

# Midterm Solutions

CS/ECE 6810: Computer Architecture

November 14, 2018

## 1 Problem 1

### 1.1

$\text{CPI} = 0.1 \cdot 10 + 0.1 \cdot 3 + 0.1 \cdot 2 + 0.4 \cdot 1 + 0.3 \cdot 7 = 4$   
 $\text{IPC} = 0.25$

### 1.2

#### 1.2.1

$\text{CPI} = 0.1428 \cdot 10 + 0.1428 \cdot 3 + 0.2857 \cdot 1 + 0.1428 \cdot 7 + 0.2857 \cdot 5 = 4.57$   
 $\text{IPC} = 0.21875$   
 $\text{Speedup} = (4) / (4.57 \cdot 0.7) = 1.25$

## 2 Problem 2

### 2.1

New dynamic power = Old dynamic power \* 0.7 =  $60 \cdot 0.7 = 42$  W  
Total power =  $30 + 42 = 72$  W  
Decrease in power =  $(90 - 72) / 90 = 20\%$   
Decrease in energy =  $((90 \cdot 30) - (72 \cdot 30 / 0.7)) / (90 \cdot 30) = -14.28\%$

### 2.2

New dynamic power = Old dynamic power \*  $(0.8)^3 = 30.72$   
New static power =  $0.8 \cdot 30 = 24$   
Total power = 54.72W  
Decrease in power =  $(90 - 54.72) / 90 = 39.2 \%$   
Decrease in energy =  $((90 \cdot 30) - 54.72 \cdot 30 / 0.8) / (90 \cdot 30) = 24 \%$

## 3 Problem 3

### 3.1

LOAD F1, 0(R1)  
STALL  
MULT F2, F1,F0  
STALL  
STALL

```

STALL
ADD F3, F2,F4
LOAD F1, 4(R1)
STALL
ADD F2, F1, F0
STALL
STALL
ADD F5, F2,F3
STALL
STALL
STORE F5, 0(R3)
ADDI R1, R1,8
ADDI R3, R3,4

```

### 3.2

```

LOAD F1, 0(R1)
ADDI R1, R1,8
MULT F2,F1,F0
LOAD F1, -4(R1)
ADDI R3, R3,-4
ADD F21, F1,F0
ADD F3, F2,F4
STALL
STALL
ADD F5, F21,F3
STALL
STALL
STORE F5, -4(R3)

```

## 4 Problem 4

### 4.1

No stalls required as POP and POC are seperated by 1 cycle  
 $IPS = (1)/(11 \cdot 10^{-9}) = 90 \text{ MIPS}$

### 4.2

$IPS = 3/(5 \cdot (5 + 1) \cdot 10^{-9}) = 100 \text{ MIPS}$

## 5 Problem 5

### 5.1

WAW:  
 2, 5(R2)  
 4, 6(R3)  
 WAR:  
 5, 6(R3)  
 RAW:  
 1, 3(R1)  
 2, 3(R2)

2, 6(R2)  
4, 5(R3)  
5, 6(R2)  
3, 5 (R2)

## 5.2

AND P11, P4,P5  
AND P12, P6,P7  
STORE P12, 8(P11)  
MULT P13, P8, P9  
LOAD P14, 16(P3)  
DIV P15, P10, P14

Hazards:

WAW: Inst 2 and 3(P12)

Renaming eliminates all other hazards mentioned in part A