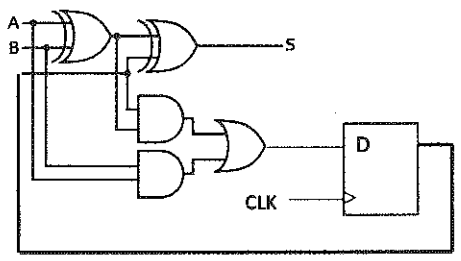
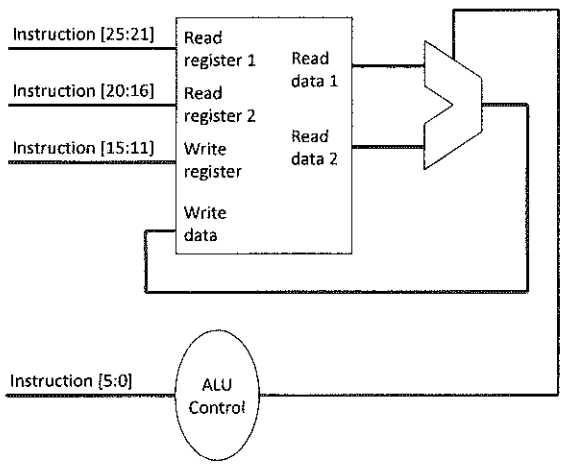
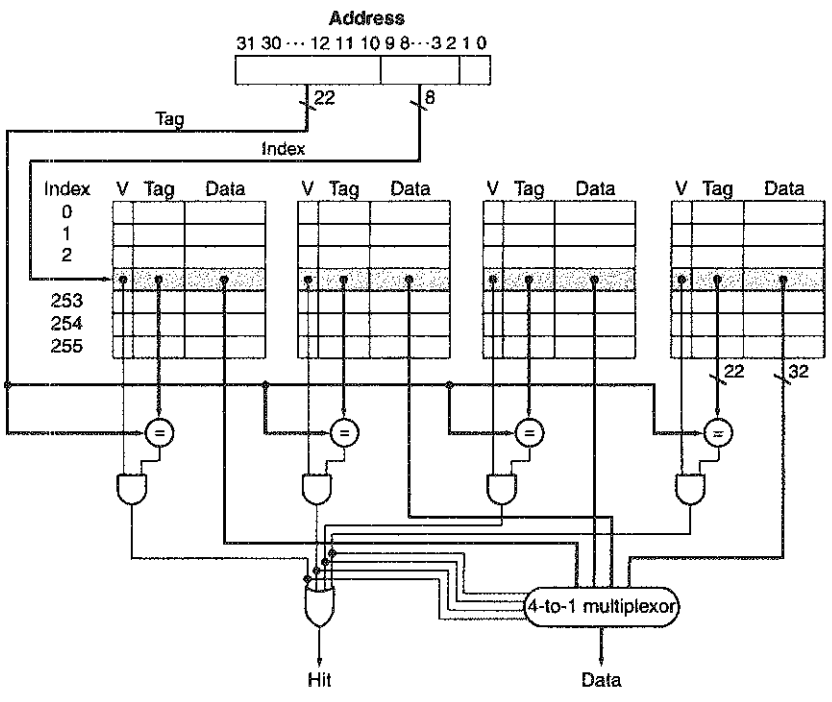
1. (15%) Describe the function of the following logic diagram and draw the state diagram of the circuit. Assume the setup time, hold time, and clock-to-q delay of the D flip-flop are 300ps, 200ps, and 100ps respectively, and each logic gate has 500ps delay. What is the maximum clock frequency of the circuit?



2. (15%) The following is the datapath to execute MIPS ALU instructions. List the three multiplexors needed to execute LW (load word) instructions.



3. (20%) The following block diagram shows a 4KB, 4-way set associative cache with 1-word blocks for a 32-bit byte-addressing memory system. Draw the block diagram of a 32KB, 2-way set associative cache with 16-word blocks for a 40-bit byte-addressing memory system.



4. (20%) Consider the following programming languages: C, C++, Java, Ruby, and Python.

   a. Which languages are mostly executed via an interpreter without a compiling stage?
   b. Which languages require a compiling stage prior to execution?
   c. Which languages support the object-oriented programming?
   d. Which languages can be developed both on the Windows and Linux operation systems?

5. (5%) Write down the output of the following C program

```
#include <stdio.h>
int main(void)
{
   int a=7,b=6,c=5;
   if(a < b < c)
      printf("Yes\n");
   else
      printf("No\n");
   return 0;
}
```

6. (5%) Write down the output of the following C program

```
#include <stdio.h>
int main()
{
      int i, count=0;
      for(i=0;i<35;i++){
            if(i%5==0) continue;
            count++;
      }
      printf("%d\n", count);
      return 0;
}
```

7. (5%) Write down the output of the following C program

```
#include<stdio.h>
int main()
{    for(int i; i<=9; i++)
     {    if(i%2)
               if(i%3)
                    printf("A");
          else
                    printf("B");        }
     return 0;   }
```

8. (10%) Write down the output of the following C program

```
void main()
{
   int s[5]={1, 3, 9, 6, 4};
   int *p=s , *ptr=s+2 ;
   printf("A:%d\n", *p+1);
   printf("B:%d\n", *ptr);
   printf("C:%d\n", s[0]);
   printf("D:%d\n", *p++);
   printf("E:%d\n", *p);
}
```

9. (5%) Write down the output of the following C program

```
int func (int a, int b)
{
     if (a < b)
          return func(b, a);
     if (b == 0)
          return a;
     else
          return func(b, a%b);
}
int main(void){
     int a, b;
     printf("%d", func(30, 75));
     return 0;
}
```