

Advanced Architecture

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Part A

Student's Name

Matricola number

Exercise 1 (8 points)	
Exercise 2 (4 points)	
Exercise 3 (5 points)	
Exercise 4 (6 points)	
Exercise 6 (6 points)	
Question (3 points)	
Total (32 points)	

Exercise 1 (8 points) - Number representation

Represent the integer number $X=21$ and its opposite $-X$ using:

- a) The **Redundant Binary (RB)** number representation, showing how to obtain both X and $-X$.
- b) The **redundant representation** obtained with using radix $r=8$ and the digit set $[-5, 5]$ using 3 digits and giving different representations for both X and $-X$. Then, specify how many values can be represented.
- c) The **residue number system** with a range $[-5X; 5X]$ and a moduli set consisting of 3 moduli. Give also the **mixed radix representation** associated to X .

Exercise 2 (4 points) - Number representation

Consider the binary signed digit numbers (radix-2) $A = 1\bar{1}1\bar{1}01$ and $B = \bar{1}00\bar{1}11$. Convert them in radix-10 and show the procedure to obtain the sum $A + B$ using the truth table below

$x_i y_i$	00	01	01	$0\bar{1}$	$0\bar{1}$	11	$\bar{1}\bar{1}$
$x_{i-1} y_{i-1}$	–	neither is $\bar{1}$	at least one is $\bar{1}$	neither is $\bar{1}$	at least one is $\bar{1}$	–	–
c_i	0	1	0	0	$\bar{1}$	1	$\bar{1}$
u_i	0	$\bar{1}$	1	$\bar{1}$	1	0	0

Exercise 3 (5 points) Gustafson-Barsis' law and Amdahl's law

- a) Briefly explain the Gustafson-Barsis' law and Amdahl's law.
- b) The analysis of a program has shown a speedup of 4.8 when running on 8 cores. What is the serial fraction according to Gustafson-Barsis's law? And according to Amdahl's law?
- c) Considering the serial fraction obtained in point b), compute the speedup when using 12 cores according to Gustafson-Barsis's law and to Amdahl's law.

Exercises 4 (6 points) Performance equation

The following measurements are recorded with respect to the different instruction classes for the instruction set running a given set of benchmark programs:

Instruction Type	Instruction Count (millions)	Cycles per Instruction
Arithmetic and logic	12	6
Load and store	10	3
Branch	6	7
Others	7	5

Assume that you have the following information on CPI:

CPI of Arithmetic and logic = 5.6

CPI of Load and store = 3.5

CPI of Branch = 4.9

Average CPI of other instructions = 5.2

Frequency of Logic Instruction (subset of Arithmetic and logic) 15%

Assume that the design alternatives are to decrease the average CPI of Load and store operations to 2.8 or to decrease the average CPI of Branch operations to 3.2. Compare the design alternatives using the **processor performance equation** and show which alternative is more cost-effective computing the respective speedup.

