

## EECS20n, Quiz 3 Solution, 10/27/00

Consider the following 6 *discrete time systems* with input and output signal space [*Ints*  $\rightarrow$  *Reals*] and 6 *continuous time systems* with input and output signal space [*Reals*  $\rightarrow$  *Reals*].

**Discrete time systems**  $\forall x, \forall n \in \text{Ints}$ :

$$\text{Delay}(x)(n) = x(n - 1)$$

$$\text{SquaredDelay}(x)(n) = x^2(n - 1)$$

$$\text{Reverse}(x)(n) = x(-n)$$

$$\text{DiffEquation}(x)(n) = y(n) \text{ where } y(n) = y(n - 2) + x(n - 1)$$

$$\text{AddOne}(x)(n) = x(n) + 1$$

$$(\text{AddOne} \circ \text{Delay})(x)(n) = \text{AddOne}(\text{Delay}(x))(n)$$

$$(\text{AddOne} + \text{Delay})(x)(n) = \text{AddOne}(x)(n) + \text{Delay}(x)(n)$$

**Continuous time systems**  $\forall x, \forall t \in \text{Reals}$ :

$$\text{Delay}_{2.5}(x)(t) = x(t - 2.5)$$

$$\text{AM}(x)(t) = \cos(2\pi 20000t)x(t)$$

$$\text{FM}(x)(t) = \cos(2\pi(20000 + x(t))t)$$

$$\text{FastForward}(x)(t) = x(2t)$$

$$\text{MovingAverage}(x)(t) = \frac{1}{10} \int_{s=t-10}^t x(s)ds$$

$$(\text{Delay} \circ \text{MovingAverage})(x)(t) = (\text{Delay}(\text{MovingAverage}(x)))(t)$$

$$(\text{Delay} + \text{MovingAverage})(x)(t) = \text{Delay}(x)(t) + \text{MovingAverage}(x)(t)$$

Fill in the entries of the following table with Yes or No. A correct answer for each row yields 1 point, an incorrect answer yields 0 points.

System Name	Linear	Time-invariant
<i>Delay</i>	Yes	Yes
<i>SquaredDelay</i>	No	Yes
<i>Reverse</i>	Yes	No
<i>DiffEquation</i>	Yes	Yes
<i>AddOne</i>	No	Yes
<i>AddOne</i> $\circ$ <i>Delay</i>	No	Yes
<i>AddOne</i> + <i>Delay</i>	No	Yes
<i>Delay</i> <sub>2.5</sub>	Yes	Yes
<i>AM</i>	Yes	No
<i>FM</i>	No	No
<i>FastForward</i>	Yes	No
<i>MovingAverage</i>	Yes	Yes
<i>Delay</i> $\circ$ <i>MovingAverage</i>	Yes	Yes
<i>Delay</i> + <i>MovingAverage</i>	Yes	Yes