# OS Online 2 Document

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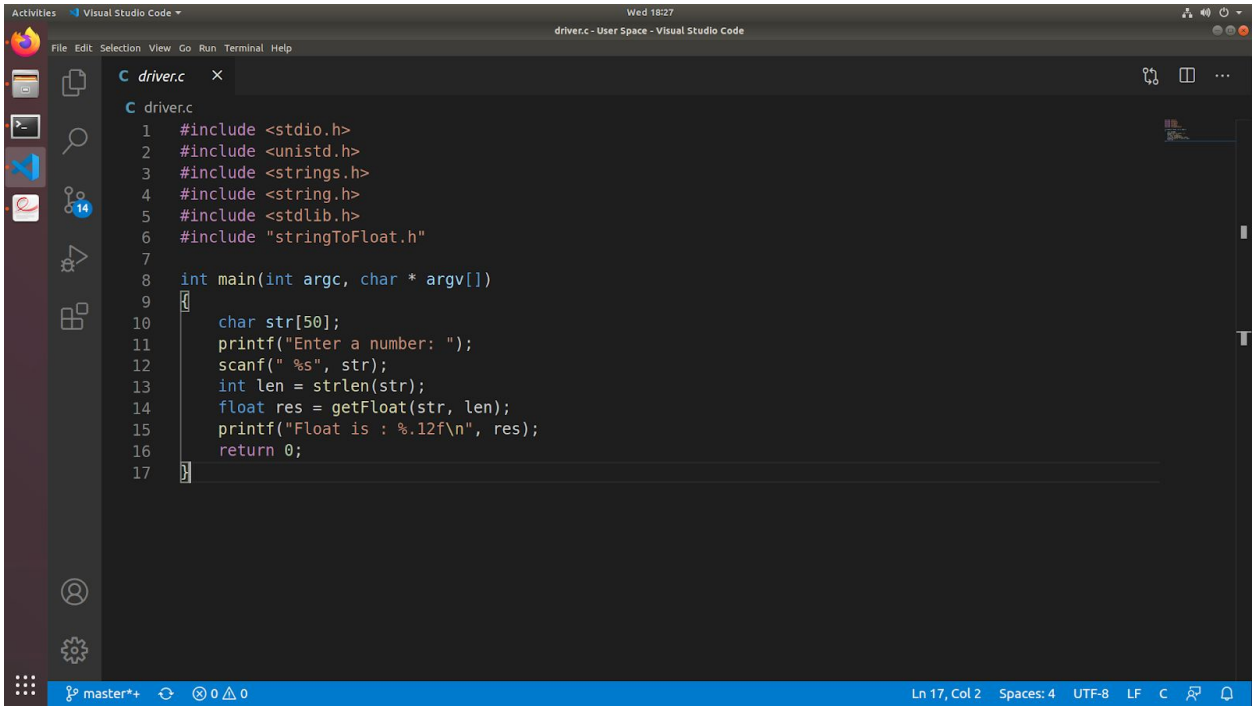
The IEEE Standard for Floating-Point Arithmetic (IEEE 754) was used for the conversion of string to long in system call parse_float_syscall in kernel mode.

# Index

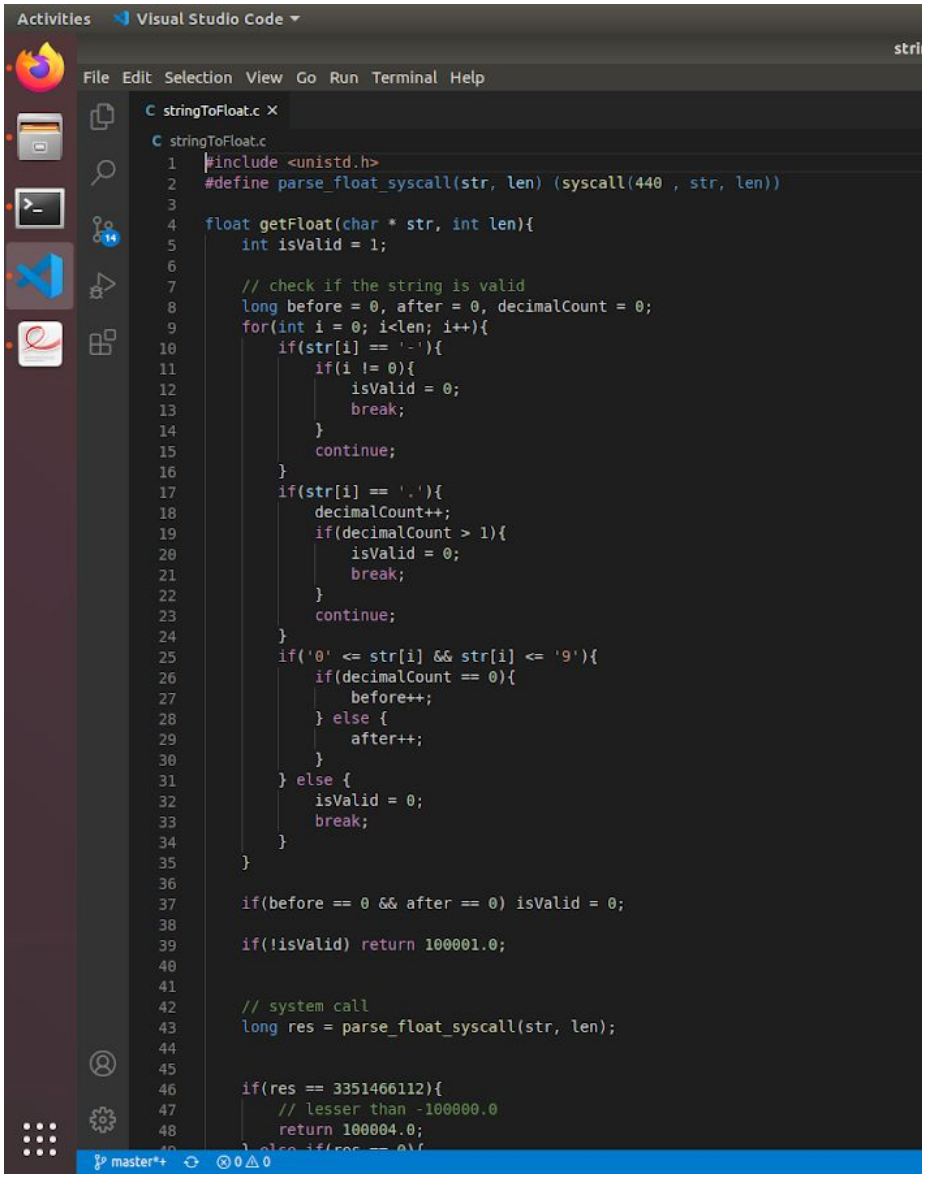
# User Space

## driver.c

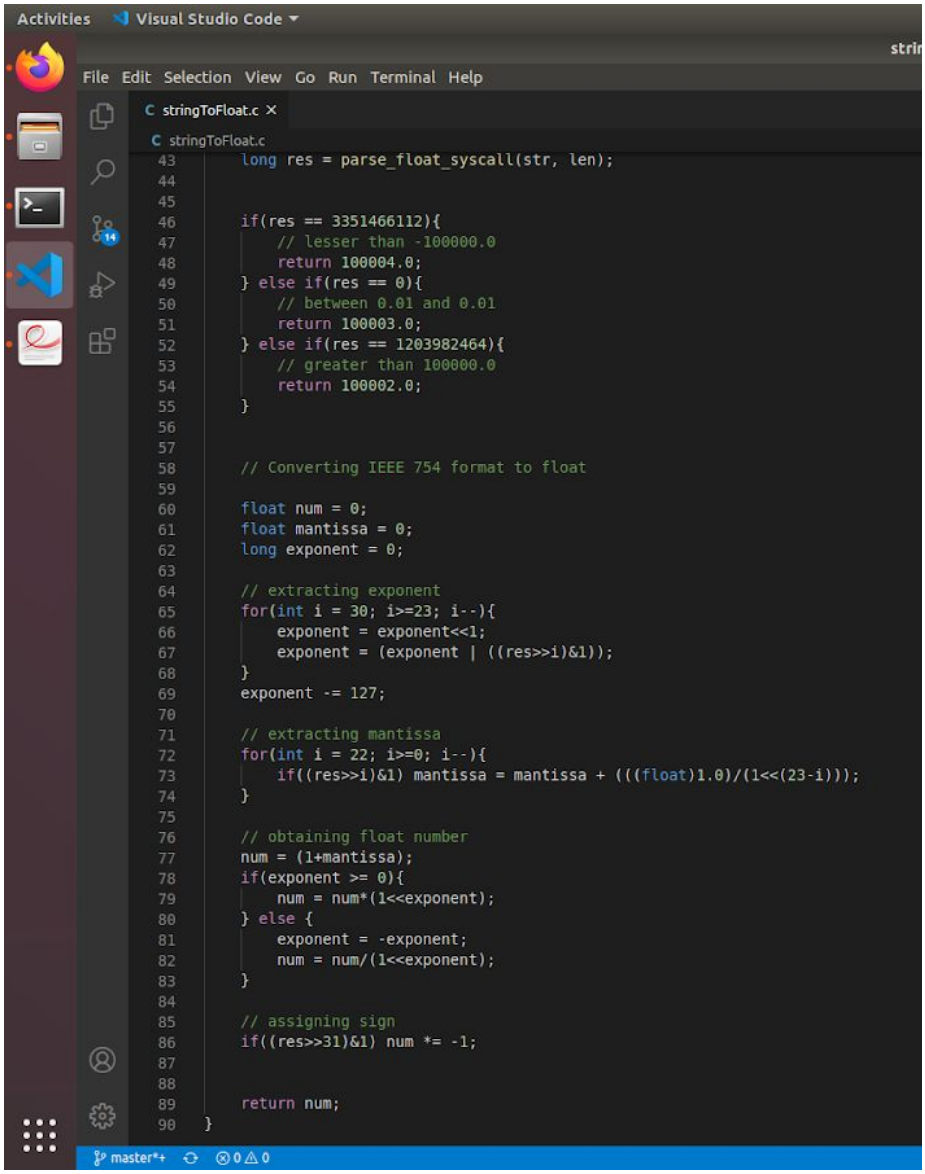



- Contains the given template for calling the wrapper function getFloat().
- Takes input form the user and prints the returned value from the wrapper function.

# stringToFloat.c



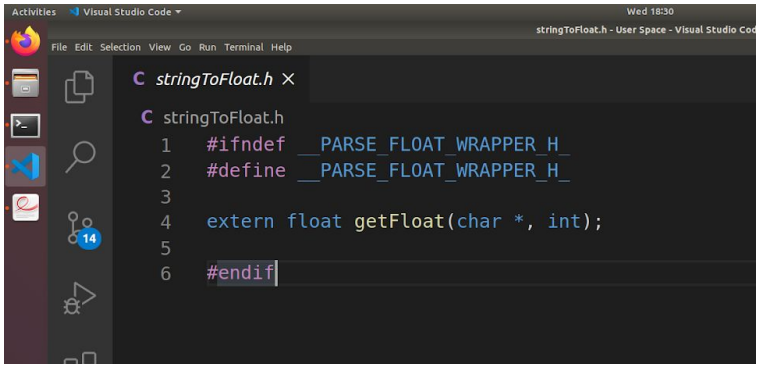

- Validates and checks if the string parameter is infact a valid float number.
- Returns 100001.0 if not valid
- Calls the system call 440 (parse_float_syscall)




```c
    long res = parse_float_syscall(str, len);


    if(res == 3351466112){
        // lesser than -100000.0
        return 100004.0;
    } else if(res == 0){
        // between 0.01 and 0.01
        return 100003.0;
    } else if(res == 1203982464){
        // greater than 100000.0
        return 100002.0;
    }


    // Converting IEEE 754 format to float

    float num = 0;
    float mantissa = 0;
    long exponent = 0;

    // extracting exponent
    for(int i = 30; i>=23; i--){
        exponent = exponent<<1;
        exponent = (exponent | ((res>>i)&1));
    }
    exponent -= 127;

    // extracting mantissa
    for(int i = 22; i>=0; i--){
        if((res>>i)&1) mantissa = mantissa + (((float)1.0)/(1<<(23-i)));
    }

    // obtaining float number
    num = (1+mantissa);
    if(exponent >= 0){
        num = num*(1<<exponent);
    } else {
        exponent = -exponent;
        num = num/(1<<exponent);
    }

    // assigning sign
    if((res>>31)&1) num *= -1;


    return num;
}
```

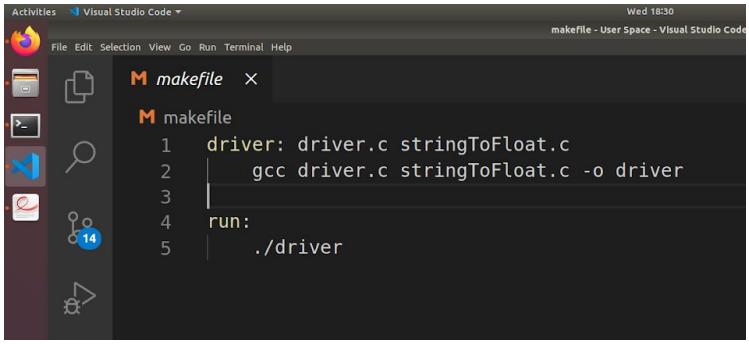
- If the number is less than -100000 ( ret value = 3351466112) returns 100004.0
- If the number is between -0.01 and 0.01 ( ret value = 0) returns 100003.0
- If the number is greater than 100000 ( ret value = 1203982464) returns 100002.0
- Extracts sign, exponent and mantissa from the response of system call.
- Construct float number and return it.

# stringToFloat.h




- Declares the function getFloat()

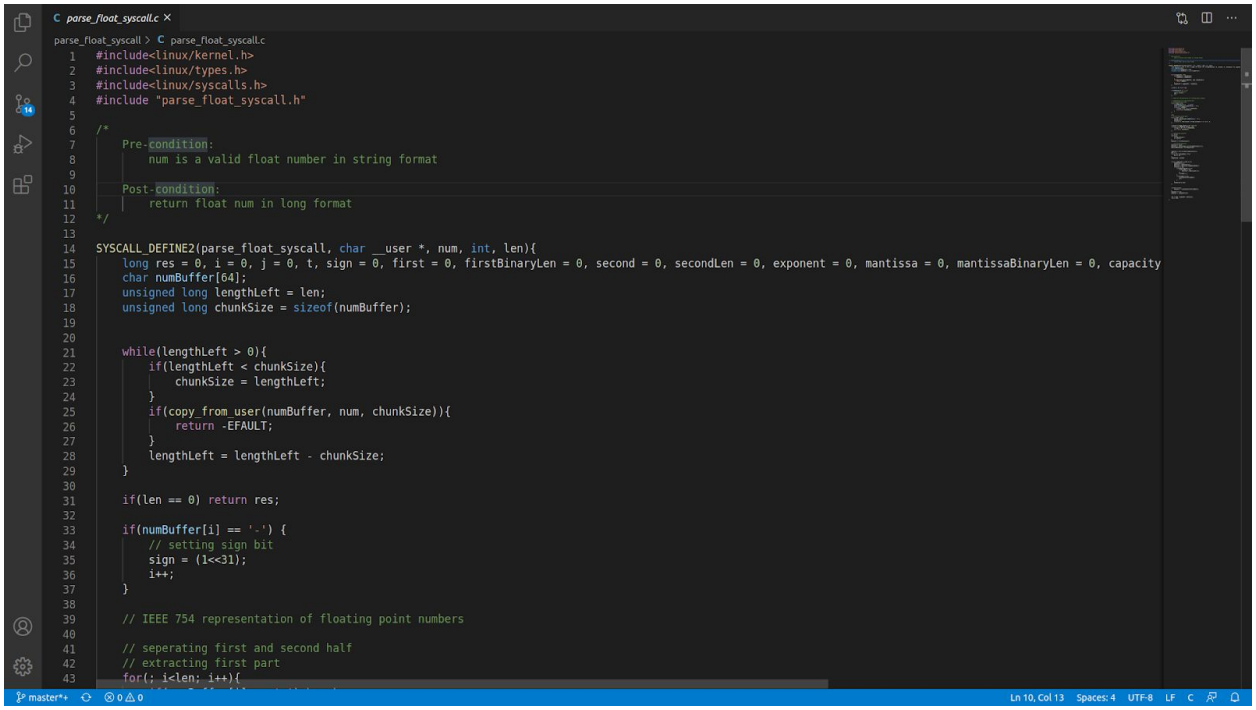
# makefile




- makefile to run driver.c

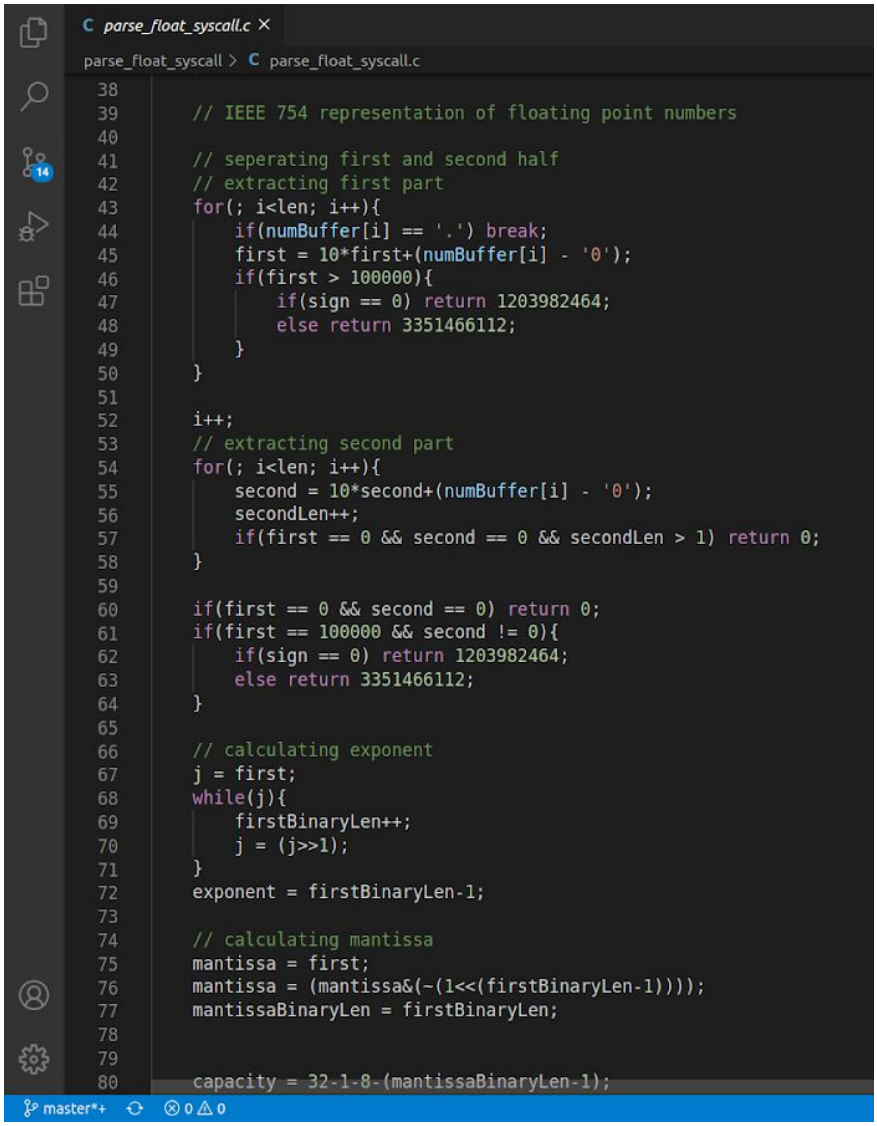
# Kernel Space

/usr/src/linux-5.8.12/parse_float_syscall/parse_float_syscall.c

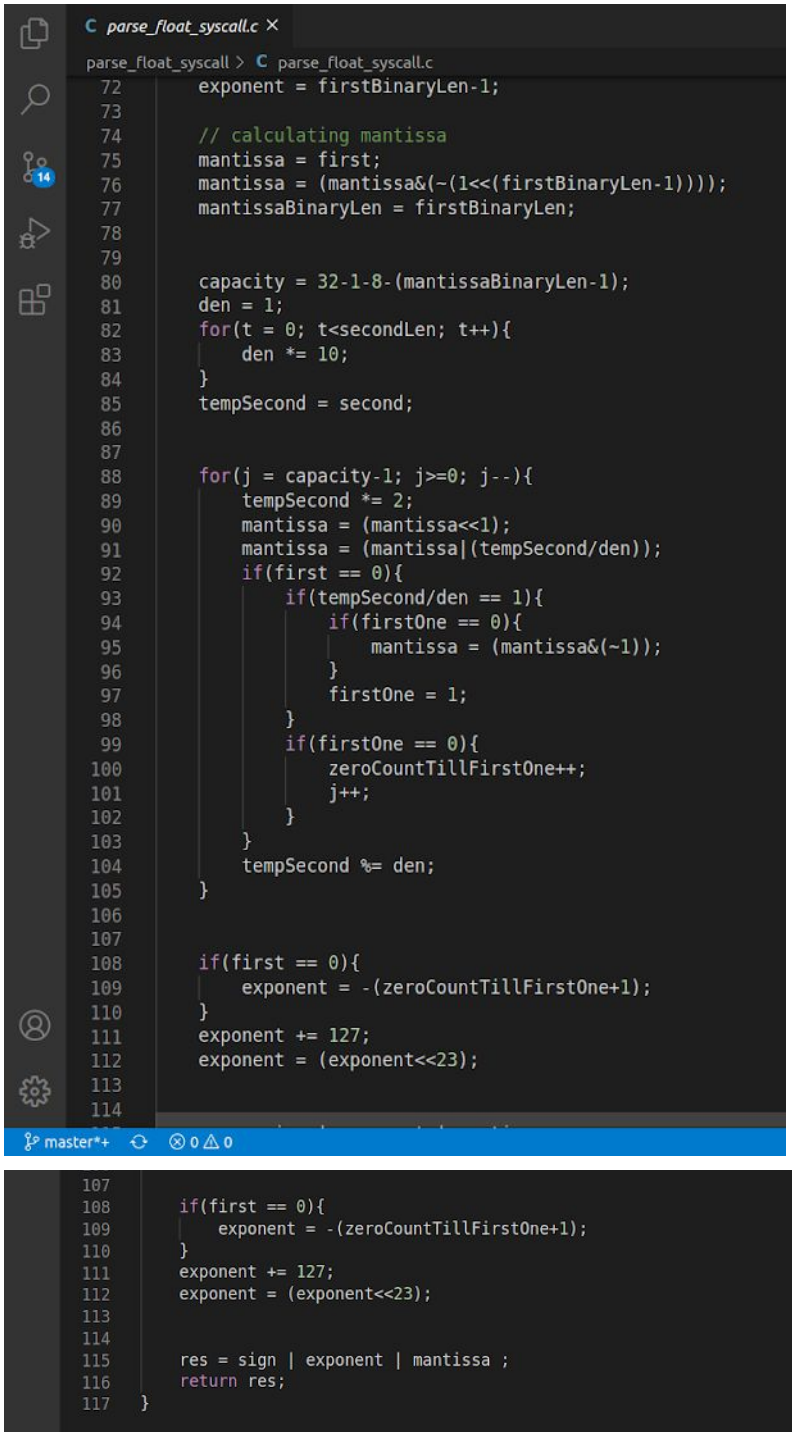


```c
#include<linux/kernel.h>
#include<linux/types.h>
#include<linux/syscalls.h>
#include "parse_float_syscall.h"

/*
    Pre-condition:
        num is a valid float number in string format

    Post-condition:
        return float num in long format
*/

SYSCALL_DEFINE2(parse_float_syscall, char __user *, num, int, len){
    long res = 0, i = 0, j = 0, t, sign = 0, first = 0, firstBinaryLen = 0, second = 0, secondLen = 0, exponent = 0, mantissa = 0, mantissaBinaryLen = 0, capacity
    char numBuffer[64];
    unsigned long lengthLeft = len;
    unsigned long chunkSize = sizeof(numBuffer);


    while(lengthLeft > 0){
        if(lengthLeft < chunkSize){
            chunkSize = lengthLeft;
        }
        if(copy_from_user(numBuffer, num, chunkSize)){
            return -EFAULT;
        }
        lengthLeft = lengthLeft - chunkSize;
    }

    if(len == 0) return res;

    if(numBuffer[i] == '-') {
        // setting sign bit
        sign = (1<<31);
        i++;
    }

    // IEEE 754 representation of floating point numbers

    // seperating first and second half
    // extracting first part
    for(; i<len; i++){
```

- Receives the char __user * input from the user as parameter
- Converted to buffer to use in kernel space using copy_from_user() function
- Uses IEEE 754 format to convert the float in string to long value




- Calculating the part before decimal point and after the decimal point.
- Using this to calculate the exponent and mantissa



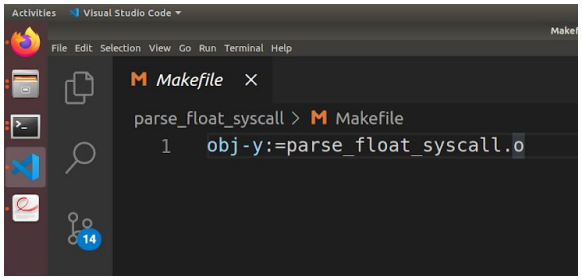
```
72      exponent = firstBinaryLen-1;
73
74      // calculating mantissa
75      mantissa = first;
76      mantissa = (mantissa&(~(1<<(firstBinaryLen-1))));
77      mantissaBinaryLen = firstBinaryLen;
78
79
80      capacity = 32-1-8-(mantissaBinaryLen-1);
81      den = 1;
82      for(t = 0; t<secondLen; t++){
83          den *= 10;
84      }
85      tempSecond = second;
86
87
88      for(j = capacity-1; j>=0; j--){
89          tempSecond *= 2;
90          mantissa = (mantissa<<1);
91          mantissa = (mantissa|(tempSecond/den));
92          if(first == 0){
93              if(tempSecond/den == 1){
94                  if(firstOne == 0){
95                      mantissa = (mantissa&(~1));
96                  }
97                  firstOne = 1;
98              }
99              if(firstOne == 0){
100                 zeroCountTillFirstOne++;
101                 j++;
102             }
103         }
104         tempSecond %= den;
105     }
106
107
108     if(first == 0){
109         exponent = -(zeroCountTillFirstOne+1);
110     }
111     exponent += 127;
112     exponent = (exponent<<23);
113
114
```



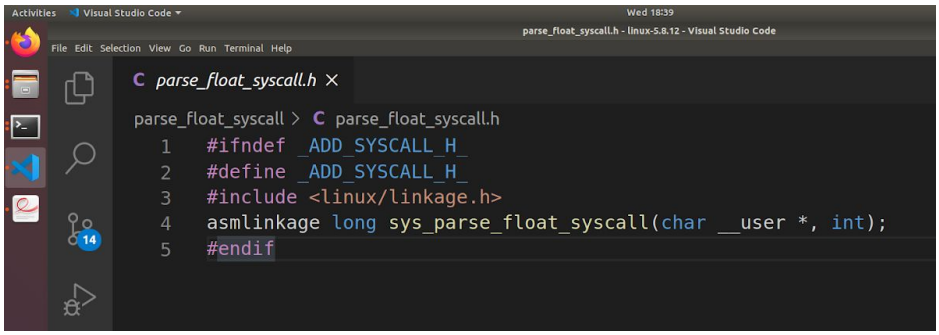
```
107
108     if(first == 0){
109         exponent = -(zeroCountTillFirstOne+1);
110     }
111     exponent += 127;
112     exponent = (exponent<<23);
113
114
115     res = sign | exponent | mantissa ;
116     return res;
117 }
```

- Combine sign, exponent and mantissa using bitwise OR and return it

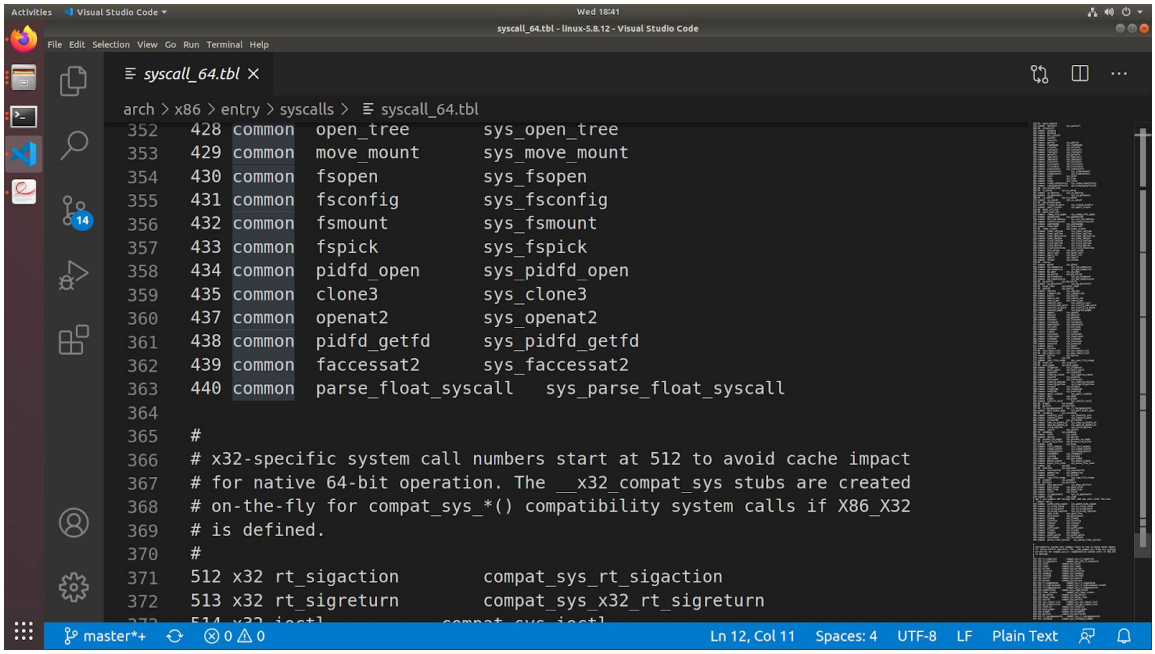
/usr/src/linux-5.8.12/parse_float_syscall/Makefile




/usr/src/linux-5.8.12/parse_float_syscall/parse_float_syscall.h

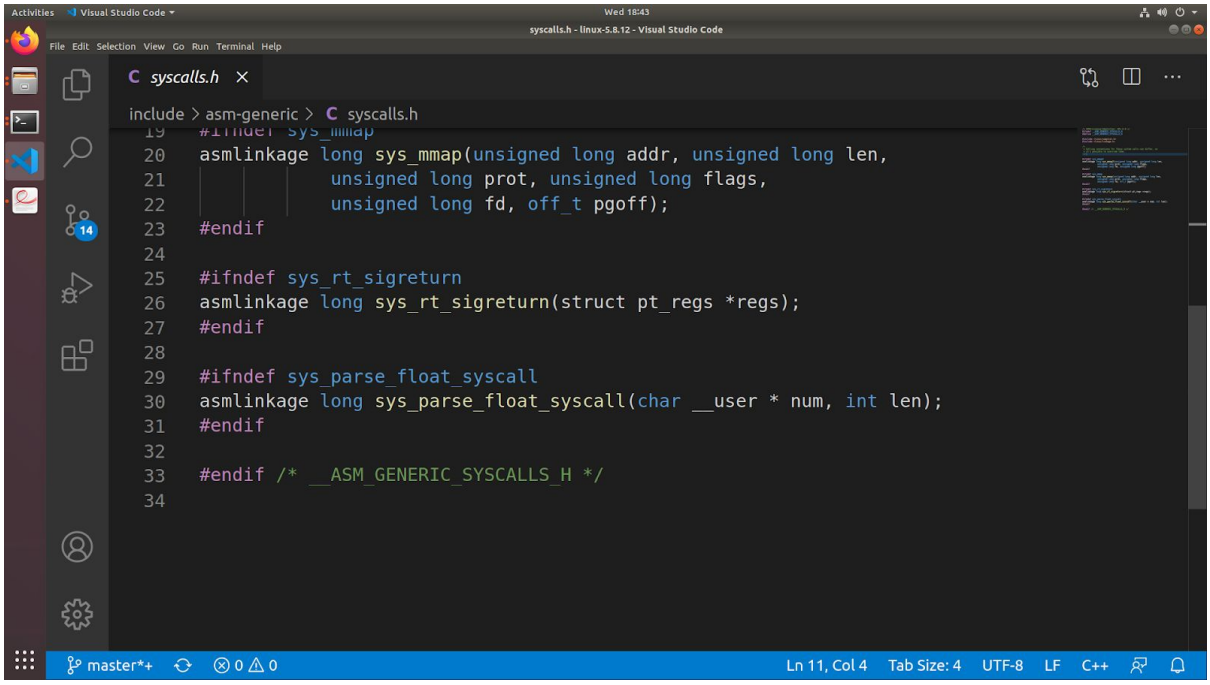



/usr/src/linux-5.8.12/arch/x86/entry/syscalls/syscall_64.tbl



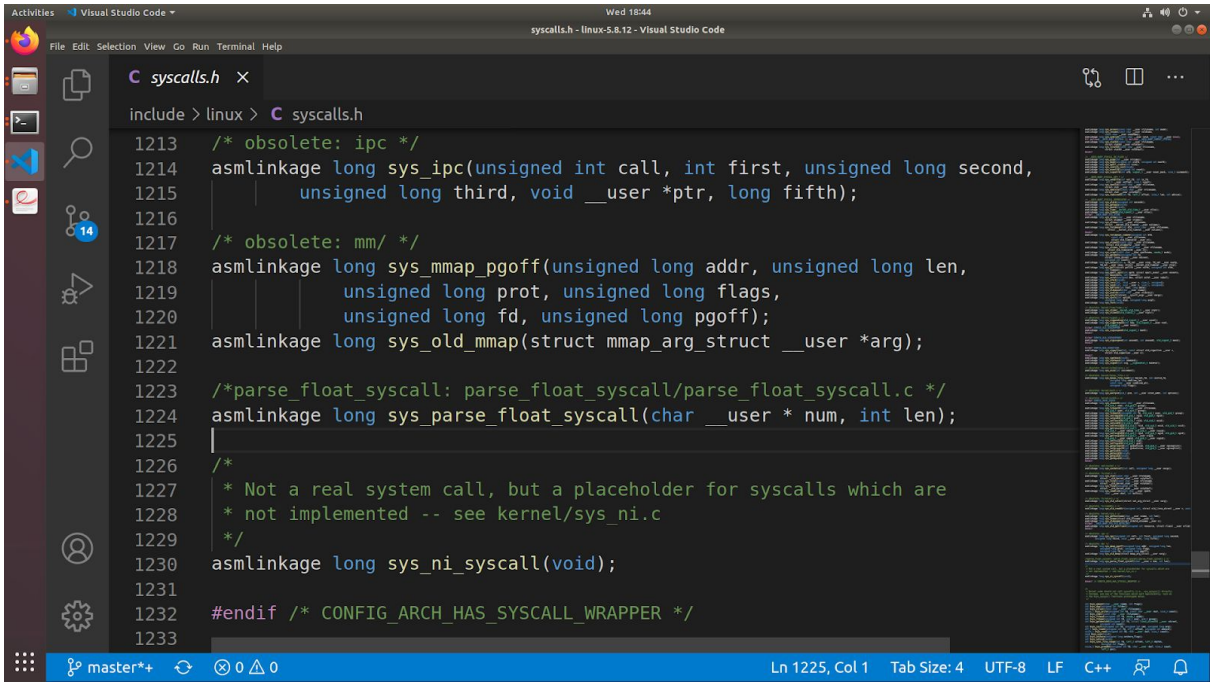

- Add sys_parse_float_syscall entry at 440 [line 363]

/usr/src/linux-5.8.12/include/asm-generic/syscalls.h



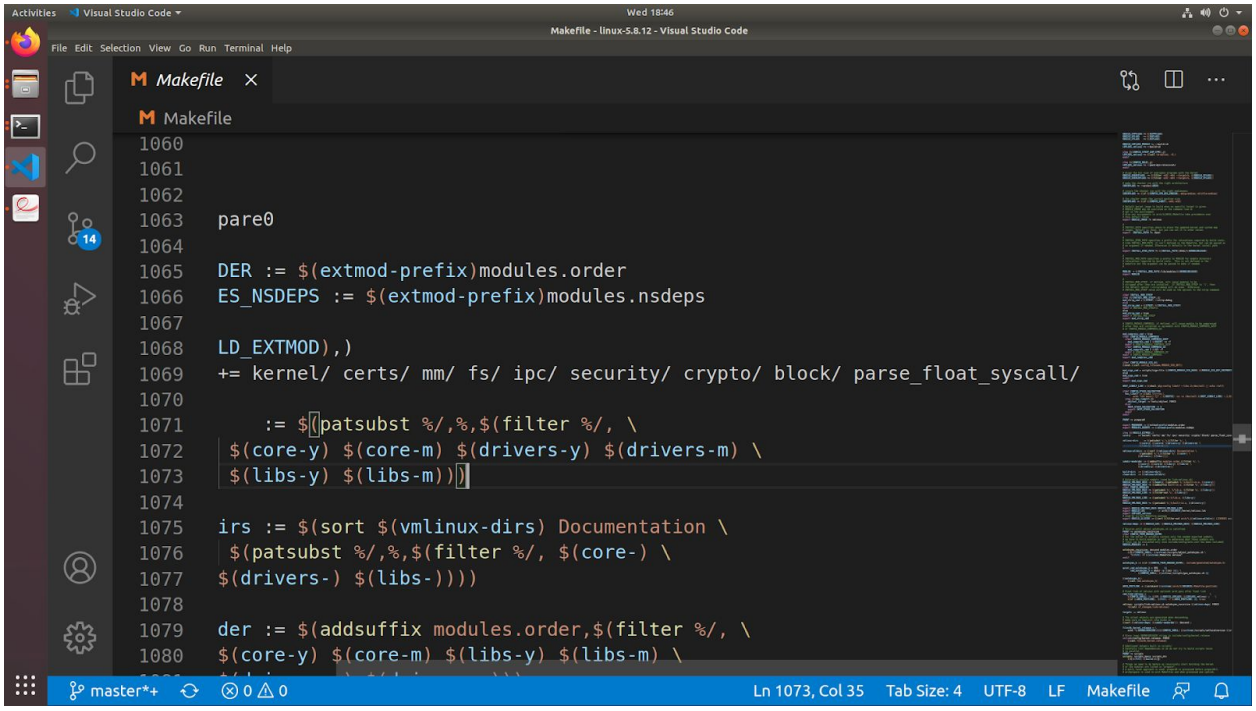

- [line 29-32]

/usr/src/linux-5.8.12/include/linux/syscalls.h



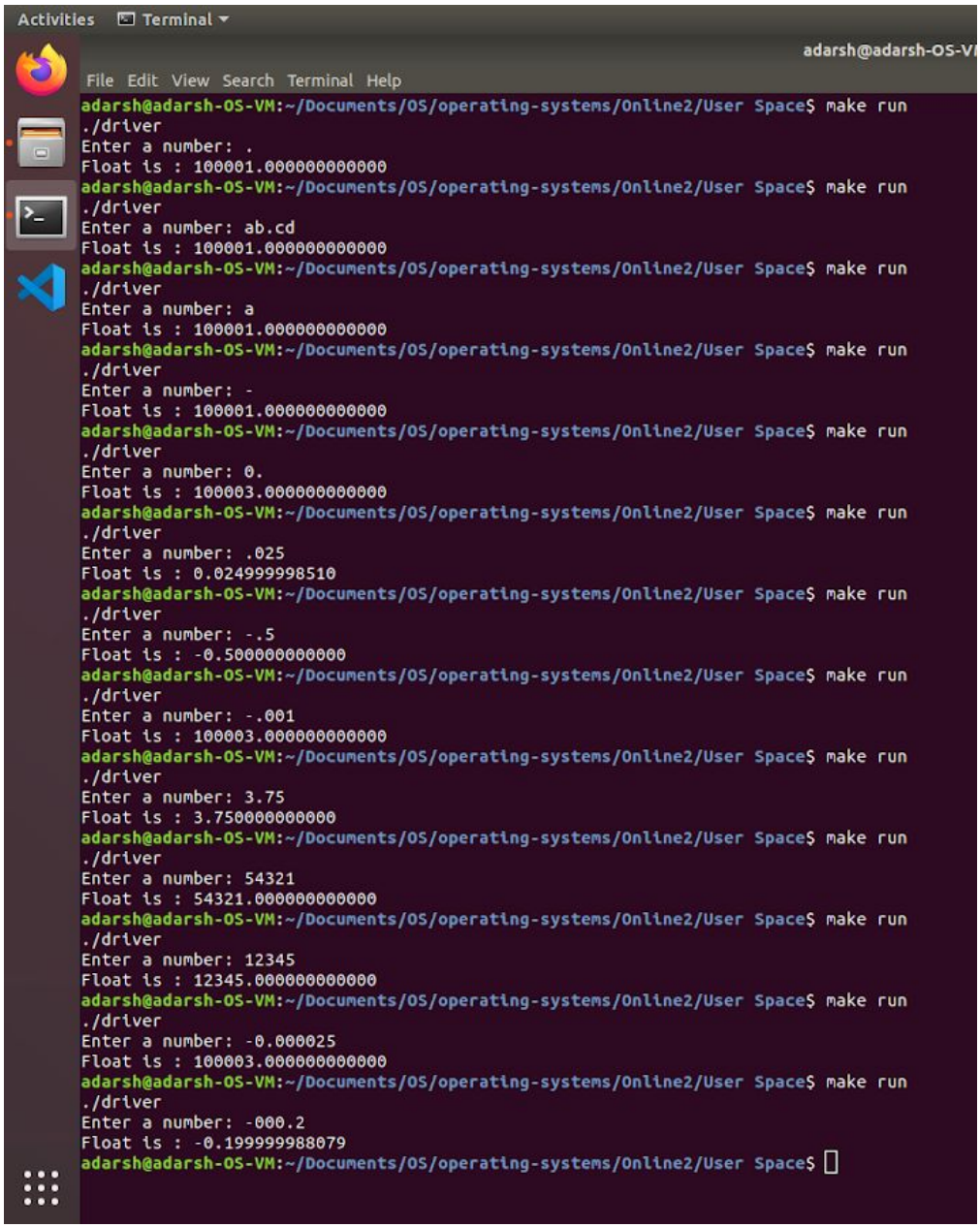

- [line 1223-1224]

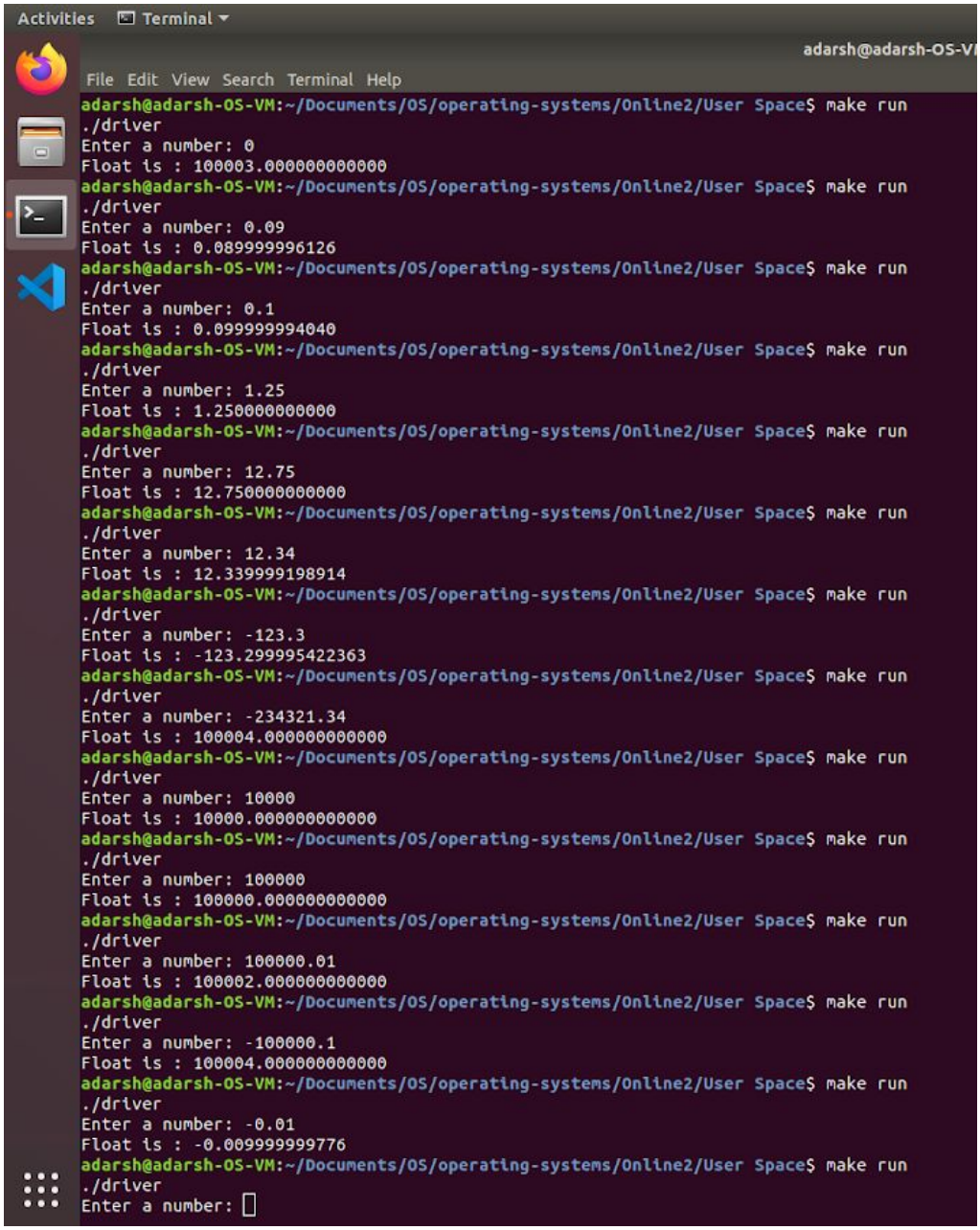
/usr/src/linux-5.8.12/Makefile




- Append parse_float_syscall/
- [line 1069]

# Test Cases


Activities
Terminal
adarsh@adarsh-OS-VM
File Edit View Search Terminal Help
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: .
Float is : 100001.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: ab.cd
Float is : 100001.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: a
Float is : 100001.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -
Float is : 100001.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 0.
Float is : 100003.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: .025
Float is : 0.024999998510
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -.5
Float is : -0.500000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -.001
Float is : 100003.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 3.75
Float is : 3.750000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 54321
Float is : 54321.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 12345
Float is : 12345.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -0.000025
Float is : 100003.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -000.2
Float is : -0.199999988079
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$


Activities
Terminal
adarsh@adarsh-OS-V
File Edit View Search Terminal Help
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 0
Float is : 100003.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 0.09
Float is : 0.089999996126
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 0.1
Float is : 0.099999994040
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 1.25
Float is : 1.250000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 12.75
Float is : 12.750000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 12.34
Float is : 12.339999198914
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -123.3
Float is : -123.299995422363
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -234321.34
Float is : 100004.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 10000
Float is : 10000.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 100000
Float is : 100000.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: 100000.01
Float is : 100002.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -100000.1
Float is : 100004.000000000000
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: -0.01
Float is : -0.009999999776
adarsh@adarsh-OS-VM:~/Documents/OS/operating-systems/Online2/User Space$ make run
./driver
Enter a number: