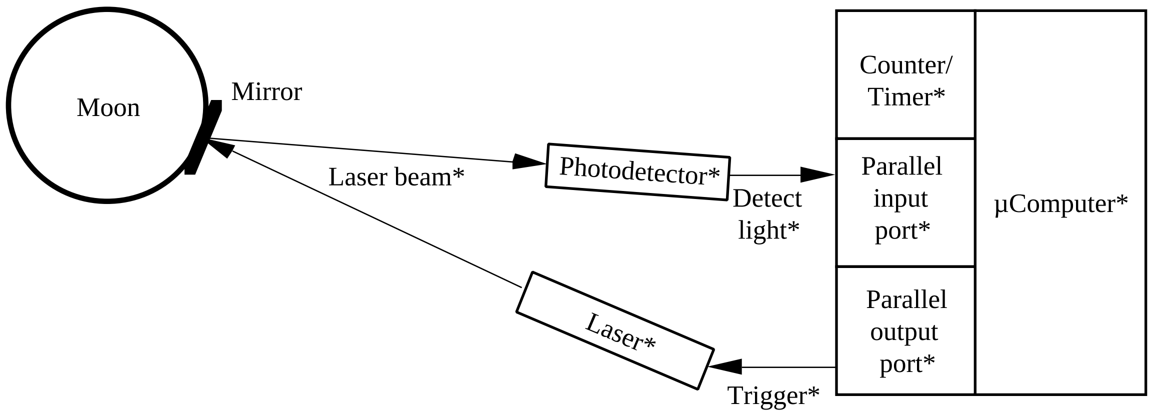
Solutions for Midterm - EECS 145M Spring 1997

1a



[showing moon or mirror was good but not required for full credit- they are strictly speaking not a part of your system]
[1.5 points off for each starred (*) element missing; 0.5 points off for each starred element without a label] [0.5 points off if one of the laser beam legs is missing]
Note: "Connection" is not limited to wires- consider radio and fiber-optic communications.

1b

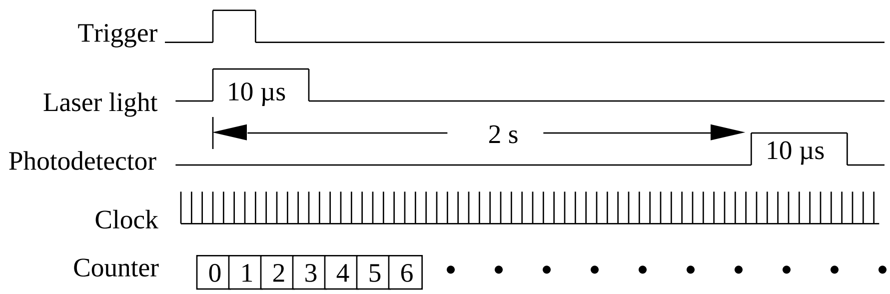
```
long i1, i2,;
double time, dist;
outport(1,0);                 /* zero counter */
outport(2,0);                 /* make trigger low */
outport(2,1);                 /* make trigger high to fire laser */
while(inport(3,1) == 1);      /* make sure detection signal starts low
                              (ignore any prompt laser light) */
while(inport(3,1) == 0);      /* wait for reflected laser beam */
outportb(1,1);                /* latch timer*/
i1 = inport(1);               /* read least significant word */
i2 = inport(1);               /* most least significant word */
time = i2 << 16 | i1;         /* pack time value in μs */
dist = time * 0.15;           /* convert to km */
```

For full credit, it was essential to do the following:

1. Assert the trigger output first low, then high
2. Wait for the reflected laser light to go high (ignoring any prompt light is good design but not required for full credit)
3. Latch the timer before reading
4. Convert time to distance in km

[2 points off if the **outport(2,0);** command is missing]

1c



[1 point off if no trigger pulse] [2 points off if no time scale or time information]

1d $d = vt/2$

$$\sigma_d^2 = \left(\frac{\partial d}{\partial t}\right)^2 \sigma_t^2 + \left(\frac{\partial d}{\partial v}\right)^2 \sigma_v^2 = \left(\frac{v}{2}\right)^2 \sigma_t^2 + \left(\frac{t}{2}\right)^2 \sigma_v^2 = \left(\frac{vt}{2}\right)^2 \left(\frac{1}{t}\right)^2 \sigma_t^2 + \left(\frac{vt}{2}\right)^2 \left(\frac{1}{v}\right)^2 \sigma_v^2$$

$$\left(\frac{\sigma_d}{d}\right)^2 = \left(\frac{\sigma_t}{t}\right)^2 + \left(\frac{\sigma_v}{v}\right)^2$$

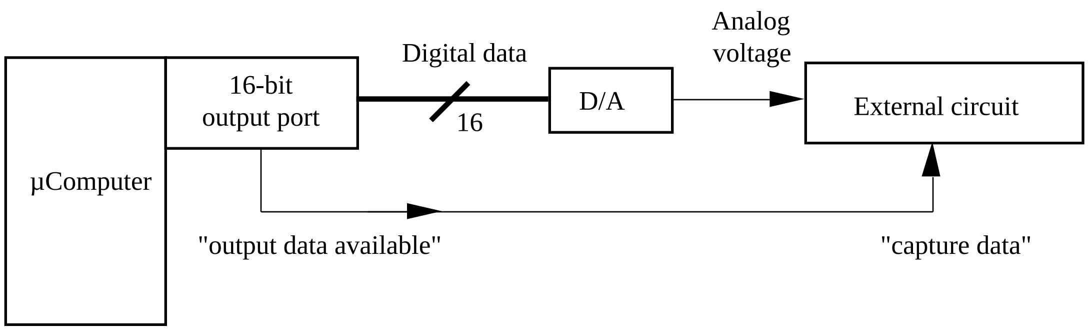
d = 300,000 km t = 2 s σ_t = 1 μs v = 300,000 km/s σ_v = 0.15 km/s

$$\left(\frac{\sigma_d}{d}\right)^2 = \left(\frac{10^{-6}}{2}\right)^2 + \left(\frac{0.15}{300,000}\right)^2 = 2\left(\frac{10^{-6}}{2}\right)^2$$

$$\sigma_d = d\sqrt{2}\left(\frac{10^{-6}}{2}\right) = \frac{0.3\text{km}}{\sqrt{2}} = 0.212\text{km}$$

[12 points off for $\sigma_d = \sigma_t \sigma_v = 1.5 \times 10^{-7}$ km]
[2 points off for v = dt]
[2 points off for the alternative, less statistically accurate method
$\Delta d = (t + \Delta t)(v + \Delta v)/2 - tv/2 = 0.3$ km]

2a



[1.5 points off for each element shown above that is missing; 0.5 points off for each without a label]

2b

1) **outport(1,i);**
   This statement asserts new data at the D/A digital input, but the switches take at least 200 ns to settle and the output op-amp has a risetime of 50 μs.

2) **outport(2,0);**
   This statement makes the handshaking line "output data available" low, and gives the D/A 1000 ns for its output to reach its final value.

3) **outport(2,1);**
   This statement makes the handshaking line "output data available" high, which signals the external circuit that the analog data are stable and can be captured.

[3 points off if the D/A output glitch is not mentioned in your design]

PROBLEM 3

Error 1- the data are asserted after the strobe so the read command will read old data. To fix, interchange the pulsing of the strobe line (step 2) with asserting the data (step 3).

Error 2- "Input data available" is never set FALSE, so the program will not wait at step 4 for new data, and will keep rapidly re-reading the same data in an infinite loop. To fix, add a step 6 so that the external circuit sets "input data available" FALSE when it detects that "ready for input data" has been set FALSE by the program.

Midterm #1 class statistics:

Problem	max	average	rms
1	50	38.9	6.5
2	30	25.4	4.7
3	20	15.4	4.6
total	100	79.7	11.3

Grade distribution:

Range	number	*approximate* letter grade
51-55	1	D?
56-60	0	
61-65	1	C?
66-70	0	
71-75	1	B-
76-80	2	B
81-85	4	B+
86-90	2	A
91-95	2	A
96-100	0	A+