Homework 1

Hamza Kamal

March 6, 2025

Question:

(2pts) Register Transfer Language (RTL)
Trace the data flow of the following code using RTL. Include the first instruction fetch. LDR R2, [R1]

Answer:

$MAR \leftarrow PC$
$PC \leftarrow PC + 2$
$IR \leftarrow mem[MAR]$
$MAR \leftarrow R1$
$R2 \leftarrow mem[MAR]$

Question:

(2 pts) Application Program Status Register (APSR)'s flags
After the following piece of instructions is executed, what value will be maintained in each of NZCV flags in APSR?

Answer:

Flag	Value
N	1
Z	0
C	0
V	1

Question:

(4 pts) Memory Endianness and Alignment
1. As you see the following example with #1234 at memory address 0x20000000, allocate #1234567890 to memory address 0x20001000. (2pts)
An example:
Big Endian:

Address	Data Contents (in hex)
0x20000000	04
0x20000001	D2
0x20000002	
0x20000003	

Little Endian:

Address	Data Contents (in hex)
0x20000000	D2
0x20000001	04
0x20000002	
0x20000003	

Answer:

#1234567890
#1234567890 in hex = $0x499602D2_{16}$
Big Endian:

Address	Data Contents (in hex)
0x20000000	49
0x20000001	96
0x20000002	02
0x20000003	D2

Little Endian:

Address	Data Contents (in hex)
0x20000000	D2
0x20000001	02
0x20000002	96
0x20000003	49

Question:

As you see the following example with exampleData, allocate myData to the memory and fill out the spaces to indicate how each data element is mapped. Assume that the memory is based on a 32-bit addressing system. (2pts)

An Example:

```
struct exampleData {
   char a;
   short b;
}
```

	+ 0th	+ 1st	+ 2nd	+ 3rd
0th byte	a		b	b
4th byte				
8th byte				

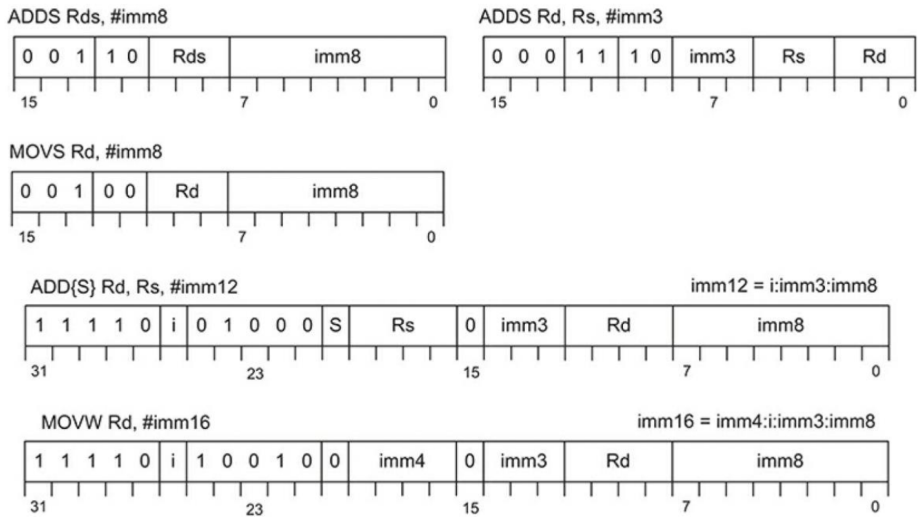
Answer:

```
struct myData {
   char a;
   long long int b;
   double c;
   short d;
   char *e;
   float f;
}
```

	+ 0th	+ 1st	+ 2nd	+ 3rd
0th byte	a		b	b
4th byte	b	b	b	b
8th byte	b	b		c
12th byte	c	c	c	c
16th byte	c	c	c	
20th byte	d	d		e
24th byte		f	f	f
28th byte	f			
32nd byte				

Question:

(4pts) Assemble the codes Using the following picture of Thumb2's encoding formats, convert the following three assembly language instructions to the machine codes in hexadecimal. You have to show your work, otherwise you get zero.



1. ADDS R7, R5, #7 (2pts)

Answer:

$R5 = 101$
$R7 = 111$
$7 = 111_2$

000	11	10	imm3	Rs	Rd

000	11	10	111	101	111

Question:

2. MOVW R10, #0x1234. (2pts)

Answer:

$R10 = 1010$
$0x1234 = 0001001000110100$

1111	i	10010	0	imm4	0	imm3	Rd	imm8

1111	0	10010	0	0010	0	010	1010	0011 0100
