Solution of ECE 315 Test 4 F05

In each case circle the correct system characteristics. (In each case x is the excitation, y is the response and stable means BIBO stable.)

$$y(t) = \begin{cases} 2x(t) & , \ x(t) < -2 \\ x(t) & , \ -2 \le x(t) \le 2 \\ 2x(t) & , \ x(t) > 2 \end{cases} .$$

Non-Linear — $x(t) = 1 \Rightarrow y(t) = 1$ and $x(t) = 3 \Rightarrow y(t) = 6$. Not homogeneous, therefore non-linear.

Static — $y(t)$ does not depend on x at any time other than *t*.

Stable — $y(t)$ is never greater in magnitude than $2|x(t)|$ so if x is bounded, y is also.

Invertible — For every $y(t)$ there is a unique $x(t)$

Time Invariant — Shifting $x(t)$ in time shifts $y(t)$ by the same amount.

$$y[n] = \sqrt{|x[n]|}$$

Non-Linear — $x[n] = 4 \Rightarrow y[n] = 2$ and $x[n] = 9 \Rightarrow y[n] = 3$ Not homogeneous, therefore non-linear

Static — $y[n]$ does not depend on x at any time other than *n*.

Stable — If x is bounded then so is y.

Non-Invertible — $|x[n]| = y^2 \Rightarrow x[n] = \pm y^2$. Sign of x is indeterminate and two different x's yield the same y.

Time Invariant — Shifting $x[n]$ in time shifts $y[n]$ by the same amount.

$$y[n] = x[3n]$$

Linear — Multiplying x by any constant multiplies y by the same constant. Adding two signals causes a response which is the sum of the responses to the two individual signals.

Dynamic — $y[1]$ depends on $x[3]$ which occurs at a time other than $n = 1$, therefore dynamic.

Stable	The values of y come directly from the values of x so if x is bounded, so is y.
Non-Invertible	x is decimated to form y. Therefore the values of x lost in decimation cannot be recovered simply by knowing y.
Time Variant	$x_1[n] = g[n] \Rightarrow y_1[n] = g[3n]$

$$x_2[n] = g[n - n_0] \Rightarrow y_2[n] = g[3n - n_0] \neq y_1[n - n_0] = g[3(n - n_0)]$$

$$y''(t) - 2y'(t) + 5y(t) = 4x(t)$$

Linear	Differential equation in which each derivative of the response is raised to the first power and excitation is also and the coefficients are all constants.
Dynamic	Differential equation.
Unstable	Eigenvalues are $1 \pm j2$. Real parts are non-negative.
Invertible	$x(t) = (1/4)[y''(t) - 2y'(t) + 5y(t)]$
Time Invariant	Standard differential equation form with no multiplications of derivatives by any functions of time.

$$y''(t) + 2y'(t) + 5y(t) = 4x(t)$$

Linear	Differential equation in which each derivative of the response is raised to the first power and excitation is also and all coefficients are constant.
Dynamic	Differential equation.
Stable	Eigenvalues are $-1 \pm j2$. Real parts are negative.
Invertible	$x(t) = (1/4)[y''(t) - 2y'(t) + 5y(t)]$
Time Invariant	Standard differential equation form with no multiplications of derivatives by any functions of time.

$$y(t) = \begin{cases} -10 & , \; x(t-1) < -2 \\ x(t-1) & , \; -2 \leq x(t-1) \leq 2 \\ 10 & , \; x(t-1) > 2 \end{cases} .$$

Non-Linear	$x(t-1) = 4 \Rightarrow y(t) = 10$ and $x(t-1) = 6 \Rightarrow y(t) = 10$. Not homogeneous, therefore non-linear.
Dynamic	$y(t)$ depends on x at a time other than *t*.

Stable	$y(t)$ cannot exceed 10 in magnitude for any $x(t)$
Non-Invertible	If $y(t)=10$ or $y(t)=-10$ it is impossible to determine $x(t)$ because multiple x's cause the same y.
Time Invariant	Shifting $x(t)$ in time shifts $y(t)$ by the same amount.