Name:

| Problem | Points | Score |
|---|---|---|
| 1a | 10 | |
| 1b | 10 | |
| 1c | 10 | |
| 2a | 10 | |
| 2b | 10 | |
| 2c | 10 | |
| 3a | 10 | |
| 3b | 10 | |
| 3c | 10 | |
| 3d | 10 | |
| Total | 100 | |

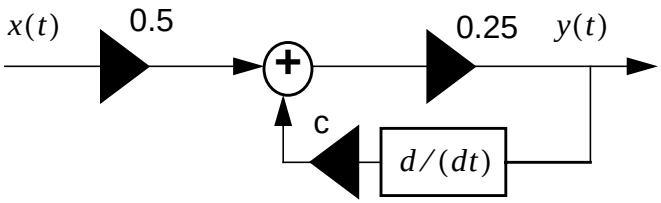
Notes:

1. The exam is closed books/closed notes - except for one page of notes.

2. Please show ALL work. Incorrect answers with no supporting explanations or work will be given no partial credit.

3. Please indicate clearly your answer to the problem. If I can't read it (and I am the judge of legibility), it is wrong. If I can't follow your solution (and I get lost easily), it is wrong. All things being equal, neat and legible work will get the higher grade:)

**Problem No. 1**: For the following system:

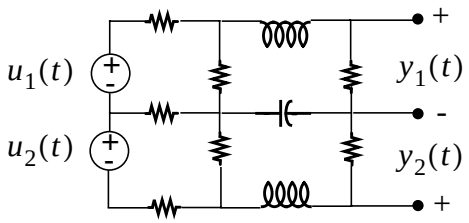



(a) For $c = 1/2$, use the Nyquist criterion to determine stability.

(b) Use the Nyquist criterion, and the gain/phase margin, to determine for what range of values of $c$ the system is stable.

(c) Verify your answer to part (b) using any other technique described in this class.

**Problem No. 2**: In the following circuit, all resistance, capacitance, and inductance values have a magnitude of 1.




(a) Define a set of state variables and justify your answer.

(b) Construct the state equations for this system.

(c) Find the system transfer function (remember this is a matrix).

**Problem No. 3**: For the signal $x(t) = [\sin(2000\pi t) + \cos(3300\pi t)]u(n)$,

(a) What is the minimum sample frequency for which this signal can be sampled without loss of information? Justify your answer. Be careful!

(b) Explain how to reconstruct the original signal from the sampled signal. Be as specific as possible.

(c) Suppose we sample the signal with an 8-bit linear quantizer. What is the signal to noise ratio of the A/D converter?

(d) Derive the $Z$-transform of $x(t)$ using the following transform: $Z[a^n u(n)] = \dfrac{1}{1 - az^{-1}}$.