Question 7

1. Header format was purposely chosen to be light – it only contains the CRC value, and size of the message. CRC was used for packet reliability, and size of message was used for messages with only partially valid data i.e. the last packet on a file transfer.
2. The format of the ACK is just a TCP message with a 1 for ACK and a 0 for NACK.
3. The LED is modulated via a GPIO pin on the Raspberry PI. In order to achieve toggle rate of 50 Khz, the interrupts had to be disabled on the raspberry PI during data transfer. This essentially shuts down the operating system – preventing it from adding latency to the 500us delay between LED state changes. The interrupts are reinabled after transmission to receive subsequent socket messages. On the Arduino side the ADC\_Read() function took 100uS to run – this was improved by changing the peripheral clock pre scale from 128 to 16.
4. The Raspberry PI and Arduino are synchronized by a simple High, Low, High LED blink. This informs the Arduino of an incoming packet. The Arduino will then sample the ADC line every 500 microseconds. This matches the LED toggle rate from the Raspberry PI. The timing was tuned so that the Arduino samples the ADC input half way though the time LED is on. This is shown on the figure below. 

The rising edge of the purple line indicates a sample being taken by the Arduino. The blue line represents the analog voltage coming out of the photodiode and the yellow line represents the voltage driving the LED.

1. Every bit takes 500us to be transmitted.
2. Reliability is ensured via a CRC check. The message contains a CRC check calculated at Laptop #1. Laptop #2 will also calculate a CRC on the data and compare it to the received CRC. If there’s a match it will send an ACK to the raspberry Pi – which then lets Laptop #1 know to send the next message. If laptop #2 does not see a match it will send a NACK to the raspberry PI, at which point the PI will decide whether to retry sending the message 5 times. If that fails, it will give up and send a NACK message to laptop 1 which will display an error message to the user.