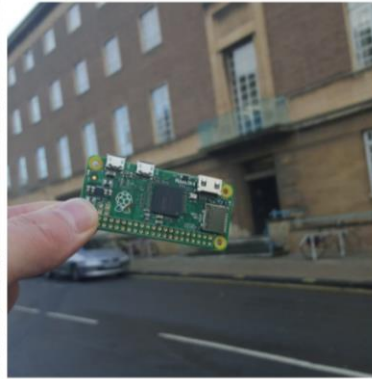


Title	Date	Time	Duration	Grade Release Date
Midterm Exam	March. 01, 2022	10:00 AM	90 minutes	March 07, 2022



	Elliott 405	Raspberry Pi Zero
Year	1957	2015
Price	£85,000 (1957)	\$5
Memory	16 KB	512 MB
Weight	3-6 tons	9 g
Size	21 cabinets, each 2m x 77cm x 77cm	65mm x 30mm x 5.4mm

Source: <https://www.spinellis.gr/blog/20151129/>

Questions

You must show your work and all steps for every question!

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

- Number System
- Universality

Q2: [20 marks: 5 marks each] Assuming an unsigned number system, show the maximum number and the smallest unit of increment given 4 integer and 3 fraction positions in the *quaternary* number system and their equal decimal values.

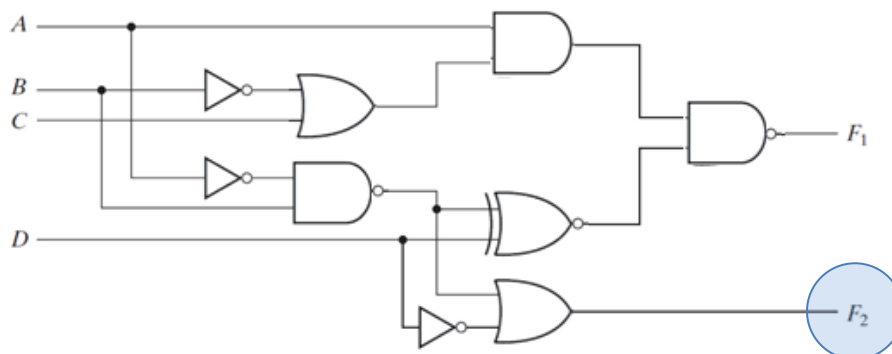
- $(\text{Max } ?)_4 = (?)_{10}$
- $(\text{Smallest Unit } ?)_4 = (?)_{10}$

Q3: [15 marks] Show the minimum possible error when converting $(16.41)_{10}$ to base-5 if only 5 positions are given in total for both integer and fraction parts. Report the error in base-10.

Q4: [15 marks] Perform $(+14) + (-16)$ in base-2 in (a) signed-magnitude and (b) signed-2's-complement. Use the least number of bits and check whether an overflow happens.

Q5: [15 marks] Analyze the logic circuit shown below only for F2:

- Show the truth table.
- $F2 = \prod (?)$



Q6: [25 marks] Design a 3-bit DECrementor, that is, the circuit generates the previous number of the input binary number (e.g., $101 \rightarrow 100$. Also, $000 \rightarrow 111$):

- Show the truth table.
- Show the Boolean expressions for the outputs in SoP.
- Design an *efficient* circuit using NAND gates only.