MAE143 A - Signals and Systems - Winter 11
Midterm, February 2nd

Instructions

(i) This exam is open book. You may use whatever written materials you choose, including your class notes and textbook. You may use a hand calculator with no communication capabilities

(ii) You have 50 minutes

(iii) Do not forget to write your name, student number, and instructor

1. **Signals**

   Consider the following mathematical description of a continuous-time signal

   $$x(t) = u(t-1) - (1 - e^{-(t-2)})u(t-2) - \delta(t+1).$$

   Sketch the plot of the following derived signals:

   (a) (2 points) $x(t)$

   (b) (2 points) $x(2-t)$

   (c) (2 points) $x(t/2)$

2. **System Properties**

   A system takes as input the signal $x(t)$ and produces as output $y(t)$. Provide a detailed answer to the following question regarding properties of the systems:

   (a) (2 points) If $y(t) = \tan^{-1}(x(t))$, is the system linear? Is it invertible?

   (b) (2 points) If $y(t) = \frac{1}{t}\int_0^t x(\tau)\,d\tau$ is the system linear? Is it time-invariant?

   (c) (2 points) If $y'(t) + y(t) = x(t)$ is the system linear? Is it BIBO stable?

3. **Impulse Response**

   An LTI system is described by the ODE

   $$y''(t) + y'(t) = x(t)$$

   (a) (3 points) Compute the impulse response $h(t)$. Use your answer to determine if the system is BIBO stable.

   (b) (3 points) Use the impulse response $h(t)$ and the convolution formula to compute $y(t)$ when $x(t) = e^{-2t}u(t)$.

   (c) (4 points (bonus)) Use Laplace transforms to compute the answer to the above items (a) and (b).