

- double addFraction(int a, int b, int c, int d)
- double subFraction(int a, int b, int c, int d)
- double multFraction(int a, int b, int c, int d)

An example input for addFraction(1, 2, 1, 4) should be:

aproximated double: 0.75
exact value: 1/2 + 1/4 = 3 / 4

Grading:

- code for each function: 2 points * 3 = 6 points
- comments: 2 points
- main function which tests each of these functions: 3 points

You can use the onlinedebugger to solve this assignment, remember to copy the code below.

Write your solution here

```
1
```

Totalpoäng: 11

5 Find two mistakes

The following program has two mistakes in it:

```
#include<stdio.h>

void main()
{
   //declaring and defining the variables
   int a=100;
   int b=200;

   //displaying the output
   printf("Sum of %d and %d is=%s\n", a ,b, sum(a,b));
}


int sum(int a, int *b)
{
   return a *b;
}
```

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
```

Totalpoäng: 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	1	Is engine on or off (the elevator moves or not). This is bit no 7 (MSB)
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 0xF6

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

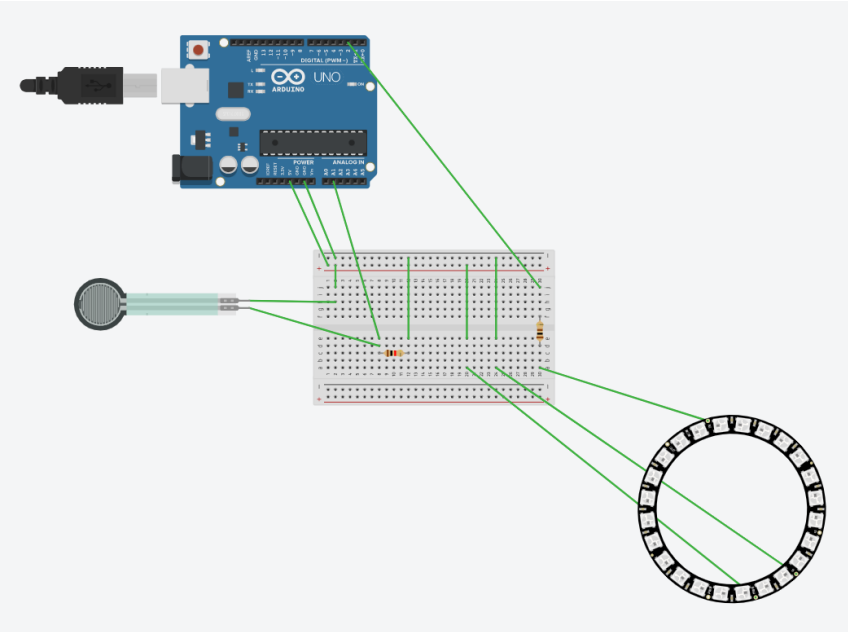
Please write your code here

```
1
```

Totalpoäng: 11

7 Arduino board programming

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



The system should use the neopixel ring to show how much force is applied to the force sensor. The number of pixels in the ring should increase linearly with the force applied.

You can use interrupts or a loop for this exercise.

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 how the number of pixels correspond to the force; or you can use a mapping function for that (2 points)
  - Where you have a separate function that reads the force and turns on/off the pixels (3 points)
  - Comments (2 points)

Please write your code here

```
1
```

Totalpoäng: 10