Autumn 2023, ISTM, Purdue-FCU 2+2 ECE Program
ISTM116 Programming Applications for Engineers, Midterm Exam

Use file name mexam_Dxxxxxxx_1.c for Question 1, file name mexam_Dxxxxxxx_2.c for Question 2, and file name mexam_Dxxxxxxx_3.c for Question 3 of your source code， where Dxxxxxxx is your student ID. When you finish a question, submit the source code files to the instructor's computer.

1. (35 points) You may start with program skeleton **mexam_skeleton_1.c** and change the file name to **mexam_Dxxxxxxx_1.c**. Consider a linear equation system of n variables, i.e., n linear equations of n variables, where $1 \le n \le 9$:

$$A_{0,0}\,X_0 + A_{01}\,X_1 + \ldots + A_{0,n-1}\,X_{n-1} = C_0$$
$$A_{1,0}\,X_0 + A_{1,1}\,X_1 + \ldots + A_{1,n-1}\,X_{n-1} = C_1$$
$$\ldots$$
$$A_{n-1,0}\,X_0 + A_{n-1,1}\,X_1 + \ldots + A_{n-1,n-1}\,X_{n-1} = C_{n-1}$$

Write a C program to perform the following steps:

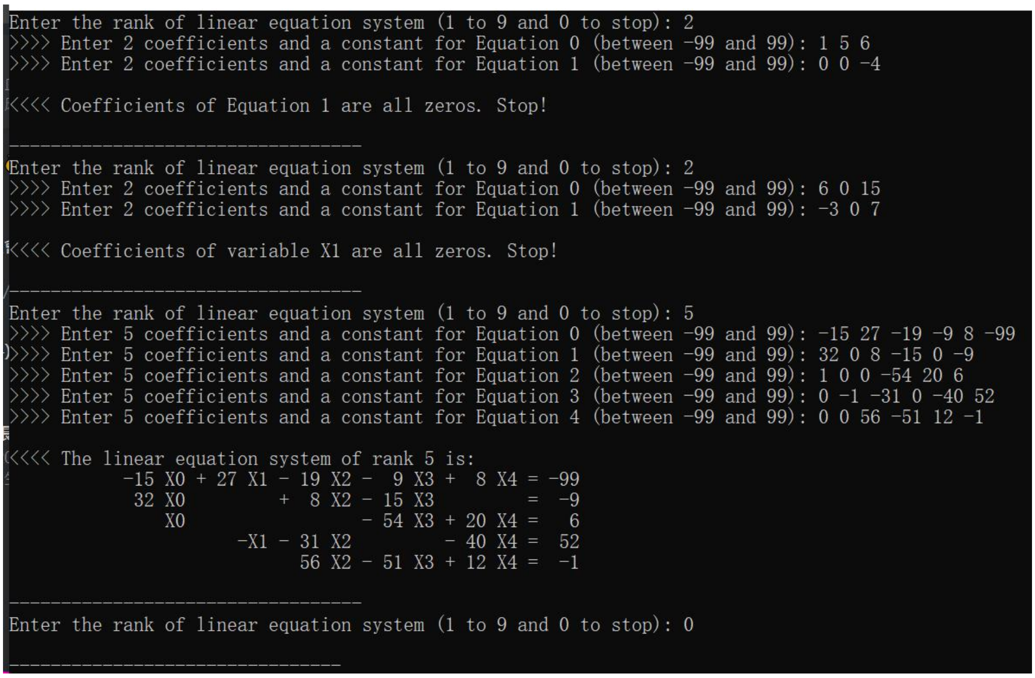
(1) Declare integer arrays A[9][9] for coefficients and C[9] for constants (the maximum value of n is 9).

(2) Input the rank of the linear equation system n, where $1 \le n \le 9$.

(3) For equation i, $A_{i,0}\,X_0 + A_{i,1}\,X_1 + \ldots + A_{i,n-1}\,X_{n-1} = C_i$, where $0 \le i \le n-1$, input n integers of coefficients and a constant to store them in A[i][j] and C[i], where $0 \le j \le n-1$, such that $-99 \le$ A[i][j], C[i] ≤ 99. Verify that (a) there is no equation with all zero coefficients, and (b) there is no variable X_j with all zero coefficients.

(4) Print the linear equation one equation in a line, leave 10 leading blanks before each equation. For each equation, print all terms in the way that (a) if a term is of coefficient zero, print blanks only, (b) if a term is the first non-zero coefficient term in an equation, do not print its operator, but print only the coefficient value and its variable name, (c) if a coefficient is either 1 or -1, omit the coefficient value and print operator '+' or '-', blanks, and its variable name, (d) for coefficients other than 0, 1, and -1, print '+' or '-', coefficient value without sign, and its variable name, (e) Align operators '+' or '-' for the terms of the same X_i and '=' in the vertical direction.

Repeat steps (2) to (4) until the value of n is 0. (Hint: Each term should have the same number of characters including spaces, e.g., 8.) Example of program execution:



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Enter the rank of linear equation system (1 to 9 and 0 to stop): 2
>>>> Enter 2 coefficients and a constant for Equation 0 (between -99 and 99): 1 5 6
>>>> Enter 2 coefficients and a constant for Equation 1 (between -99 and 99): 0 0 -4

<<<< Coefficients of Equation 1 are all zeros. Stop!

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Enter the rank of linear equation system (1 to 9 and 0 to stop): 2
>>>> Enter 2 coefficients and a constant for Equation 0 (between -99 and 99): 6 0 15
>>>> Enter 2 coefficients and a constant for Equation 1 (between -99 and 99): -3 0 7

<<<< Coefficients of variable X1 are all zeros. Stop!

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Enter the rank of linear equation system (1 to 9 and 0 to stop): 5
>>>> Enter 5 coefficients and a constant for Equation 0 (between -99 and 99): -15 27 -19 -9 8 -99
>>>> Enter 5 coefficients and a constant for Equation 1 (between -99 and 99): 32 0 8 -15 0 -9
>>>> Enter 5 coefficients and a constant for Equation 2 (between -99 and 99): 1 0 0 -54 20 6
>>>> Enter 5 coefficients and a constant for Equation 3 (between -99 and 99): 0 -1 -31 0 -40 52
>>>> Enter 5 coefficients and a constant for Equation 4 (between -99 and 99): 0 0 56 -51 12 -1

<<<< The linear equation system of rank 5 is:
           -15 X0 + 27 X1 - 19 X2 -  9 X3 +  8 X4 = -99
            32 X0         +  8 X2 - 15 X3         =  -9
               X0                 - 54 X3 + 20 X4 =   6
                      -X1 - 31 X2         - 40 X4 =  52
                            56 X2 - 51 X3 + 12 X4 =  -1

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Enter the rank of linear equation system (1 to 9 and 0 to stop): 0

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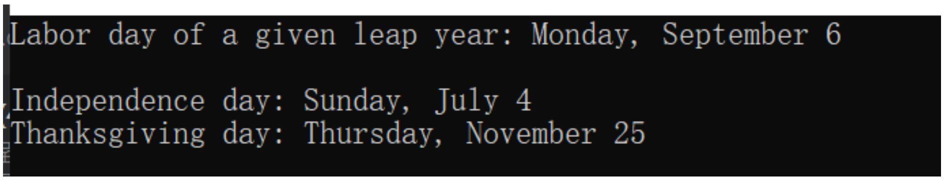
(to be continued)

2. (30 points) You may start with program skeleton **mexam_skeleton_2.c** and change the file name to **mexam_Dxxxxxxx_2.c**. Consider holidays in the United States of America. In a given *leap* year, Labor day (the first Monday in September) is September 6. Write a C program to compute and print the following days of that year:
   (a) Independence day, July 4,
   (b) Thanksgiving day, the forth Thursday in November.

   Example of program execution:



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Labor day of a given leap year: Monday, September 6

Independence day: Sunday, July 4
Thanksgiving day: Thursday, November 25
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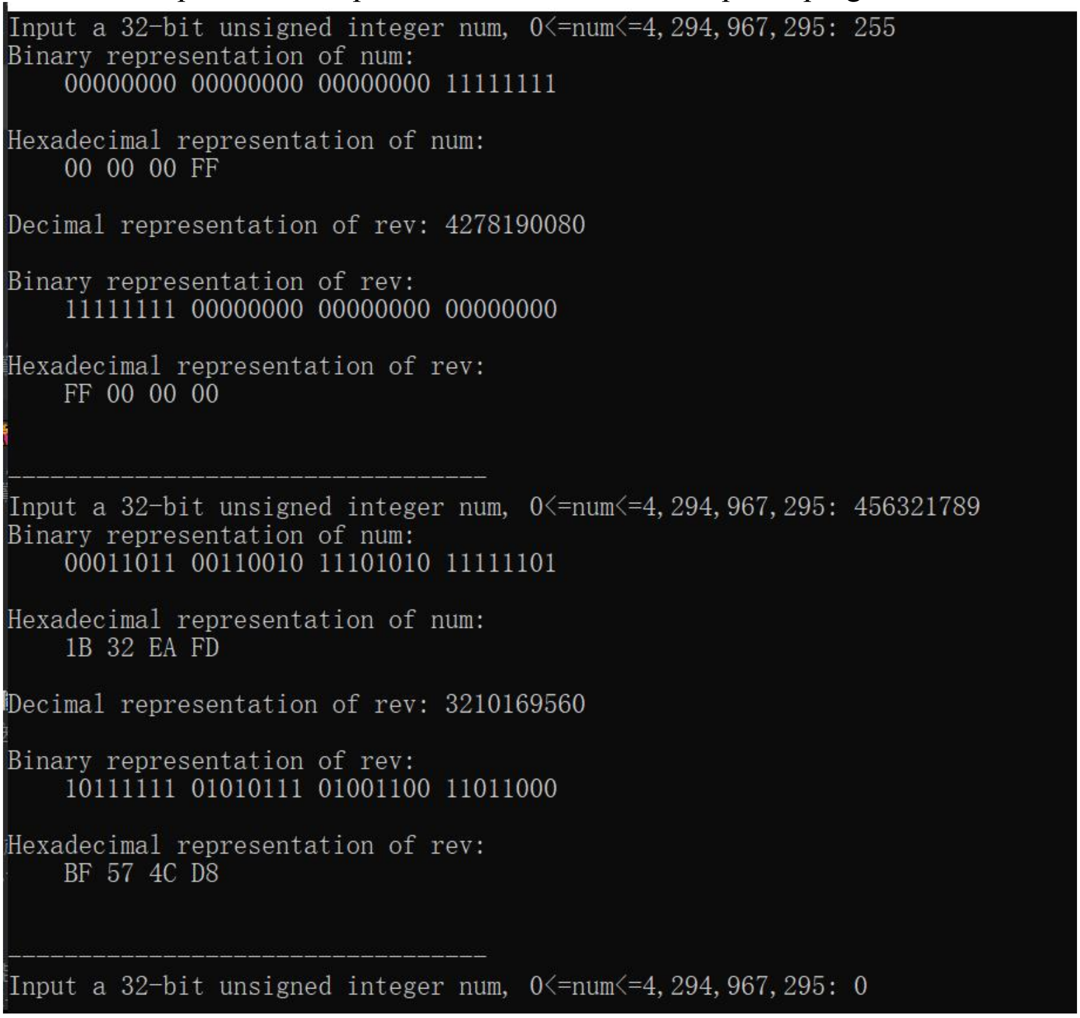
(to be continued)

3. (35 points) You may start with program skeleton **mexam_skeleton_3.c** and change the file name to **mexam_Dxxxxxxx_3.c**. Given a 32-bit binary stream $b_{31}b_{30}\ldots b_1b_0$, its ***bit reversal*** is defined as $b_0b_1\ldots b_{30}b_{31}$. Write a C program to perform the following computing steps:
   a. Input a 32-bit non-negative integer num, i.e., $0 \le num \le 4{,}294{,}967{,}295$.
   b. Print num in its binary representation, a space after every 8 bits.
   c. Print num in its hexadecimal representation, print a space after every 2 digits.
   d. Assign rev to be the bit reversal of num.
   e. Print rev in its decimal representation.
   f. Print rev in its binary representation, a space after every 8 bits.
   g. Print rev in its hexadecimal representation, print a space after every 2 digits.

Repeat the above steps until the input value of num is 0. Example of program execution:



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Input a 32-bit unsigned integer num, 0<=num<=4,294,967,295: 255
Binary representation of num:
    00000000 00000000 00000000 11111111

Hexadecimal representation of num:
    00 00 00 FF

Decimal representation of rev: 4278190080

Binary representation of rev:
    11111111 00000000 00000000 00000000

Hexadecimal representation of rev:
    FF 00 00 00


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Input a 32-bit unsigned integer num, 0<=num<=4,294,967,295: 456321789
Binary representation of num:
    00011011 00110010 11101010 11111101

Hexadecimal representation of num:
    1B 32 EA FD

Decimal representation of rev: 3210169560

Binary representation of rev:
    10111111 01010111 01001100 11011000

Hexadecimal representation of rev:
    BF 57 4C D8


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Input a 32-bit unsigned integer num, 0<=num<=4,294,967,295: 0
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