Question 1 (2 points)
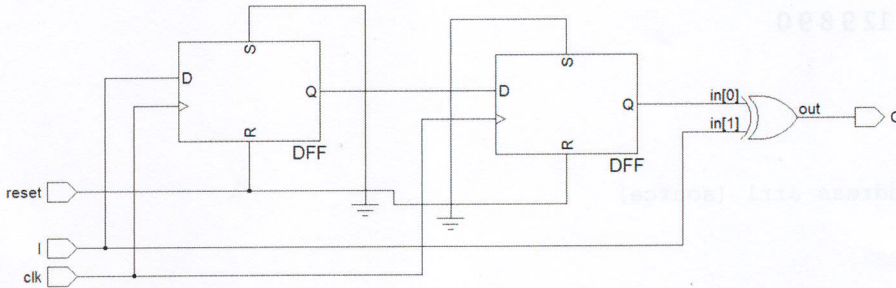
$$f(A, B, C, D) = \sum (8,9,10,12) + \sum_{d} (0,2,13)$$

Q1: Simplify function f in sum-of-products form

Question 2 (1 + 1 points)

Q1: Is this a MOORE or a MEALY machine?
Q2: How many states does the FSM of this machine have?

Question 3 (1 + 1 + 1 points)
Given is a normalized floating point representation in base 2. The bit pattern from left to right is:
- Sign bit: 1 bit (1 is negative, 0 is positive),
- Exponent field: 10 bits in excess 15,
- Fraction field: 21 bits (not included is the hidden bit). Point is right of hidden bit.

When the exponent field is filled with all zeros, the representation is not normalized. In that case the decimal number 0 is represented, independent of the sign and fraction field.

Q1: What is the bit pattern of the decimal number **-9**.
Sign bit:
Exponent field:
Fraction field:

Question 4 (2 + 2 points)

Present state	Next state		Output
	$\bar{X}$	X	Z
S0	S3	S1	0
S1	S2	S2	0
S2	S1	S3	0
S3	S0	S0	1

For the encoding of this state machine two D flip-flops are used (F1, F0) with S0=00, S1=01, S2=10 and S3=11.
Q1: Give a minimal SOP form for the data input of flip-flop F1 (i.e. DF1=f(X,F1,F0))
Q2: Give a minimal SOP form for the output Z

Question 5 (2 points)
Give the machine code in HEX of the ARC instruction
srl %r1, 10, %r3

Question 6 (5 points)

An array of integers (an integer has a size of 4 bytes) is to be copied from location with start address 100 (decimal) to address 200 (decimal). Negative numbers are not copied!

The end of the array is terminated with integer 0. The number of elements of the array is less than 20 integers (you do not have to check the maximum length in your program).

You may only use the subset instruction (documentation page 2; fig 5-2).

An example:

Original array begins at address 100: 12 -4 9 8 -23 9 0

After the copy begins at address 200: 12 9 8 9 0

```
.begin
.org 0
sethi arr1, %r1
srl %r1,10,%r1      ! in %r1 address arr1 (source)
```

< your code here >

```
halt
.org 100
arr1:   12, -4, 9, 8, -23, 9, 0
.org 200
arr2:
.end
```

Question 7 (4 points)

The following ARC microprogramme is executed. Symbolic names are used in the fields. Before execution the contents of the registers are (decimal values): %r0=0, %temp0=10, %temp1=20 and %temp2=30

address	A	Amux	B	Bmux	C	Cmux	Rd	Wr	ALU	Cond	Jump addr
500	%r0	0	%r0	0	%temp0	0	0	0	orn	next	10
501	%temp0	0	%r0	0	%r0	0	0	0	addcc	next	20
502	%temp0	0	%temp1	0	%temp2	0	0	0	inc	jump	2047

Execution starts at address 500. What is the content of the following registers after these three micro-instructions are executed.

a	%r0	
b	%temp0	
c	%temp1	
d	%temp2	