Assignment No. 5

Q1. Represent the following real numbers in 32 bit single & double precision floating point numbers representation

a. +7.5

1. Single precision floating point format.

Sign bit (S) = 0

$7.5 = 0111.1 \times 2^0$

$= 1.111 \times 2^2$

- Exponent is excess - 127 in single precision format

bias exponent = actual exponent + bias value

$= 127 + 2 = 129$

Mantissa (M) = (0.111)

0	10000001	11100000000000000000000

$\therefore +7.5 = 0 \times 40F00000$

2. Double precision floating point format

Sign bit (S) = 0

$7.5 = 0111.1 \times 2^0$

$= 1.111 \times 2^2$

- Exponent is excess - 1023 in double precision format

bias exponent = actual exponent + bias value

$= 1023 + 2 = 1025$

Mantissa (M) = (0.111)

0	10000000001	11100000000000000000000000000000000000000000000000

$\therefore +7.5 = 0 \times 401E0000\ 0000\ 0000$

b. -24.75

1. Single precision floating point format

Sign bit(S) = 1

$24.75 = 11000.11 \times 2^0$

$= 1.100011 \times 2^4$

- Exponent is excess -127 in single precision format

bias exponent = actual exponent + bias value

$= 127 + 4 = 131$

Mantissa (M) = (1.100011)

1	10000011	10001100000000000000000

∴ -24.75 = 0xC1C60000

2. Double precision floating point format

Sign bit(S) = 1

$24.75 = 11000.11 \times 2^0$

$= 1.100011 \times 2^4$

- Exponent is excess -1023 in double precision format

bias exponent = actual exponent + bias value

$= 1023 + 4 = 1027$

Mantissa (M) = (1.100011)

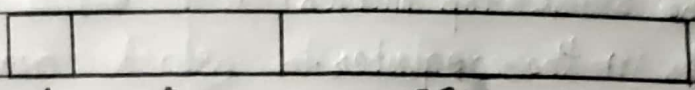
1	10000000011	1000110000000000000000000000000000000000000000000000

∴ -24.75 = 0xC038 C000 0000 0000

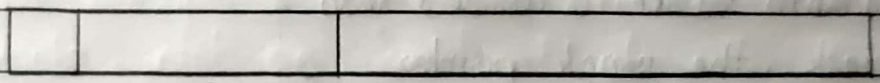
Q2. List different kinds of floating point numbers in IA32 architectures. Also draw formats.

→ There are three kinds of floating point numbers in IA32 architecture

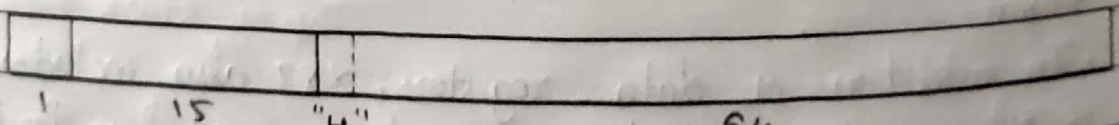
• IEEE754 Single precision floating point format
- These are 32 bit wide numbers & have three parts - a sign, a mantissa & an exponent
- Sign is 1 bit wide ~~number~~ & represents the sign of the number. Mantissa is 23 bit wide & represents the fractional part of the floating point number in binary. A leading one bit integer is not stored & is assumed as 1 in the normalized numbers.
- Exponents are stored in excess-127 representation.



• IEEE754 Double precision floating point format.
- These are 64 bit wide with sign, mantissa & exponent in excess 1023 representat^{n}.



• ~~IEEE~~ Double extended precision floating point number.
- Double extended precision floating point nos. are 80 bit wide.
- This no. format is used to perform computat^{n} internally in IA32 processors when instruct^{n} in x87 floating pt. instruction set are used.

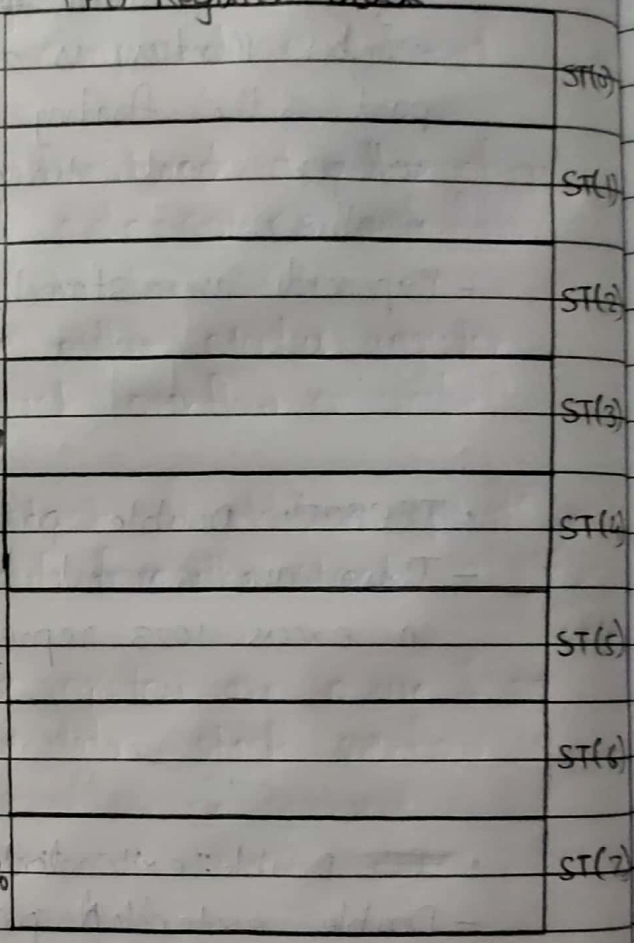


Q3. Write short note on.

a. x87 data registers in IA32 processor

→ - It include 8 general purpose data registers, each 80 bit wide & capable of storing a real no. in double extended precision format.

- As data is loaded into the FPU Stack, the stack top moves downward in the register.
- When eight value have been loaded into the stack, all eight FPU data registers have been utilized.
- If a ninth value is loaded into the stack, the stack pointer wraps around to the first register & replaces the value in that register with the new value.



- When an integer, BCD, single & double precision operand is loaded into one of these data registers, the operand is implicitly converted to double extended precision format.
- In addition of data registers, x87 also includes three 16 bit registers which are used in controlling the computation.
- These registers are the following.
  - x87 control register.
  - x87 status register.
  - x87 tag register.

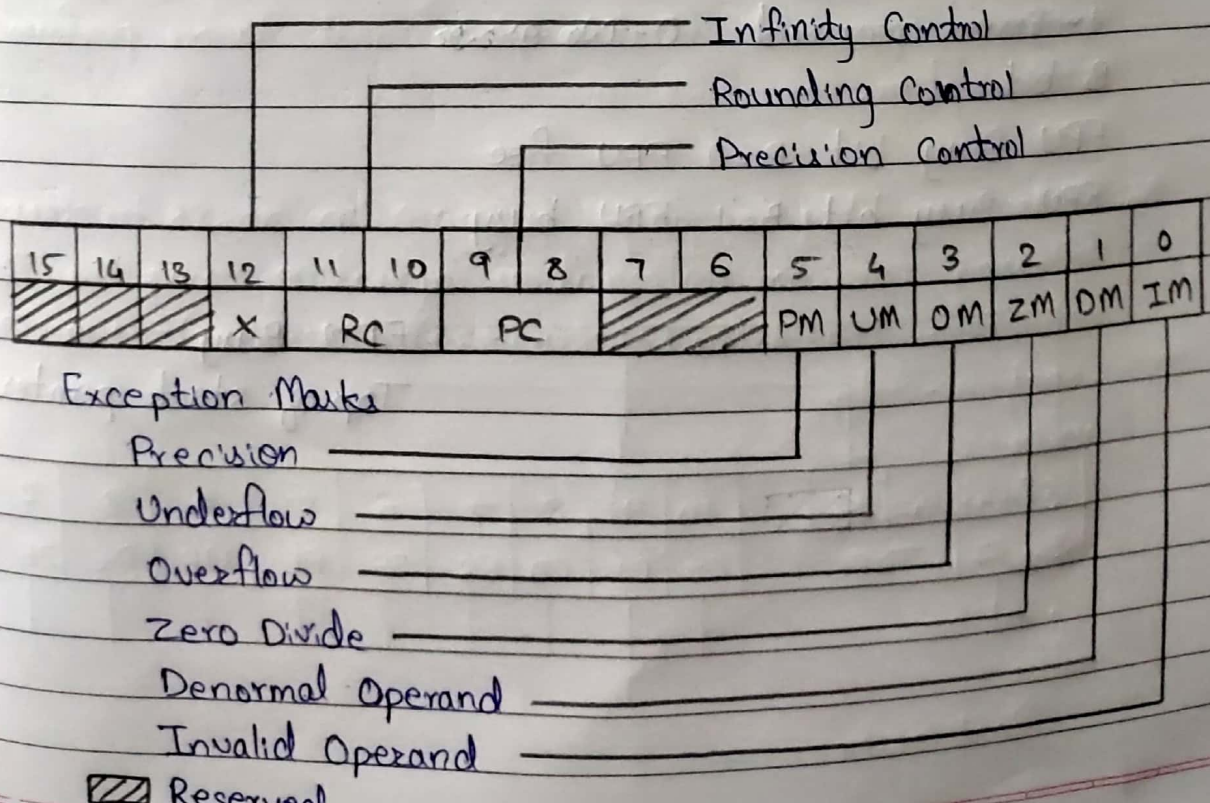
b. x87 control register

→ - During computat^n, several floating pt. error condit^n such as divide by zero occur.
- In case of such errors, x87 FPU can be performed to raise floating pt. execution.
- Bit 0 to bit 5
  0 indicate : unmask exception
  1 indicate : mask exception
- Used to handle the precision & rounding of operands
- Infinity bit always set to 0

• Precision control
  00 - Single precision
  01 - unused
  10 - Double precision
  11 - Double extended precision

• Rounding control
  00 - Round to nearest
  01 - Round down
  10 - Round up
  11 - Round towards zero (Truncate)

• Exception Mask
  0 - UnMask
  1 - Mask



c. X87 Status Register

→ 1. Top: It is 3 bit field contain index to register assumed to be at the top of the stack.

2. Four conditional code flags C0 to C3

A floating pt. no. can be compared in different ways with other floating pt. no.

The result of comparison is stored in either eflags or in floating pt. conditional code C0 - C3 ~~underflow conditions~~

3. SF: The stack fault bit in ~~either~~ status register indicates error due to stack overflow or underflow conditions.

Example: When one data on stack & addition operat^{n} is performed which takes two data from the stack, a stack fault occurs.

Stack overflow, when all 8 registers are in use & an attempt is made to load an data, stack overflow occurs.

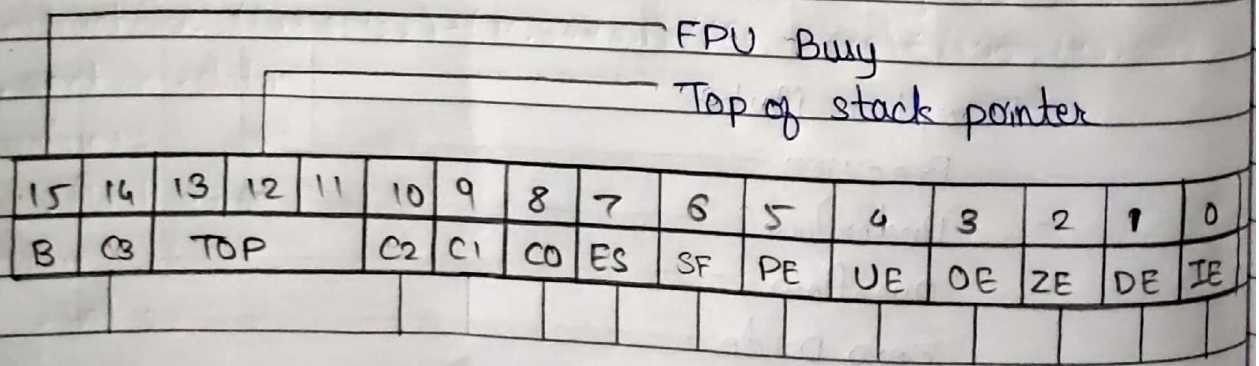
ES - Error Status

1 - Error occured 0 - No error

B bit

FPU Busy bit B=0 FPU free

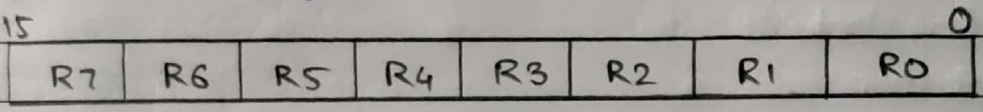
FPU Busy bit B=1 FPU busy



d. x87 Tag register

→ - Each data register of x87 FPU has an associated 2 bit tag contained in a tag register.
- The code in the tag register indicates the type of the value of the corresponding data register.
- Tag is associated with data register.

00 - R has a valid value.
01 - R has a zero.
10 - R has a special value (Nan, +/- infinity, renormalized no.).
11 - R is empty.



Q4. Explain the following arithmetic instructions.

a. fadd

→ Add two floating point no. available in stack registers.
Example: fadd %.st(1), %.st(0)
Here, %.st(0) is added with %.st(1) & result restored in destinat^n stack %.st(0)

b. Fiadd

→ It is used to add an integer stored in memory location to the floating point no. on the top of stack.

f. Fchs

→ This instruction is used to change the sign of the input argument on the top of stack i.e. st(0).

g. Fabs

→ This instruction is used to compute the absolute value of register st(0).

h. Fsqrt

→ This instruction is used to compute square root of a no. on top of stack st(0) & returns the result in register st(0) overwriting the value stored previously.

c. Fsubrp

→ This instruction perform the additional operation of popping the FPU register stack following the substraction. To pop the register stack, the processor marks the st(0) register as empty & increments the stack pointer (TOP) by 1.

d Fidivr

→ This instruction converts an integer source operand to double extended-precision floating-pt. format before performing the division.

e. Fimul

→ This instruction converts an integer source operand to double extended-precision floating-pt. format before performing the multiplication.

Q6. Write assembly language program in 80386 to compute following complex mathematical operation using the IA32 FPU instructions. ((43.65/22)+(76.34×3.1))/((12.43×6)÷(140.2/94.21))

→
```
.section .data
value1:
  .float 43.65
value2:
  .int 22
value3:
  .float 76.34
```

```
value4:
.float 3.1
value5:
  .float 12.43
value6:
  .int 6
value7:
  .float 140.2
value8:
  .float 94.21
.section .text
.globl _start
_start :nop
finit
flds value1
fto fidiv value2
flds value3
flds value4
fmul %.st(1), %.st(0)
faddd %.st(2), %.st(0)
flds value5
fimul value6
flds value7
flds value8
fdivrp
fsubr %.st(1), %.st(0)
fdivr %.st(2), %.st(0)
movl $1, %.eax
movl $0, %.ebx
int $0x80
```

Q7. Write assembly language program in 80386 to find roots of quadratic equation using IA32 FPU instructions.

→
```
.section .text
.globl _start
_start :nop
    flds a
    fimul val1
    flds c
    fmul %.st(1), %.st(0)
    flds b
    fmul %.st(0), %.st(0)
    fsubp %.st(1), %.st(0)
    fsqrt
    flds b
    fchs
    fadd %.st(1), %.st(0)
    fldsb
    fchs
    fsub %.st(2), %.st(0)
    flds a
    fimul val2
    fsts val5
    fdivr %.st(2), %.st(0)
    fsts val3
    flds val5
    fdivr %.st(2), %.st(0)
    fsts val4
movl $1, %.eax
movl $0, %.ebx
int  $0x80
```

Q8 Write assembly language program in 80386 to convert degree to radian & compute its sin cosine & tan value.

→

```
.section .data
degree1:
    .float 90.0
val180:
    .int 180
.section .bss
    .lcomm radian1, 4
    .lcomm result 1, 4
    .lcomm result 2, 4
    .lcomm result3, 4
.section .text
.globl _start
_start: nop
finit
    flds degree1
    fidivs val180
    fldpi
    fmul %st(1), %st(0)
    fsts radian1
    fsin
    fsts result1
    flds radian1
    fcos
    fsts ~~rad~~ result2
    flds radian1
    ~~fp~~tan
    fsts result3
    movl $1, %eax
    movl $0, %ebx
    int $0x80
```

Q9. Write assembly language program in 80386 to compute $\log_b x = (1/\log_2 b) \times \log_2 x$ where b=10, x=17

→
```
.section .data
value:
  .float 17.0
base:
  .float 10.0
.section .bss
  .lcomm result, 4
.section .text
.globl _start
_start: nop
finit
fld1
flds base
fyl2x
fld1
fdivp
flds value
fyl2x
fsts result
movl $1, %eax
movl $0, %ebx
int $0x80
```

Q10. Write a short note on SIMD Environment.

→ - SIMD technology provides additional way to define integers.
- It performs arithmetic operat^{n} on a group of multiple integers simultaneously.
- SIMD architecture uses packed data type.
- A packed integer is series of bytes that can represent more than one integer.
- SIMD instruction set provide a few register called mmx registers & xmm registers.
- mmx registers includes 8, 64 bit registers named mm0 - mm7.
- Data register are 80 bit wide, out of which only 64 bit are used by instructions in the SIMD instruction set.
- It is recommended to use finit instruction to initialize x87 FPU at the time of switching from SIMD to x87 environment.
- xmm registers support integer & floating pt. data types.
- xmm registers includes 8, 128 bit registers named xmm0 - xmm7.
- Supported floating pt. data type include a packed single precision floating pt. nos.

Q12. Write 80386 program to perform mmx addition on following integer value 10 & 20 with 30 & 40 nos.

→
```
.section .data
value1:
  .int 10,20
value2:
  .int 30,40
.section .bss
  .lcomm result,8
```

```
.section .text
.globl _start
_start: nop
    movq value1, %mm0
    movq value2, %mm1
    paddd %mm1, %mm0
    movq %mm0, result
  movl $1, %eax
  movl $0, %ebx
  int  $0x80
```

Q13. Write 80386 program to perform SEE addition on following four single precision floating pt. no.

value1: 12.34, 2345.5, -93.2, 10.44

value2: 39.234, 21.4, 100.94, 10.56

→

```
.section .data
.align 16
value1:
   .float 12.34, 2345.5, -93.2, 10.44
value2:
   .float 39.234, 21.4, 100.94, 10.56
.section .bss
   .lcomm result, 16
.section .text
.globl _start
_start: nop
    movaps value1, %xmm0
    movaps value2, %xmm1
    addps %xmm1, %xmm0
    movaps %xmm0, result
  movl $1, %eax
  movl $0, %ebx
  int  $0x80
```

Q5. List & explain any four each constant loading & Trigonometric x87 FPU instructions.

→ - In x87 instruction set, there are certain instructions that can load commonly used constants on the stack top. Those instructions are the following.

Instructions	Constant pushed in ST
fld1	st(0) = 1.0
fldz	st(0) = 0.0
fldpi	st(0) = 3.14
fldl2e	$\log_2 e$
fldln2	$\log_e 2$
fldl2t	$\log_2 10$
fldlg2	$\log_2 10$

• Trignometric x87 FPU instructions

- In the x87 FPU instruction set, following instructn are availble & can compute trigonometric functions for arguments stored on the stack top.

- Fsin : It compute sin of angle in radians provided in st(0).
- Fcos : It compute cosine of angle in radians provided in st(0).
- Fsincos : It compute & leaves two values in the reguter stack.
- Fptan : It removes the angle provided on top of the reguter stack & computees its tangent.