

## Exam Computational Foundations II (LRG0061, Summer Term 2022)

### Rules:

- Keep these sheets closed until the official start of the examination is announced.
- Already now, write your name and matrikel number onto this front page. Have your passport and student ID available on your desk.
- No further items except this examination document, paper given out by us, a few pens, and passport / student ID are allowed on your desk.
- If you have a question, raise your hand. If the answer is relevant to everyone, we will share it with everyone.
- If you are done, please stay in your location quietly and double-check everything. If you need to go to the restrooms, raise your hands. Only one person is allowed to leave the room at the same time.

Last Name: \_\_\_\_\_

Given Name: \_\_\_\_\_

Matrikel No.: \_\_\_\_\_

### Evaluation

Task 1: Multiple Choice	/ 5
Task 2: Quadrature Phase Shift Keying	/ 5
Task 3: Number Representation	/ 10
Task 4: Analog Digital Conversion	/ 10
Task 5: Circuit Analysis	/ 10
Task 6: 4-to-1 Multiplexer	/ 10
Task 7: State Machines	/ 3
Task 8: Dijkstra	/ 10
<b>Sum</b>	<b>/ 63</b>

**Task 1:** Multiple Choice

(5 points.)

Answer the following questions with yes or no.

*A wrong answer is counted as -1, a correct answer is counted as +1, an answer not given is counted as 0 (if you don't know the answer it is smarter not to give an answer!). If you reach more than 5 points, the points will become bonus points, if you reach less than 0 points, the result is 0 points.*

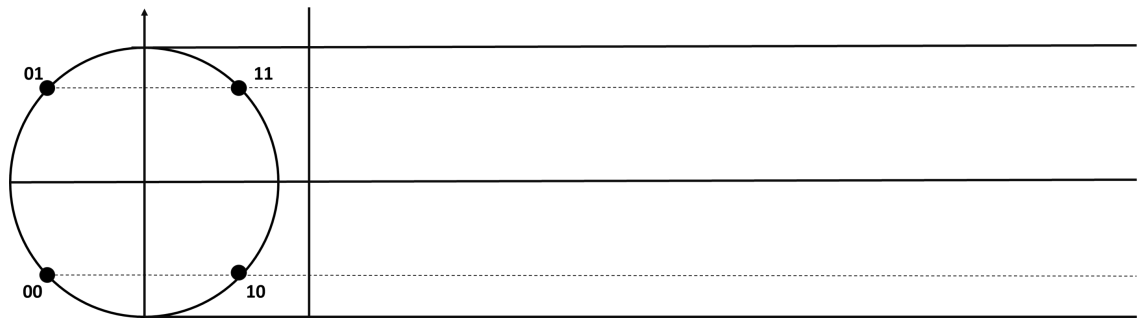
Are the following statements true or false?		True	False
a	IEEE standard for floating point numbers (754) supports certain special values like infinity.		
b	A 4-bit signed integer ranges from including -7 to including 8.		
c	When adding two 8-bit numbers, the result can be held in 9 bit.		
d	For computing the shortest path between all nodes of a graph, one typically runs Dijkstra with each node as the starting point		
e	Binary Search is performing a search on ordered datasets by looking at the (approximately) middle data and continuing in each iteration with only (roughly) half of the array size.		
f	The SPI bus is a communication system for connecting devices using 4 lanes ( $SCLK$ , $\overline{CS}$ , $MISO$ , $MOSI$ )		
g	In merge sort, the data is first cut into pieces for being sorted and the sorted pieces are assembled to a sorted version of the data.		

**Task 2:** Quadrature Phase Shift Keying

(5 points.)

The idea of the QPSK phase shift keying is that various phases represent different symbols, such that two bit are transmitted at the same time.

- a. Given a bitstring of 11011110, draw the modulation waveform in the following diagram and mark all keypoints (e.g., points where the waveform intersects the organizational lines) for better readability. Each symbol of two bit shall be transmitted with one roundtrip of the wave.



(10 points.)

a. Represent 42 as an 8-bit unsigned integer (give all bits!)

- b. Represent -42 as an 8-bit signed integer (give all bits!)
  
  
  
  
  
  
  
  
  
  
- c. Represent 1.2 in IEEE Floating Point using 1 bit for the sign, 8 bit for the exponent, and 23 bits for the mantissa.

**Task 4:**      Analog Digital Conversion

(10 points.)

Analog Digital Conversion converts analogous signals into a digital representation.  
Explain the following two aspects each in one sentence:

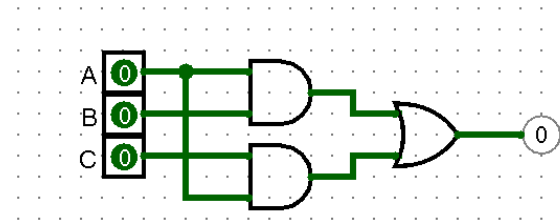
a.    Quantization:

b.    Sampling:

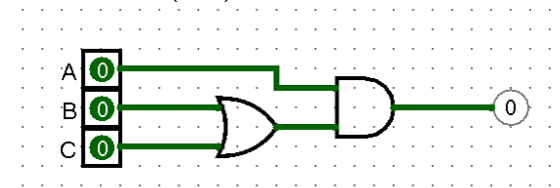
### Task 5: Circuit Analysis

(10 points.)

Consider the following two circuits.



### Circuit 1 (C1)



### Circuit 2 (C2)

- a. Show that they implement the same Boolean function using truth tables.
- b. Show that they implement the same Boolean function using algebraic identities

- b. Show that they implement the same Boolean function using algebraic identities



**Task 7:** State Machines

(3 points.)

A state machine is a programming model in which two combinatorial circuits are combined with a state memory in order to achieve very complex behaviour.

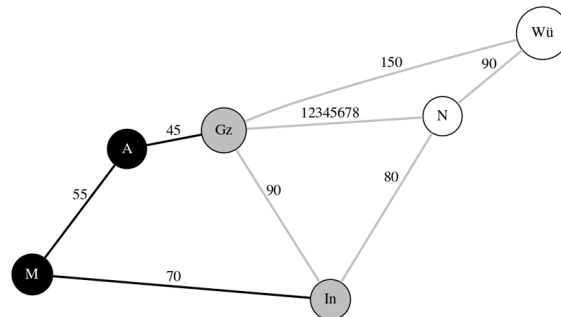
- a. Give names or very short descriptions for the two combinatorial circuits



**Task 8: Dijkstra**

(10 points.)

Consider the diagram below.



Given our formulation of Dijkstra, answer the following questions:

- Give the Queue contents. Remember, that elements in the queue are pairs of a vertex and a weight and that the queue is sorted.
- Give the complete distance map and the complete predecessor map at the moment in the diagram. Remember, that the distance map is initialized to  $\infty$  and that the predecessor map is initialized such that for every vertex we store the vertex itself.

**Distance Map (d)**

Node	Value
M	0
A	
In	
Gz	
N	
Wü	

**Predecessor Map (p)**

Node	Value
M	M
A	
In	
Gz	
N	
Wü	

- The  $A^*$  algorithm is considered to be faster than Dijkstra in many scenarios. What is the additional information it exploits?