

Title	Date	Time	Duration	Grade Release Date
Midterm Exam	Oct. 21	4:00 PM	60 + 15 minutes	Oct. 28

You must justify your answer for every question!
You may do the questions in any order you wish but use your time wisely.

Q1: [10 marks: 5 marks each, easy, warmup] Explain the following terms in two or three sentences.

- Quantization
- Digital System

Q2: [80 marks: main workout] We want to design a **2-bit subtractor** in **2's-complement** system. Let $X=X_1X_0$, and $Y=Y_1Y_0$. We need to perform $R=X-Y$, where $R=R_1R_0$. Also, there might be an overflow. So, we need another output called Ovf. In total, there should be 4 Boolean variable in the left (input) side of the truth table, and 3 Boolean functions Ovf, R2, and R1 in the right (output) side.

- Complete below truth table **[40 marks: 16 rows \times 2.5 marks each]** (*hint: when Y becomes -2, i.e., $Y=10$, weird things happen ...*)
- Write Ovf, R1 and R2 functions based on an efficient number of gates (SOP vs. POS) **[30 marks: 10 marks for each function]**
- Draw the circuit only for **Ovf** based on a single universal gate (either NOR- or NAND-only gates) **[10 marks]**

Interpretation (Y)	Y1	Y0	Interpretation (X)	X1	X0	Ovf	R1	R2	Interpretation (R)	Steps
+0	0	0	+0	0	0	0	0	0	$+0 - (+0) = +0$	$00-00 = 00+2's(00)=00+00=00$ Two pos yield pos \rightarrow No Ovf
+0	0	0	+1	0	1	0	0	1	$+1 - (+0) = +1$	$01-00 = 01+2's(00)=01+00=01$ Two pos yield pos \rightarrow No Ovf
+0	0	0	-2	1	0	0	1	0	$-2 - (+0) = -2$	$10-00 = 10+2's(00)=10+00=10$ One neg, one pos \rightarrow Never Ovf
...										

Question 5: [10 marks, easy, cool down] There is something that you spend time studying but was not asked on this exam. What is it? Explain in detail.

Oct-21-24

Comp 2650 : Midterm

- ① (a) Quantization is the process of mapping continuous infinite values to a smaller set of discrete infinite values.
- (b) Digital system refers to elements such as hardware, software and networks and their use. Hardware may include the motherboard, mouse, etc while the software may include Microsoft Excel, Teams, Adobe Acrobat.
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⑤ Something I spent time studying but was not asked was the 1CF and 2CF arithmetic, I understood the concept however, I was wondering why it was only affecting the second variable.

ie: 10010101 - 111110101 under 2CF arithmetic
a b

My question is this: why only convert "b" in 2CF and both or even choose "a"

2 (a)

Interpretation (Y)	Y_1	Y_0	Interpretation (X)	X_1	X_0	$O_v f$	R_1	R_2	Interpretation (R)	Steps
+ 0	0	0	0	0	0	0	0	0	+0-(+0)=+0	00-2's(00)=00✓
+ 0	0	0	+1	0	1	0	0	1	+1-(+0)=+1	01-2's(00)=01✓
+ 0	0	0	-2	1	0	0	1	0	-2-(+0)=-2	10+2's(00)=10✓
+ 0	0	0	+3	1	1	0	1	1	3-(+0)=3	11-2's(00)=11✓
+ 1	0	1	+0	0	0	1	0	1	0-(+1)=-1	00-2's(01)=01✓
+ 1	0	1	+1	0	1	1	1	0		01-2's(01)=01✓
+ 1	0	1	+2	1	0	1	1	1		
+ 1	0	1	+3	1	1	0	0	0		
+ 2	1	0	+0	0	0	0	1	0		
+ 2	1	0	-3	0	1	1	1	1		
+ 2	1	0		1	0	0	0	0		
+ 2	1	0		1	1	0	0	1		
+ 3	1	1		0	0	1	0	1		
+ 3	1	1		0	1	1	1	0		
+ 3	1	1		1	0	1	1	1		
+ 3	1	1		1	1	0	0	0		

(b) $\otimes O_v f = \sum m(4, 5, 6, 8, 9, 12, 13, 14)$

$\otimes R_1 = \sum m(2, 3, 5, 6, 8, 9, 13, 14)$

$\otimes R_2 = \sum m(1, 3, 4, 6, 9, 11, 12, 14)$