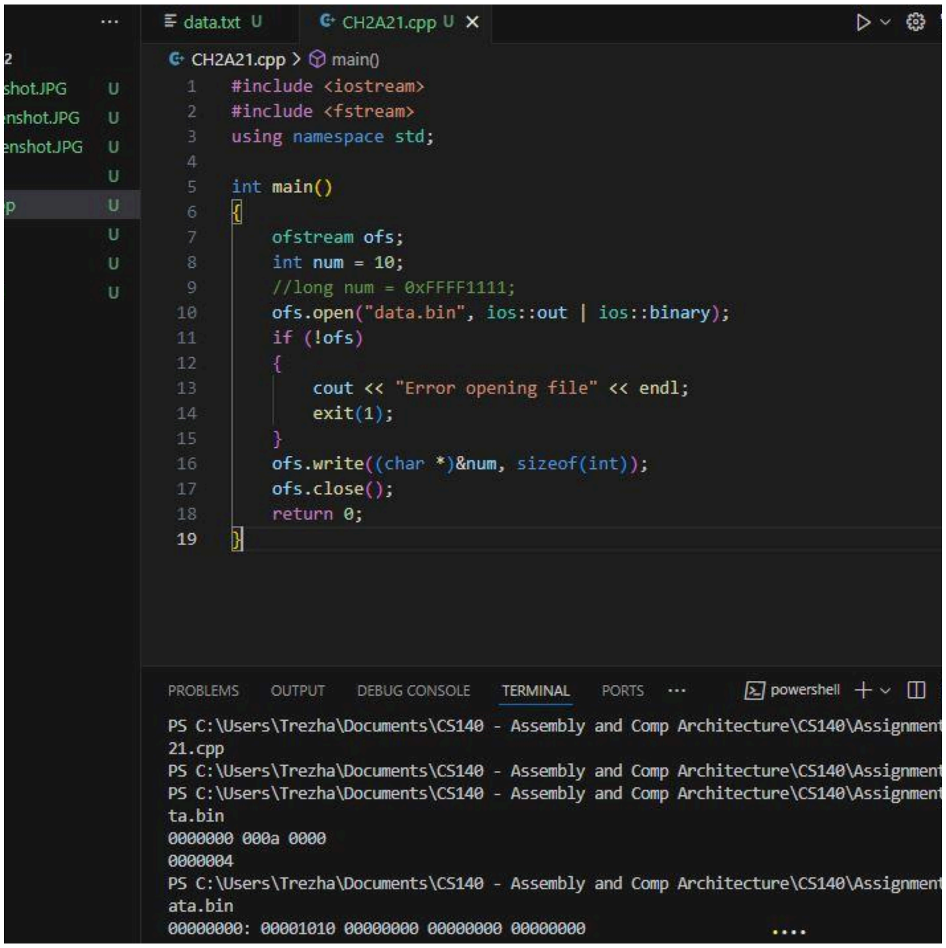
# Assignment 2-2-1 Byte Order of Integer Values

**1. Integer value 10 to the binary file.**



```cpp
#include <iostream>
#include <fstream>
using namespace std;

int main()
{
    ofstream ofs;
    int num = 10;
    //long num = 0xFFFF1111;
    ofs.open("data.bin", ios::out | ios::binary);
    if (!ofs)
    {
        cout << "Error opening file" << endl;
        exit(1);
    }
    ofs.write((char *)&num, sizeof(int));
    ofs.close();
    return 0;
}
```

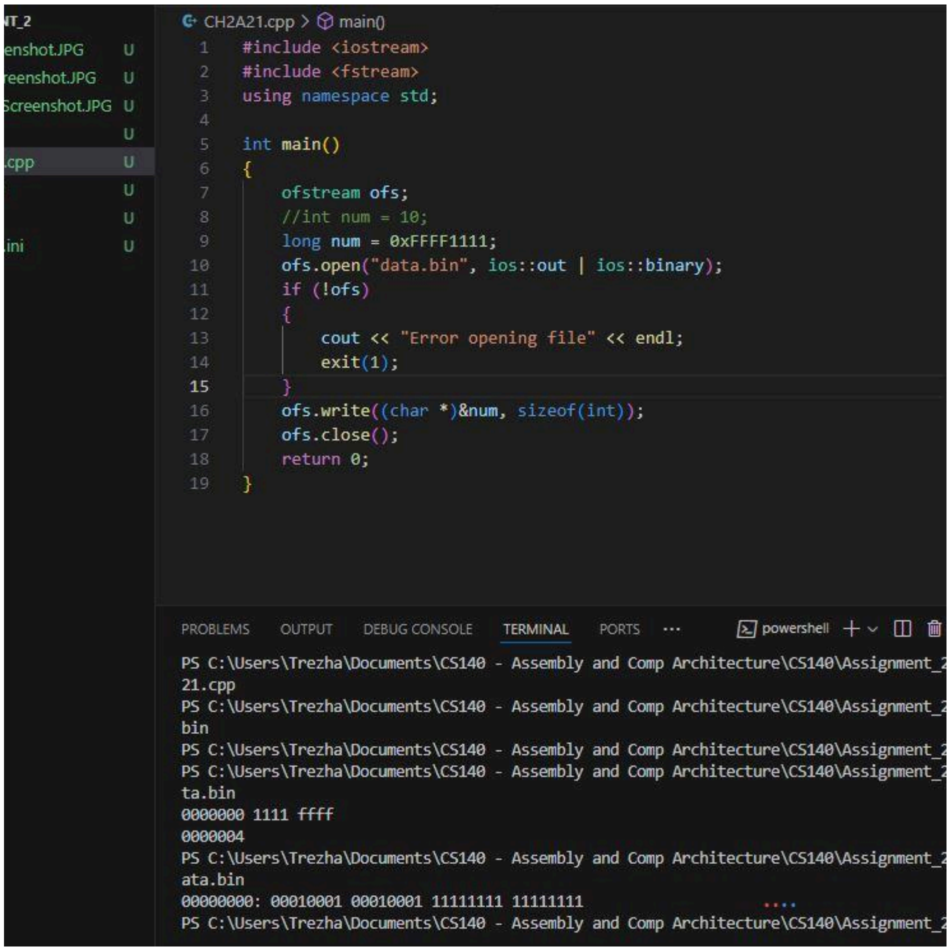
```
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment
21.cpp
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment
ta.bin
0000000 000a 0000
0000004
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment
ata.bin
00000000: 00001010 00000000 00000000 00000000          ....
```

*(Notes: xxd command is used to dump the contents of a file in various formats, like hexadecimal and binary. The -b option specifies that the output should be in binary format.*

Keep in mind: od - x typically uses little-endian*)*

**Explanation.** The output of using this command is in **Big Endian**. Because the Most significant byte(MSB) is (0a) and it's stored in the first byte (as the first pair read from right to left), ([2] 00=0000) ([1]: 0a=1010) = (1st byte = 0000 1010), followed by the remaining bytes which contain mainly 0s for padding because it's a 4 bytes, or 32 bits.

**2. Try with Hexadecimal Value**



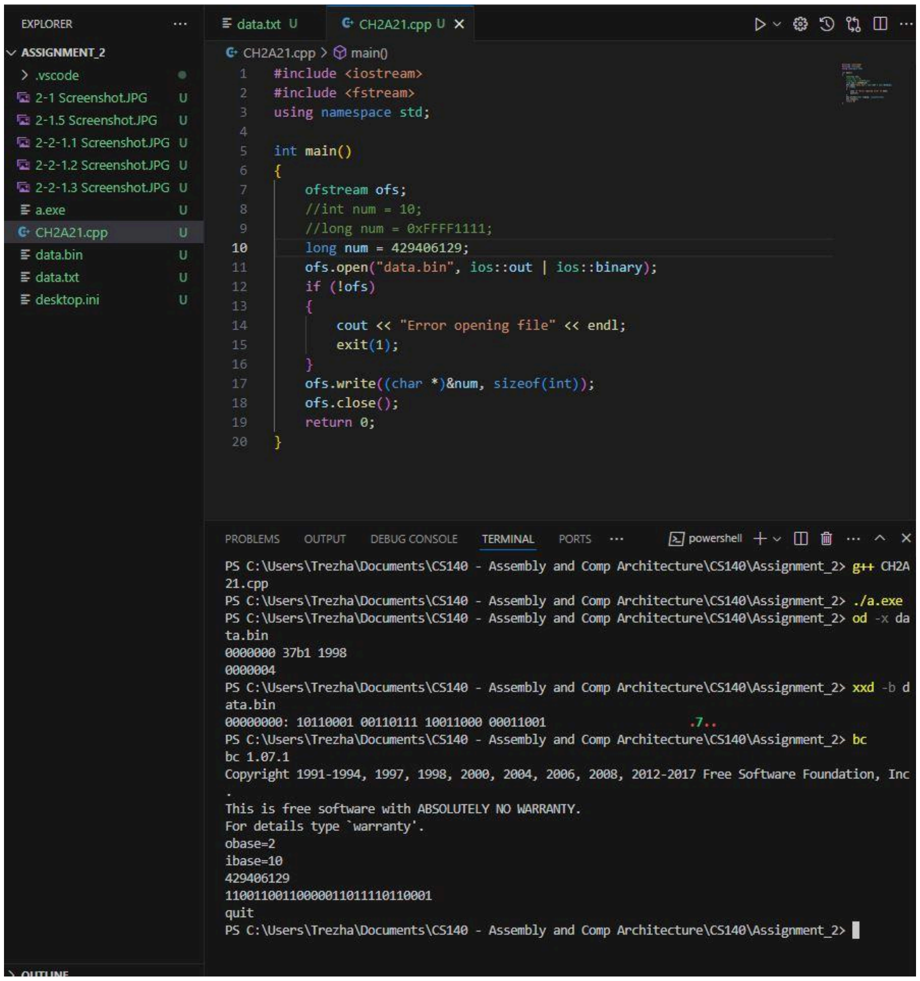
```cpp
#include <iostream>
#include <fstream>
using namespace std;

int main()
{
    ofstream ofs;
    //int num = 10;
    long num = 0xFFFF1111;
    ofs.open("data.bin", ios::out | ios::binary);
    if (!ofs)
    {
        cout << "Error opening file" << endl;
        exit(1);
    }
    ofs.write((char *)&num, sizeof(int));
    ofs.close();
    return 0;
}
```

```
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2
21.cpp
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2
bin
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2
ta.bin
0000000 1111 ffff
0000004
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2
ata.bin
00000000: 00010001 00010001 11111111 11111111                  ....
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2
```

**Explanation:** The output for the Hexadecimal value is in **Little Endian**. The MSB is FF(11111111) and it's stored in the last byte. The least significant byte (LSB) is 11(00010001) and we can see that it’s stored in the first byte. We can even see this in the output of od -x, which is 1111 ffff. The byte count is **4 bytes(32 bits in total)** which is used to store the number 0xFFFF1111 which makes sense because it's **declared as a long which allows num to be stored in 4 bytes (32 bits)**. The decimal conversion totals **4294906129**.

**3. Show the bytecode for the "num" = 429406129.**



```cpp
#include <iostream>
#include <fstream>
using namespace std;

int main()
{
    ofstream ofs;
    //int num = 10;
    //long num = 0xFFFF1111;
    long num = 429406129;
    ofs.open("data.bin", ios::out | ios::binary);
    if (!ofs)
    {
        cout << "Error opening file" << endl;
        exit(1);
    }
    ofs.write((char *)&num, sizeof(int));
    ofs.close();
    return 0;
}
```

```
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2> g++ CH2A
21.cpp
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2> ./a.exe
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2> od -x da
ta.bin
0000000 37b1 1998
0000004
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2> xxd -b d
ata.bin
00000000: 10110001 00110111 10011000 00011001                     .7..
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2> bc
bc 1.07.1
Copyright 1991-1994, 1997, 1998, 2000, 2004, 2006, 2008, 2012-2017 Free Software Foundation, Inc
.
This is free software with ABSOLUTELY NO WARRANTY.
For details type `warranty'.
obase=2
ibase=10
429406129
11001100110000011011110110001
quit
PS C:\Users\Trezha\Documents\CS140 - Assembly and Comp Architecture\CS140\Assignment_2>
```

**a.)** Num uses 4 bytes (32 bits).
**b.)** No, they are in different Endians. There's also 3 bits missing but these bits aren't included in BC's output because they were at the front of the binary and leading bits that are 0 aren't included. But if we were to include them back in, we can see the pattern and what kind of endian the system uses.
[n] - endian order

| | | | | |
|---|---|---|---|---|
| BC | [6]**000**1 [5]1001 | [8]1001 [7]1000 | [2]0011 [1]0111 | [4]1011 [3]0001 |
| Xxd -b | [4]1011 [3]0001 | [2]0011 [1]0111 | [8]1001 [7]1000 | [6]0001 [5]1001 |

Od -x data.bin = **37b1** **1998**. What each "nibble"(4 bits) represents
Keep in mind: od - x typically uses little-endian so don't forget MSB and LSB are switched

| | 1st Byte (LSB) | | 2nd Byte | | 3rd Byte | | 4th Byte (MSB) | |
|---|---|---|---|---|---|---|---|---|
| Hex # | 3 | 7 | b | 1 | 1 | 9 | 9 | 8 |
| Bits | 0011 | 0111 | 1011 | 0001 | 0001 | 1001 | 1001 | 1000 |

Therefore, we can see how real **binary numbers (BC) uses Big Endian while xxd -b uses Little Endian.**