Name-Last Name: _____ **Student ID:** _____

Hacettepe University	Computer Engineering Department
BBM431-Advanced Computer Architecture	Instructor: Prof. Dr. Suleyman TOSUN
Midterm Exam	
Duration: 100 minutes	Exam Date: 30.11.2020

Questions	1	2	3	4	Total
Marks	20	25	30	25	100
Earned					

Make a single pdf of your answer sheets and send it to aca.odev@gmail.com.

Q1. a) What are the three cache misses and how do they occur?

b) Give a method for each miss type to reduce their miss rates. Explain how these methods affect other miss types.

Q2. Suppose we have a direct mapped cache and following memory access pattern. Suppose A and B are mapped to set 1 and C and D are mapped to set 2. Assume that cache and victim cache are initially empty.

Access order: A, B, C, D, B, C, D, A, C, D

a- What is the miss rate if we do not have any victim cache? Show which ones are hit (H) and which ones are miss (M).

Access	A	B	C	D	B	C	D	A	C	D	Miss rate
H or M											

b- What is the miss rate if we have one entry victim cache? Show which ones are hit in cache (Hc), hit in victim cache (Hv), and which ones are miss (M).

Access	A	B	C	D	B	C	D	A	C	D	Miss rate
Hc, Hv or M											

Q3. You are given the following loop that iterates 1000 times.

```
for(i=1000; i!=0; i--)
     c[i]=a[i]+ b[i];
```

a) Suppose we have a five stage pipelined MIPS with hazard unit. How many clock cycles (i.e., number of fetched instructions) does the above code take for each iteration? You should add NOPS on the code below if necessary. [7]

```
Loop:Lw $s2, 0($s1)       # $s2=a[i]
     Lw $s3, 0($t0)       # $s3=b[i]
     Add $s2, $s2, $s3    # $s2=a[i]+b[i]
     Sw $s2, 0($t1)       # c[i] = $s2
     Addi $t0, $t0, -4    # decrement address of b
     Addi $t1, $t0, -4    # decrement address of c
     Addi $s1, $s1, -4    # decrement address of a
     Bne $s1, $0, Loop    # if i!=0, go to loop
```

b) Schedule the code if possible. How many cycles does an iteration take now? [7]

c) Unroll the original loop once. How many cycles does an iteration take now? [10]

d) Schedule the unrolled code to further reduce the clock cycles and find new cycle count for an iteration. [6]

Q4. Suppose you have the following code that compares the numbers on the same index and checks how many of the numbers in array A is greater than array B. Let us compare some branch prediction methods on this code with given values.

```
int A = {3, 5,7,9,11}
int B = {3, 4, 5, 6, 7}
int counter =0;
for (int i=0; i<5; i++)
{
        if (A[i] > B[i])
                counter++;
}
```

a) If we use a static branch predictor that predicts as always "branch taken (T)", how many predictions will be correct? Show in the following table. (T=Branch Taken, N=Branch Not Taken) [7]

Branch	For (i=0)	if	for (i=1)	if	for (i=2)	İf	For (i=3)	İf	For (i=4)	if	For (i=5)	Total
Result	T	N										
Prediction												

b) Answer the same question for the branch predictor that predicts as always "branch not taken (N)". [6]

Branch	For (i=0)	İf	For (i=1)	İf	For (i=2)	İf	For (i=3)	İf	For (i=4)	if	For (i=5)	Total
Prediction												

c) Answer the same question for "1-bit branch predictor". Suppose initial state is T. [6]

Branch	For (i=0)	İf	For (i=1)	İf	For (i=2)	İf	For (i=3)	İf	For (i=4)	if	For (i=5)	Total
Result												
Prediction												

d) Answer the same question for "2-bit branch predictor". Suppose initial state is T. [6]

Branch	For (i=0)	İf	For (i=1)	İf	For (i=2)	İf	For (i=3)	İf	For (i=4)	if	For (i=5)	Total
Result												
Prediction												