1. (20 %) An 8-bit ALU with registers R1, R2, and R3 (also 8 bits) has the instructions listed below.

Instruction		
ADD Ri, Rj	Ri+Rj →C•Ri	addition, C is a carry bit, i,j=1, 2, or 3, i≠j
ADDC Ri, Rj	Ri+Rj+C→ C•Ri	add with previous carry bit(as LSB); i,j= 1, 2, or 3, i≠j
SETC	1 →C	set carry
CLRC	0 →C	clear carry
AND Ri, Rj	Ri ∧Rj→Ri	Logic AND, i,j= 1, 2, or 3, i≠j
XOR Ri, Rj	Ri⊕Rj→Ri	Logic exclusive-or, i,j= 1, 2, or 3, i≠j
LD Ri, Int	Integer →Ri	Immediate mode, i = 1, 2, or 3
LD Ri, Rj	Rj→Ri	data transfer, i,j = 1, 2, or 3, i≠j

(a) If R2 and R1 store 1's complement numbers A and B, respectively, how do you perform R2= A-B by write a program using the instructions listed above?

(b) If R2 and R1 store 2's complement numbers A and B, respectively, how do you perform R2= A-B by write a program using the instructions listed above?

2. (20%) One commonly used method for accessing I/O devices is through interrupts. Interrupts and bus arbitration require means for selecting one of several requests based on their priority. Please design a circuit that implements a rotating-priority scheme for a processor that has four interrupt input lines, REQ1 through REQ4. Initially, REQ1 has the highest and REQ4 the lowest priority. After some line receives service, it becomes the lowest priority line, and the next line receives the highest priority. For example, after REQ2 has been serviced, the priority order, starting with the highest, becomes REQ3, REQ4, REQ1, and REQ2. Your circuit should generate four output grant signals, GR1 through GR4, one for each input request line. One of these outputs should be asserted when a pulse is received on a line called DECIDE.

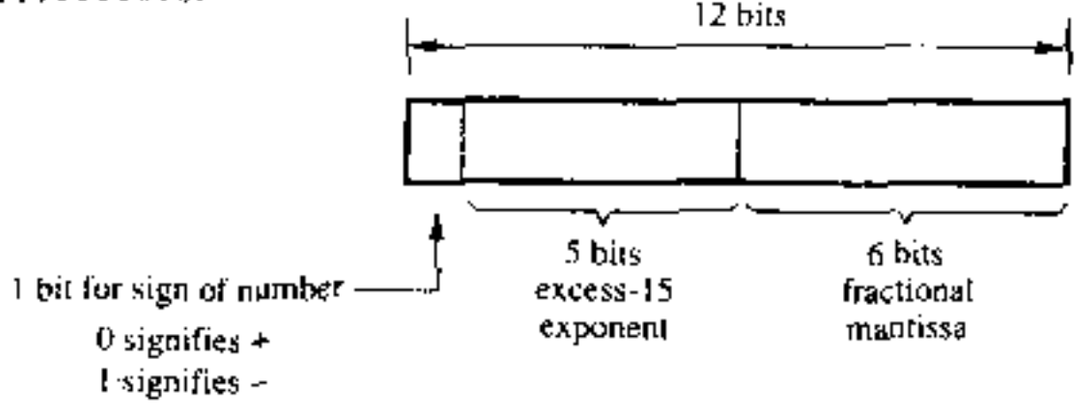
3 (20%) Consider that floating-point numbers are represented in a 12-bit format as shown below. The scale factor has an implied base of 2 and a 5-bit, excess-15 exponent, with the two end value of 0 and 31 used to signify exact 0 and infinity, respectively. The 6-bit mantissa is normalized as in the IEEE format, with an implied 1 to the left of the binary point.

(a) Represent the numbers +1.7, -0.012, +19, and 1/8 in this format.

(b) What are the smallest and largest numbers representable in this format?

(c) How does the range calculated in (b) compare to the ranges of a 12-bit signed integer and a 12-bit signed fraction?

(d) Perform Add and Multiply operations on the operands: A = 010001011011, B=101111101010.



4. (20%) A computer has 32 pages of virtual address space but only 4 page frames in main memory. Initially, the main memory is empty. A program references the virtual pages in the order

0, 3, 2, 3, 5, 7, 8, 2, 4

(a) Make a list to show page faults with LRU, and

(b) Make a list to show page faults with FIFO.

5. (20%) Stack addressing is also called LIFO (last-in-first-out) addressing. Consider the following code segment using stack addressing. The code segment performs arithmetic operations on the inputs and store the final result to the output.

```
push a
push b
add
push c
push d
add
multiply
push e
push f
add
divide
pop y
```

(a) Give the reversed Polish notation for the arithmetic operations performed by the code segment.

(b) What is the value of y after the code segment has been executed?

(c) The stack is frequently used in computer systems. Give an example application (other than arithmetic expressions as shown above) where stack is used. Give a brief description—code segment is not required.