Jonathan W. Valvano October 7, 2011, 2:00pm-2:50pm.

(15) Question 1. Show the variables and the instrument (5 is a calibration constant to compensate for the time it takes to run the instrument.

```
unsigned long Buffer[256];
unsigned char N=0;
void inline RecordTime(void){
  Buffer[N] = NVIC_ST_CURRENT_R-5;
  N++;  // 8-bit variable goes 0 to 255
}
```

(20) Question 2. Use one **semaphore**.

```
int Ready=1; // true when Fun0 can run, false when Fun1 can run
void Timer0A_Handler(void){
if(Ready){
  Ready = 0;  // stop running Fun0, start running Fun1
  Fun0();
}
  TIMER0_ICR_R = TIMER_ICR_TATOCINT; // acknowledge timer0A timeout
}
void main(void){
  while(1){
    if(Ready==0){
      Fun1();
      Ready = 1;  // stop running Fun1, start running Fun0
    }
}
```

(10) Question 3. In Lab 10 we will be interfacing an XBee wireless module to the LM3S1968.
Figure 1.17b shows the model when the output is high. To make the output high, a PNP transistor in the output module is conducting (Q_1) driving +3.3 V to the output. The high voltage will activate the gate of NPN transistors in the input module (Q_4). The I_{IH} is the current into the input module needed to activate all gates connected to the input. The actual current I will be between 0 and I_{IH}. For a high signal, current flows from +3.3V, across the source-drain of Q_1, into the gate of Q_4, and then to ground. As the actual current I increases, the actual output voltage V will drop. I_{OH} is the maximum output current that guarantees the output voltage will be above V_{OH}. Assuming the actual I is less than I_{OH}, the actual voltage V will be between V_{OH} and +3.3V. If the input voltage is between V_{IH} and +3.3V, the input signal is considered high by the input. For the high signal to be transferred properly, V_{OH} must be larger than V_{IH} and I_{OH} must be larger than I_{IH}.

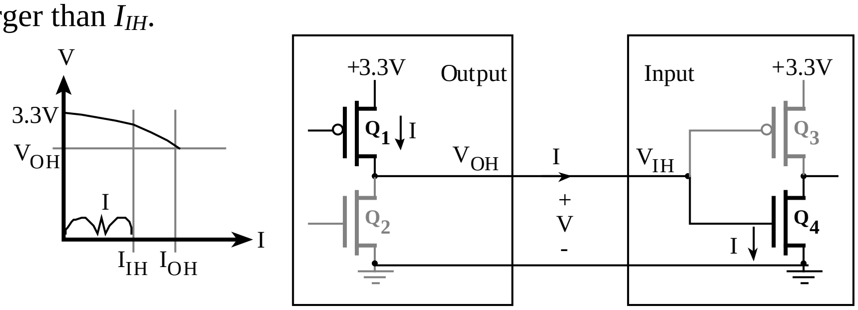


Figure 1.17b. Model for the input/output characteristics when the output is high.

Figure 1.17c shows the model when the output is low. To make the output low, an NPN transistor in the output module is conducting (Q_2) driving the output to 0V. The low voltage will activate the gate of PNP transistors in the input module (Q_3). The I_{IL} is the current out of the input module needed to activate all gates connected to the input. The actual current I will be between 0 and I_{IL}. For a low signal, current flows from +3.3V in the input module, across the source-gate of Q_3, across the source-drain gate of Q_2, and then to ground. As the actual current I increases, the actual output voltage V will increase. I_{OL} is the maximum output current that guarantees the output voltage will be less than V_{OL}. Assuming the actual I is less than I_{OL}, the actual voltage V will be between 0 and V_{OL}. If the input voltage is between 0 and V_{IL}, the input signal is considered low by the input. For the low signal to be transferred properly, V_{OL} must be less than V_{IL} and I_{OL} must be larger than I_{IL}.

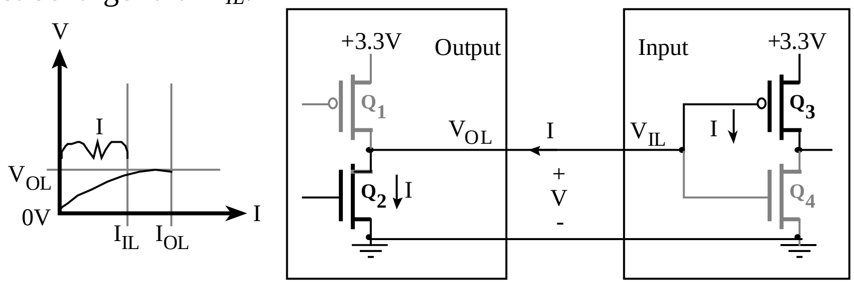


Figure 1.17c. Model for the input/output characteristics when the output is high.

Part a) Yes

Current output > Current input;	Xbee output is 2mA, LM3S1968 input is 2 μA
Xbee V_{OL} < LM3S1968 V_{IL};	0.5 < 1.3
Xbee V_{OH} > LM3S1968 V_{IH};	2.8 > 2.4

Part b) Yes

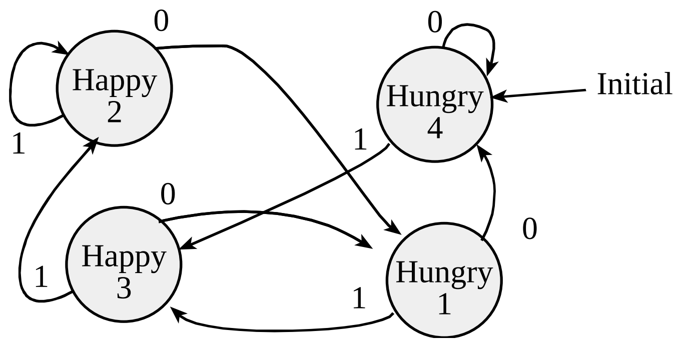
Current output > Current input;	LM3S1968 output is 2mA, Xbee input is 1 μA
LM3S1968 V_{OL} < Xbee V_{IL};	0.4 < 1.3
LM3S1968 V_{OH} > Xbee V_{IH};	2.4 > 2.31

Being friendly does not always remove a critical section. **Question 4** in the actual Quiz1 was inappropriately confusing. So to help subsequent students study, I rewrote the question and this is the answer to the new question.

(15) Question 4. Yes, there is a nonatomic read modify write access to Port G.
Use bit banding (or use a different port, or set two ISRs to the same priority)

```
void ISR0(void){                    void ISR1(void){
  GPIO_PORTG0 ^= 0x01;                GPIO_PORTG1 ^= 0x02;
  Stuff0();                           Stuff1();
}                                   }
```

(10) Question 5. You can convert any Mealy to a Moore and convert any Moore to a Mealy. For each state in the Mealy define a separate Moore state for each output value.



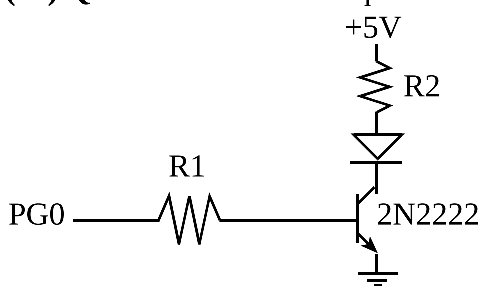
(15) Question 6. Write C code

s = m/1000
r = n/1000
s = (6.2)*(**r**^{2} + **r)**
m/1000 = 6.2*((n/1000)^2 + (n/1000))
m= 6.2*(n^2/1000 + n)
m= 62*(n^2 + 1000*n)/10000
m= (62*(n+1000)*n)/10000
m= (31*(n+1000)*n)/5000

with rounding

```
m = (31*(n+1000)*n+2500)/5000;
```

(15) Question 7. A LED requires 3.2 V at 100 mA to activate. Use 5 V supply so diode voltage is 3.2.



100 mA will require the 2N2222 (because it can handle up to 500 mA of I_{CE}). The V_{CE} on voltage of the 2N2222 is 0.3V. The R2 resistor value is calculated as (5-3.2-0.3)/0.1 = 1.5V/0.1A = 15Ω. Because the current gain is 100 (h_{fe}) the base current needs to be 100mA/100 = 1mA. The I_{OH} of the LM3S1968 can supply this 1mA (I_{OH} can be up to 2, 4, or 8 mA). Because the V_{OH} of the LM3S1968 is 2.4V (or greater) and the V_{BE} if the 2N2222 is 0.6V (or less), the R1 resistor must be less than (2.4-0.6V)/1mA = 3.6/0.001 = 1.8kΩ.