

# NET3001

## Assignment 1

**Due:** Oct 16, midnight

**Submitting:** In electronic form. The file format should be: *.txt* or *.doc (MS Word)*.

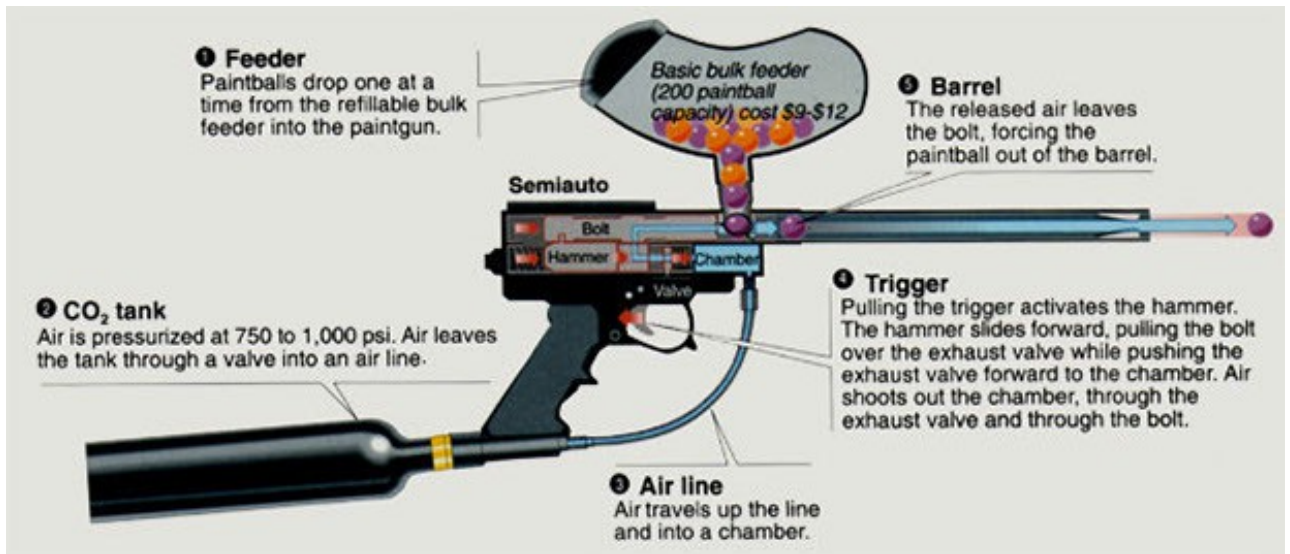
1. A “bus” is used in computers to transmit patterns of information. Describe the “bus” technologies used in microprocessors and microcontrollers<sup>1</sup>. Emphasize the difference between them. (2 marks)

Microprocessors and microcontrollers need to store instructions for execution in bulk, and in a persistent medium. Describe the storage technique for these, and emphasize the differences. (2 marks)

2. The STM32 ARM/Cortex-M3 microcontroller has 3 areas of memory: registers, RAM and program memory. Use the “resources” web page and the Internet to list
  - a) the size of each on the device that we'll be using in the lab (it's an STM32F100RB); be careful to detail whether you mean bits, bytes or words
  - b) what each type of memory is used for
  - c) the properties of each: persistence, speed, changeable(4 marks)
3. What is a cross assembler? (1 mark)  
Describe 2 functions of the linker. (1 mark)
4. Suppose you are given the task of selecting a microcontroller to be used to log the performance of a new paint-ball pistol. This device operates by using a cartridge of compressed air to propel a small sphere of paint at <100m/sec.
  - a) Your company has developed a new firing system, and you must use a microcontroller to log the pressure as each paintball is fired. The pressure varies from 1500psi when the gun is first filled, and it drops down with each paintball, and may end up as low as 500psi. To measure this parameter, the system has a *transducer* which can convert air pressure to a short integer (16 bits).
  - b) The paintball gun is designed to hold 250 paintballs

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<sup>1</sup> As defined in this class. There are many interpretations of these three terms, so I'm looking for the definitions as I stated them.



from [http://www.paintballpalace-or.com/paintball\\_history.html](http://www.paintballpalace-or.com/paintball_history.html)

- c) Estimate the data storage requirements for a microcontroller that could handle this task.
  - d) Search the internet and find a microcontroller that can perform this function, and which costs the manufacturer less than \$2 in large quantities. In your answer, state the name of the microcontroller and the website where you found the information. [Choose the microcontroller based on memory requirements only. Your choice of microcontroller does *not* need to include the transducer function; assume that is handled by some external device.]
  - e) Suppose the transducer is modified so that you get a byte of information at each reading. The measurements therefore range from 50 to 150. What impact will this have on your choice of microcontroller?
  - f) Suppose the task is changed so that the pressure must be recorded for a complete day of use *and the time that each shot was fired*. The pressure cartridge may be filled several times during the day. The maximum number of paintballs fired in the day is 1000. It takes 2 bytes to store the time. Calculate the memory requirements, locate another microcontroller (also known as *mcu*) which can perform this function, and state its cost, in \$. Show your calculations, and include the web site in your answer. [Again, make your choice based on memory requirements only]
- (8 marks)

Hints: try the phrase "less than a dollar" in your search; other search term you might try: \$1, \$0.99, 99 cents, mcu; sometimes you can find prices of things by looking for a press release; if you still can't find a price, try [www.digikey.ca](http://www.digikey.ca); for this question, you can assume that the code size is <2k and the stack size is <20bytes)

5. Suppose we need to build a device to be used on a bicycle to help with an athletic workout. It should beep a fast pattern when the user is pedaling too fast, and beep slowly when the user is pedaling too slow, and it should be silent when the user pedaling the correct speed. It should flash a green light every half-second, to tell the user that it is operating correctly. It should have a push button for ON/OFF. Assume this will have a microcontroller in it. List *all* the input and the output transducers that you will need to make this device. (2 marks)
6. A microcontroller on a rocket contains an accelerometer capable of measuring 3 axes.

It has the following tasks to perform:

- a) measure the X, Y and Z forces (one byte each), and store these three numbers in case the main computer needs to read the information
- b) keep 2 alarm values for each of X, Y and Z, which the main computer can set; if the real X,Y or Z force goes over (or under) these alarm values, then a warning is sent to the main computer; the accelerometer also remembers the out-of-bounds value, and whether it was X, Y or Z

c) the accelerometer can be set to sample once every  $n$  seconds, where  $n$  is between 0 and 255

d) the accelerometer keeps a running log of the last 64 X,Y,Z samples

The accelerometer task is so simple that it does not need a stack. Estimate the RAM requirements for the accelerometer cpu. (2 marks)

7. Fill in the blanks in the following assembly language snippet. Report the total byte count for this snippet of code. Assume there is a subroutine called `square` which multiplies a single argument times itself and returns the value.

```
mov  r3, #5           // move _____ into _____
mov  r2, #0x20000000 // move _____ into _____
ldr  r1, [r2]        // move _____ into _____
add  r3, #21         // r3 now contains _____
str  r3, [r2, #8]    // store the contents of r3 at _____
mov  r0, #15         // _____
bl   square          // _____
_____             // add 3 to the subroutine's return value (r0); set the
                    // condition codes
str  r0, [r2, #12]! // _____ (be careful)
_____             // store r5 into address 0x20000020 (trick question)
```

What are the final values of `r0` and `r2`?  
(10 marks)