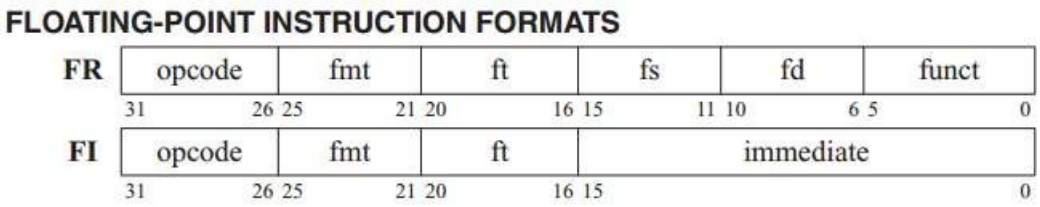
Lab Sheet 3 for CS F342 Computer Architecture
Semester 1 – 2020-2021

Goals for the Lab: We build up on Lab Sheet 2 and explore floating point instructions. We also use some new registers (especially those for floating point operations and remainder for integer arithmetic – HI / LO) and convert across numeric data types.

Reference for Floating point Instructions – refer to the **MIPS Reference Data sheet ("Green sheet"** - ARITHMETIC CORE INSTRUCTION SET – Page 1, column 2).

Some of the new instructions (and pseudo instructions) are l.s, mov.s, l.d, mov.d, cvt.d.s, cvt.s.d and similarly single precision and double precision flavours of add, sub, neg, mul, div.



There are 32 single precision floating point registers / 16 double precision values. In QtSpim they are labelled as FG0, FG1, FG2 .. FG31 for single precision and FP0, FP2, FP4 .. FP30 for double precision.

Exercise 1: Scan and Print Float.

```
.data
val1:
      .float 0.001
.text
main:
l.s $f12, val1
li $v0,2
syscall

li $v0, 6
syscall

mov.s $f12, $f0
li $v0,2
syscall

li $v0,10
syscall
```

Exercise 2: Use double precision using l.d and mov.d instead of l.s and mov.s. Also use cvt.d.s and cvt.s.d to convert across precession types.

Exercise 3: Add/Sub of float: use instructions like add.d and add.s; sub.s, neg.s etc. Use addition along with negation to implement subtraction.

Exercise 4: use examples from Lab week 2 for Integer Multiply / Divide. Sample code is given below. Extend it to print the remainder as well.

```
.data .asciiz "\nMul:"
str0:
      .asciiz "\nDiv:"
 str1:

      .word 300
 w1:
      .word 7lw $t0, w1 lw $t1, w2
 w2:

.text
main:


la $a0, str0
li $v0, 4
syscall

 mul $a0, $t0, $t1
li $v0,1    # print from $a0
syscall

la $a0, str1
li $v0, 4
syscall

 div $a0, $t0, $t1
li $v0,1    # print from $a0
syscall

 # Modify to also print the modulo / remainder


li $v0,10
syscall
```

Exercise 5: Convert Integer to Single precession float and vice versa. Also compute the conversion errors for mathematical operations – e.g. rounding off during divide, precision loss during convert to float and multiple etc. Some of the new instructions are cvt.s.w, cvt.w.s, mtc1/mtcz, mfc1/mfcz … Note that cvt.x.w or cvt.w.x (where we convert from / to integers) can only be done with registers in CP1. So if the value is in the main registers you first need to use mtc1. Similarly after converting to integer, you need to use mfc1 to get the values in regular registers.

Skeletal algorithm:

//A. Define two integers with relatively large values – but ensure that no overflow in multiplication

//B. multiply and print output – save integer output to a spare register

//C. Convert both integers to single precision float; multiply and print output using float [make sure to use mtc1 first and then cvt.s.w or similar

//D. Convert the output to integer and compare with saved values from step B – first convert to integer in co-processor 1 register and then move the value to a0 register of main processor.

//E. Convert both integers to double precision float; multiply and print using double precision float

//F. Convert the output to integer and compare with saved values from step B

//G. Print difference in output of D and E – (may happen only if large integer values are used)

Exercise 6: Explore disassembly for the new instructions.

1. `44880000`
2. `46800060`
3. `460208c2`
4. `3c041001`
5. `44042000`
6. `0000000c`