NEW YORK CITY COLLEGE OF TECHNOLOGY

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LAB REPORT

CET 3510 – OL71

(MICROCOMPUTER SYSTEMS TECHNOLOGY LABORATORY)

LAB #7

Bit Manipulation

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Due Date: 11/21/21

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Objective:

The objective of this lab is to examine bit manipulation because bit manipulation is based on using bitwise AND operation, bitwise OR operation, bitwise XOR operation, bitwise NOT operation, bit shift left and right operation. This lab allows us to utilize bit manipulation instructions such as setting bits, clearing bits, inverting bits, extracting bits from a bit string and inserting bits in a bit string.

Materials:

- Microsoft Visual Studio C++ Community Edition 2019

Procedure:

1. First, open Microsoft Visual Studio C++ Community Edition 2019
2. Then, type program#1, compile and run the program.
3. Then modify the code.
4. Lastly, analyze the output.

Code:

```
#include <stdio.h>
#include <iostream>
#include <bitset>
#include <time.h>
using namespace std;
int main()
{
    unsigned short packedDate;
    unsigned char m;
    unsigned char d;
    unsigned char y;
    int count = 0;
    //randomize seed
    srand(time(0));
    //generate a random number between 1 and 12
    unsigned char month = (unsigned char)rand() % 12 + 1;
    //generate a random number between 1 and 31
    unsigned char day = (unsigned char)rand() % 31 + 1;
    //generate a random number between 0 and 255
    unsigned char year = (unsigned char)rand() & 0xff;
    //generate a random number between 0 and 100
    while (year > 100 || year < 0)
    {
        year = (unsigned char)rand() & 0xff;
        count++;
    }
    cout << "The value of the loop counter to generate the year between 0 and 100:" << dec << count << endl;
    cout << "---------------------------------" << endl;
    cout << "The generated month, day, and year (in decimal format) are:\n";
    printf("%u\t%u\t%u\n", month, day, year);
    cout << "The generated month, day, and year (in hexadecimal format) are:\n";
    printf("0x%x\t0x%x\t0x%x\n", month, day, year);
    bitset<8> monthBits(month);        //convert month to an 8 bits to store
    cout << "month bits:\t" << monthBits << endl;    //display binary bits
    bitset<8> dayBits(day);            //convert day to an 8 bits to store
    cout << "day bits:\t" << dayBits << endl;    //display binary bits
    bitset<8> yearBits(year);          //convert year to an 8 bits to store
    cout << "year bits:\t" << yearBits << endl;    //display binary bits
    _asm
    {
        mov BL, month;
        shl BX, 5;
        or BL, day;
        shl BX, 7;
        or BL, year;
        mov packedDate, BX;
    }
    cout << "=================================" << endl;
    cout << "The packed date in hexadecimal is\t\0x" << hex << packedDate << endl;
    //convert packetDate to a 16 bit number to store in a bitset
    bitset<16> packetBits(packedDate);
    cout << "packed date:\t" << packetBits << endl;  //display binary bits
    cout << "=========================================" << endl;
```

```
54      _asm
55      {
56          mov AX, packedDate;
57          and AX, 0xf000;          //extracting month bits to use mask away
58          rol AX, 4;               // rotate left four positions
59          mov m, AL;               //move month bits to m
60          mov AX, packedDate;
61          and AX, 0x0f80;          //extracting day bits to use mask away
62          ror AX, 7;               //rotate right 7 positions
63          mov d, AL;               //move day bits to d
64          mov AX, packedDate;
65          and AX, 0x007f;          //extracting year bits to use mask away
66          mov y, AL;
67      }
68      cout << "The retrieved month, day, and year from bit string (in decimal format) are:\n";
69      printf("%u\t%u\t%u\n", month, day, year);
70      cout << "The retrieved month, day, and year from bit string (in hexadecimal format) are:\n";
71      printf("0x%x\t0x%x\t0x%x\n", month, day, year);
72      system("pause");
73      exit(0);
74  }
```

Output:

```
The value of the loop counter to generate the year between 0 and 100:2
==================================
The generated month, day, and year (in decimal format) are:
3       14      96
The generated month, day, and year (in hexadecimal format) are:
0x3     0xe     0x60
month bits:     00000011
day bits:       00001110
year bits:      01100000
================================
The packed date in hexadecimal is       3760
packed date:    0011011101100000
========================================
The retrieved month, day, and year from bit string (in decimal format) are:
3       14      96
The retrieved month, day, and year from bit string (in hexadecimal format) are:
0x3     0xe     0x60
Press any key to continue . . .
```

Conclusion:

Throughout this lab, I learned about the concepts of bit manipulation and how to examine and utilize them in C++ and Assembly programming. Most importantly, I wrote a program to pack and unpack bit strings and to display the output in the decimal format, hexadecimal format and performed bit manipulation instructions.