Examples of Short-Answer Questions

(A) Suppose you are presented with an “investment opportunity” for a new start-up, the QuickPartition company, whose main product is a software program that they claim can solve the Partition Problem for any $N$ numbers in $N^2$ seconds. Should you invest? Explain why or why not.

NO! The Partition Problem is a well-known hard problem for which only exponential-time solutions are known. It would take centuries to solve for relatively small $N$. There are no known $N^2$ and therefore this company is either lying or confused. In either case, not a good investment!

(B) Describe briefly, using words and diagrams, the idea of Public Key Cryptography.

Public Key Cryptography is based on the existence of problems (like the Partition Problem, or the Traveling Salesman Problem) which are exponentially hard to solve, but it is fast and easy to check a solution for correctness. If a bank uses PKC to protect your account, you and the bank (and anyone else) have an instance of the problem, but to gain access to the account, you must provide a solution, which the bank can check. The point is that if someone hacks into the bank’s computer, there is no password to steal!

(C) Discuss the application of the Nyquist Sampling Theorem to determining the sample rate for modern CD players.

The Nyquist Sampling Theorem says that to store an analog signal in digital form (as samples), you must sample the signal at least twice as fast as the highest frequency in the signal. Since the highest sound most humans can hear is about 20,000 Hertz (vibrations per second), then you must sample at least 40,000 times a second. (The actual CD sample rate is 44,100, which is just over-estimating the limit to be sure of capturing all the frequencies.)
(D) If we decrease the “bit depth” (the number of bits used to store a pixel) of a picture, what effect might this have on the picture?

The effect would be to reduce the number of possible colors that can be represented, so in addition to having a picture with less variety of colors, you will get “blotchy” patches where a formerly smooth transition between closely-related colors becomes a visible jump between two different colors.

(E) In which situation would a Huffman encoding do a much better job of compressing a text file, compared with Run Length Encoding? Explain your answer carefully.

The RLE does a good job when there are sequences of exactly repeated numbers (or colors, or letters, etc.), and the Huffman encoding does a good job when the probability of some letters is not evenly distributed, and some numbers occur with much higher frequency than others. RLE tends to do a good job with media files (sound, pictures, video) but not so good for text files; the Huffman code can do a good job with any kind of file depending on the probability of the letters or numbers.
Examples of True/False Questions

Write True or False to the left of each statement.

1. The ASCII code can represent over a million different symbols. FALSE: ASCII is an 8 bit code, so can only represent $2^8 = 256$ symbols.

2. Run-Length Encoding is an example of a lossy compression method. FALSE: It records the exact sequence in a shorter sequence of symbols by counting repeated symbols.

3. The thesis of “Strong AI” is that an appropriately programmed computer can exhibit life-like qualities such as growth and evolution. FALSE: The Strong AI thesis per se says nothing about growth and evolution.

4. If we add $1111 + 101$ we get a binary number whose decimal equivalent is 22. FALSE: You get $10100 = 20$ in decimal. Alternately, you can see that the original problem is adding $15 + 5$.

5. Huffman Encoding is an example of a lossless compression method. TRUE: Each letter is given a distinct binary code, so no information is lost.

6. The ratio between successive Fibonacci Numbers approaches the Golden Ratio (1 : 1.618...). TRUE

7. Kurt Godel proved that some mathematical statements are true but can never be proved so by mathematics. TRUE

8. In the Turing Test, a person attempts to figure out which of two hidden people is a woman and which is a man. FALSE: The Turing Test (called by Turing the Imitation Game) attempts to figure out which is a human and which a machine.

9. To specify 32 different possibilities, we would need at least 6 bits. FALSE: You only need 5 bits, since $2^5 = 32$. 
10. This statement is true. 😊 Just for fun, I won’t ask you such a trick question on the exam! It could be true or false! If it is true, then, well, it is true; if it is false, then the statement is not true, hence the statement is false. Either works!
Example of Essay Question

Suppose that eventually computers will be able to pass the Turing Test and also to prove hard mathematical theorems, make scientific discoveries on their own, and compose music and write novels that can not be distinguished from human-produced works of arts.

(A) What is the most optimistic scenario for this future? How would human beings benefit from such machines?

(B) What is the most pessimistic scenario for this future (using the article about Bostrom as a source of ideas)?

(C) In such a world (which is has already partly arrived), what does human life mean if just about everything can be done better, or at least equivalently (and probably faster!) by a machine? Is it worth writing novels and music? What would be the meaning of your life in such a world?

I don’t think a specific answer to this question is necessary. What I would expect is an answer about 2-3 times longer than the short answer questions given above. **The goal is for you to show me that you understood the material presented in lecture and in the reading for the last homework.**