



İTÜ Computer Engineering Department
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COMPUTER ARCHITECTURE FINAL EXAM QUESTION 1

Rules:

1. The normal end time of this question is **15:45**. However, because of the 10-minute buffer period, the submission will be closed at **15:55**.
2. **Answer the question on its own sheet** and upload your files during the time allotted for that question, as explained in the file “Exam policies”. Create your files in **PDF format**.
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 the 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: (30 Points)

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

- a) A CPU that has an instruction pipeline with branch prediction runs a program containing a conditional branch instruction such as “BZ - Branch if zero” that is executed many times in a program. We check the decision of the prediction strategy in any **six** executions (runs) of the instruction and observe the following pattern.

#run	1	2	3	4	5	6
Prediction	N	N	T	N	T	T

N: Predict NOT to take the branch
T: Predict to take the branch

- i. Which of the 2-bit dynamic prediction strategies covered in the lectures is used in this system? Draw the state transition diagram. **Explain** your answer. (10 p)
- ii. Consider how the predictions change, and fill in the table below that shows the prediction bits and whether the branch is really taken or not. Fill the last row only for the five runs of the BZ instruction. (10 p)

#run	1	2	3	4	5	6
Prediction	N	N	T	N	T	T
Prediction bits						
Really <u>T</u> aken or <u>N</u> ot						X

- b) A CPU that has an instruction pipeline with branch prediction runs a program containing a conditional branch instruction such as “BZ - Branch if zero” that is executed **7** times in a program.

We check the condition (if zero) in each execution of the instruction and observe the following pattern.

T T F F F T F T: True F: False

In this system, a 1-bit dynamic branch prediction strategy is used, and at the beginning, the Branch Target Table is **empty**.

Consider how the condition changes, and fill in the table below that shows the prediction bit and whether the prediction is correct or not for each run of the BZ instruction. (10 p)

#run	1	2	3	4	5	6	7
Condition	T	T	F	F	F	T	F
Prediction bit							
Prediction is <u>C</u> orrect or <u>F</u> alse							