Assignment 1: Bit Operation

Modify the provided skeleton code and implement the following five functions in C as shown below.

- Do not modify function declaration.
- Do not use C++. Your code has to be compiled with the up-to-date gcc. (e.g., version 7 or above)
- You should use bit operations to solve the problems.
- You can not use any C library functions other than malloc and free. Do not include any other header files.
- All the implementation should be executed without any error if there is no assumption, e.g., your implementation should check all corner cases that may cause segmentation faults.
- Assume the "pointer" type is defined as "unsigned char *". (Provided with the skeleton)

```
void reverse_bit(pointer a, int len); (2pt)
void split_bit(pointer a, pointer out1, pointer out2, int len); (2pt)
unsigned int mul_four_plus_one(unsigned int a); (2pt)
unsigned int convert_endian(unsigned int a); (2pt)
void get_date(unsigned int date, int* pYear, int* pMonth, int* pDay);  (2pt)
```

Due

Submit your implementation before Apr 15, Friday, 11:59:59pm, to LMS. We DO NOT allow late submission.

Submission

Submit the c file that has your implementation. You have to implement all the functions in a single c file. Before the submission, rename the c file with this format: "hw1_YOURSTUDENTID.c". For example, "hw1_200012345.c"

Function Specification

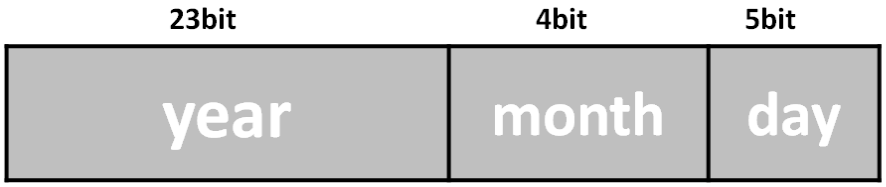
1. void reverse_bit(pointer a, int len);
    a. Reverse the bit order for the data stored in a
    b. e.g., for two-byte data, a = 1111000010111101(2), the function manipulates it by 1011110100001111(2).
    c. Parameters:
        i. a: data to be reversed (byte array)
        ii. size: the size of a in bytes

2. void split_bit(pointer a, pointer out1, pointer out2, int len);
    a. For the data stored in a, take all odd bits and store it into out1 / take all even bits and store it into out2
    b. e.g., for e.g., for two-byte data, a = 1111000010111101(2), the function stores 11001110(2) and 11000111(2) to out1 and out2, respectively.
    c. Assume the length of a, i.e., len, is multiplies of 2. Also assume that the byte lengths in out1 and out2 are len/2.
    d. Parameters:
        i. a: data to be split (byte array)
        ii. out1 / out2: odd/even bits as the outputs
        iii. len: the size of a in bytes

3. unsigned int mul_four_plus_one(unsigned int a);
    a. Implement a*4 +1 only using shift & bitwise operations
    (i.e., DO NOT USE any arthmetic operation like +, -, *, /)
    b. Return the result of a*4+1
    c. Assume there is no overflow issue (i.e., the variable a is small enough, so not creates any overflow issues in computing a*4+1)
    d. Parameters:
        i. a: the unsigned integer value to be computed

4. unsigned int conver_endian(unsigned int a);
    a. Convert the endian of the data given in the variable a to the other way
    b. For example, assuming that a is formatted with the little endian, you can change it to the big endian, or vice versa
    c. e.g., for a = 0x12345678, the return value will be 0x78563412
    d. Parameters:
        i. a: the unsigned integer value to be converted

5. void get_date(unsigned int date, int* pYear, int* pMonth, int* pDay);
    a. Assume the date is encoded with an unsigned integer, date, as follows:



[32bit]

    b. Decode it and store the results into pYear, pMonth and pDay.

Sample

Note: We will check with other example inputs for grading.

Sample Code

```c
int main() {
    printf("Problem 1\n");
    unsigned int v1 = 0x1234CDEF;
    print_bit((pointer)&v1, sizeof(v1));
    reverse_bit((pointer)&v1, sizeof(v1));
    print_bit((pointer)&v1, sizeof(v1));


    printf("Problem 2\n");
    unsigned int v2 = 0x1234CDEF;
    unsigned short out1 = 0, out2 = 0;
    print_bit((pointer)&v2, sizeof(v2));
    split_bit((pointer)&v2, (pointer)&out1, (pointer)&out2, sizeof(v2));
    print_bit((pointer)&out1, sizeof(out1));
    print_bit((pointer)&out2, sizeof(out2));


    printf("Problem 3\n");
    unsigned int v3 = 100;
    unsigned int v3_ret = mul_four_plus_one(v3);
    printf("%u*4+1 = %u\n", v3, v3_ret);
    print_bit((pointer)&v3, sizeof(v3));
    print_bit((pointer)&v3_ret, sizeof(v3_ret));


    printf("Problem 4\n");
    unsigned int v4 = 0x12345678;
    unsigned int v4_ret = convert_endian(v4);
    print_bit((pointer)&v4, sizeof(v4));
    print_bit((pointer)&v4_ret, sizeof(v4_ret));


    printf("Problem 5\n");
    unsigned int date = 1035391;
    int year, month, day;
    print_bit((pointer)&date, sizeof(date));
    get_date(date, &year, &month, &day);
    printf("%d -> %d/%d/%d\n", date, year, month, day);

    return 0;
}
```

Output

```
Problem 1
11101111 11001101 00110100 00010010
01001000 00101100 10110011 11110111
Problem 2
11101111 11001101 00110100 00010010
11111010 01000001
10111011 01100100
Problem 3
100*4+1 = 401
01100100 00000000 00000000 00000000
10010001 00000001 00000000 00000000
Problem 4
01111000 01010110 00110100 00010010
00010010 00110100 01010110 01111000
Problem 5
01111111 11001100 00001111 00000000
1035391 -> 2022/3/31
```