



İTÜ Computer Engineering Department
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BLG 231E DIGITAL CIRCUITS FINAL EXAM QUESTION 1

Rules:

1. The duration of this question is **50 minutes**. You may upload your file to Ninova until **15:50**.
2. **Answer the question on its own sheet** and upload it during the time allotted for that question, as explained in the file “Exam policies”. Create a separate zip file for this question.
3. **You may not ask any questions during the exam**. State any assumptions you have to make.
4. Any cheating or any attempt to cheat will be subject to University disciplinary proceedings.
5. Please **show ALL work**. Answers with no supporting explanations or work will be given no partial credit. If we cannot read or follow your solution, no partial credit will be given. PLEASE BE NEAT!

QUESTION 1 (35 Points):

Note: Parts (a) and (b) below are not related.

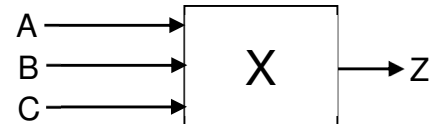
- a) [10 points] One of the expressions of a logic function $F(A,B,C,D,E)$ is given below:

$$F(A,B,C,D,E) = (\bar{A} + \bar{C} + D) \cdot (\bar{B} + C + D + E) \cdot (A + \bar{B} + \bar{C} + D + \bar{E})$$

Write the **2nd canonical (POS) form** expression for the function $F(A,B,C,D,E)$.

- b) [25 points] A combinational digital circuit, X, shown on the right has the following logic function:

$$Z = \bar{A} \cdot \bar{B} \cdot C$$



- i. Show that we can use this X circuit as a **2-input universal gate**. (10 points)
Hint: Constant 0 and 1 values are available as inputs.
- ii. Design and implement a one-bit half adder **using the X circuits given in (a) only**. Use the **fewest possible** number of X circuits to make your circuit design as simple as possible. (15 points)