Jonathan W. Valvano November 20, 2009, 2:00pm-2:50pm.

(15) Question 1. The inputs to a software function are **x**, **y** unsigned **n**-bit integers.
(5) Part a) An **n**-bit number is less or equal to 2^n-1, so the product of two **n**-bit numbers is less than (2^n-1)*(2^n-1), which is less than (2^{2n}-1). So, the product **x*y** will fit in a 2**n**-bit number. **2n**
(5) Part b) If **y** = 1, then the quotient **x/1** requires **n** bits. If **y**>1, then **x/y** will be less than **x**, so the quotient will always fit into an n-bit number. **n**
(5) Part c) The input **x** ranges from 0 to 2^n-1, so the square root of **x** ranges from 0 to sqrt(2^n-1). This will be less than ($2^{n/2}$-1). So, the sqrt(**x**) will fit in an **n/2**-bit number. **n/2**

(5) Question 2.

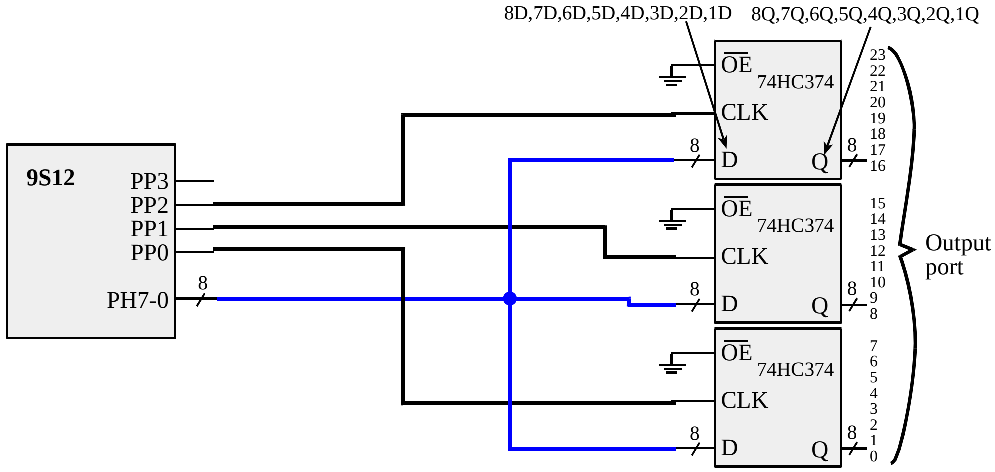
C) CMOS logic needs charge whenever a digital line rises or falls. Current through the resistance of the wire will cause a voltage drop. The closer the capacitor is to the chip, the less voltage drop there will be on the V_{DD} pin. **C**

(20) Question 3. Write a C program that scans a buffer and returns the **mode** of the data.

```
char FindMode(char *pt){ unsigned char i,mode;
unsigned short Counts[256]={0}; // one count for each possible value
unsigned short max;
  for(i=0; i<255; i++)
    Counts[(unsigned char)pt[i]]++;  // count frequency of each
  max = 0;
  for(i=0; i<255; i++){ // i is the value of data
    if(Counts[i]>=max){ // Counts is the number of that value
      max = Counts[i];  // find max count
      mode = i;         // value at max is the mode
    }
  }
  return (char)mode;
}

char FindMode( char *pt){
char answer;
  unsigned short maxtimes = 0,i;
  unsigned short Counts[256] = {0};
  for(i=0;i<1000;i++){
    Counts[*pt]++;
    if(Counts[(unsigned char)*pt] > maxtimes){
      maxtimes = Counts[(unsigned char)*pt];
      answer = *pt;
    }
    pt++;
  }
  return answer;
}
```

(35) Question 4. Put data out Port H clock into one 74HC374 using Port P rising edge CLK.
Part a) Show the hardware interface between the 9S12 and the three 74HC374 octal D flip flops.



Part b) Ritual makes all outputs zero.

```
unsigned char Out0,Out1,Out2;  // output values
void Init(void){
  Out0 = Out1 = Out2 = 0; // data=0
  DDRH = 0xFF;  // data outputs
  DDRP |= 0x07; // clock outputs
  PTH = 0;      // data=0
  PTP &= ~0x07;   PTP |= 0x07;  // clock data into all three 374
  PTP &= ~0x07;
}
```

Part c) Write a C function that sets individual bits in the interface.

```
void SetPort(unsigned char bit){unsigned char mask;
  mask = 1<<(bit&0x07); // 1,2,4,8,16,32,64,128
  if(bit<8){
    Out0 |= mask;  // set bit
    PTH = Out0;     PTP_PTP0 = 1;    PTP_PTP0 = 0; // latch
  }
  else if(bit<16){
    Out1 |= mask;  // set bit
    PTH = Out1;     PTP_PTP1 = 1;    PTP_PTP1 = 0; // latch
  }
  else {
    Out2 |= mask;  // set bit
    PTH = Out2;     PTP_PTP2 = 1;    PTP_PTP2 = 0; // latch
  }
}
```

Part d) Write a C function that clears individual bits in the interface.

```
void ClrPort(unsigned char bit){unsigned char mask;
  mask = 1<<(bit&0x07); // 1,2,4,8,16,32,64,128
  if(bit<8){
    Out0 &= ~mask;  // clear bit
    PTH = Out0;     PTP_PTP0 = 1;    PTP_PTP0 = 0; // latch
  }
  else if(bit<16){
    Out1 &= ~mask;  // clear bit
    PTH = Out1;     PTP_PTP1 = 1;    PTP_PTP1 = 0; // latch
  }
  else {
    Out2 &= ~mask;  // clear bit
    PTH = Out2;     PTP_PTP2 = 1;    PTP_PTP2 = 0; // latch
```

```
    }
}
```

(10) Question 5. The data is clocked into 9S12 on the rising edge. Idle clock is high.

D) CPOL = 1; CPHA = 1

(15) Question 6. V_{out} = 5-2*V_{in}. Use reference for constant. V_{ref} = 2.5V. Use ground to make sum of gains equal to 1. V_g = 0. V_{out} = 2*V_{ref}-2*V_{in}+V_g. R_f/R_0=2, R_f/R_1=1, R_f/R_2=2.