Name:

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| Problem | Points | Score |
| 1 | 25 |  |
| 2 | 25 |  |
| 3 | 25 |  |
| 4 | 25 |  |
| Total | 100 |  |

Notes:

1. The exam is open books and notes, and you are allowed to use your laptop as well.
2. By signing your name to this sheet, you are acknowledging you have abided by the MSU honor code, agreeing that the work presented in this exam is solely your own, and stating that you have not used email, text messaging, or other similar tools to discuss the solutions with others during the exam. Violation of this policy will result in a grade of 0 on this exam and possibly other disciplinary action by the university.
3. The details of your solutions are more important than the answers. Please explain your solutions clearly and include as many details as possible. You might consider drafting an outline of your solution to begin the problem, so that I can easily follow your logic.

**1.**Consider the circuit shown below:



(a) Using Laplace transforms, write a set of equations that can be used to find the transfer function of the circuit.

(b) Using MATLAB, find the transfer function (using Laplace transforms).

(c) Find and plot the impulse response in the time domain.

(d) Plot the frequency response of the impulse response.

(e) Explain why this makes sense (hint: consider what happens a DC and at very high frequencies).

**2.** For the signal shown to the right:

(a) Using analytic techniques, write an expression for the Fourier transform.

(b) Using MATLAB, compute and plot the frequency response of this signal. Explain why this makes sense.

(c) Compute the convolution of this signal with a unit pulse.

(d) Plot the frequency response of the result to (c) and explain why this makes sense.

**3.** Given the transfer function of a discrete-time system shown below:



(a) Is this system stable?

(b) Plot the frequency response of the system.

(c) Assume a sample frequency of 8000 Hz. Compute the output of the system to a periodic train of unit pulses with a fundamental frequency of 1000 Hz.

(d) Compare and contrast this to the output that would result from a periodic pulse train with a fundamental frequency of 500 Hz.

**4.** Go to the exam directory on the course web site and download the audio file named beatles.wav. Listen to the file on your laptop. Load this file into MATLAB using the wavread function.

(a) Display the frequency response of this signal as a function of time. Think carefully how to compute this so that the result is meaningful. Explain why your plot makes sense.

(b) The Beatles were known to enjoy a good joke. For example, one of their more famous stunts evolved around a suggestion to play a song backward on an old record player. Time reverse the signal in (a) and repeat your analysis in (a). Explain the similarities and differences between the two plots.