COMPUTER ARCHITECTURE

HOMEWORK-II

1. for (i=0 ; i<150; i++)

```
{ result = memArray[i];
  result= result+S1;
}
```

3. 8bits require 7adders and if each adder require 5 time units.
Total time required= 7×5= 35 time units

4. Input 1- 0x23 - 00100011_2 - 35_{10}
Input 2- 0x75- 01110101 - 117_{10}.

35 can be written as $(2^5+3) = (2^5+2^1+2^0)$

$117 \times 35 = (117) \times (2^5+2^1+2^0)$
$= 117 \times 2^5 + 117 \times 2^1 + 117$

Best way to multiply these two numbers is to shift 117 by 5 and add it to 117 shifted by 1 and add that to 117.

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The final answer is: $(0000011111111111)_2 = (4095)_{10} = 0xfff_{16}$

5. a) The instruction memory block, Register block, ALU and Data memory block can be used for the instruction

~~b) Additionally we would require a sign extend unit to extend~~ No Additional Blocks required from 16 to 32 bits if required.

c) The instruction would require separate read & write control lines, although only one can be accessed at an instant.

b) No additional control blocks.

6. a) load word is the longest data path, so we will calculate clock cycle for it

$T_{mem}(400ps) + Add(250ps) + MUX(30ps) + ALU(120ps) + Regs(200ps) + D\text{-}MEM(550ps) + Control\ blocks(90ps)$

Clock cycle time without improvement = 1440 ps.

Clock cycle time after improvement:

Clock cycle time before improvement + Additional time for MUL

$= 1440 + 400 = 1840$ ps.

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b) Clock time is increased by 400ps
So it slows down the clock time doesn't speed it
Assuming each block takes 1 clock cycle to compute
According to Amdahl's law

$$\text{Speedup} = \frac{1}{(1-P)+\frac{P}{S}} = \frac{1}{(0.9)+\frac{0.1}{(400)}} = 1.111$$

c) Cost performance ratio without improvement.

(1000) + (30×2) + (10×3) + (100×1) + (200×1) + (2000) + ...
I-MEM ADD MUX ALU Regs D-MEM Cost

Total cost = 3790.

Cost/performance = 3790 / 1440 = 2.632

Costperformance Ratio with improvement.

(1000) + (30×2) + (10×3) + (600) + (200) + (2000) + 400
IMEM ADD MUX ALU REGs D-MEM Cost

Total Cost = 4290

Cost/performance = 4290 / 1840 = 2.331

2. f: addi $sp, $sp, -4
sw $ra, 0($sp)
jal func
sub $a0, $v0, $0
sub $a1, $a2, $a3
jal func
Continue on next page.

```
lw    $ra, 0($sp)
addi  $sp, $sp, 4
jr    $ra
```