SIGNALER OG SYSTEMER - QUIZ 1

Problem 1

Let $x(t)$ be input and $y(t)$ be output. Which of the systems is LTIC?

1: $\dot{y}(t) + y(t) = x^2(t)$

2: $\dot{y}(t) - y(t) = x(t)$

3: $\dot{y}(t) + t^2 y(t) = x(t)$

Sol

1: $\dot{y}(t) + y(t) = x^2(t)$ $\rightarrow$ nonlinear, time-invarrent, causal

2: $\dot{y}(t) + -y(t) = x(t)$ $\rightarrow$ LTIC

3: $\dot{y}(t) + t^2 y(t) = x(t)$ $\rightarrow$ Linear, but time-varrant, causal

Answer: 2: $\dot{y}(t) - y(t) = x(t)$

Problem 2

Which of the systems is linear?

1: $\ddot{y}(t) - 4y(t) = \tanh(x(t))$

2: $\ddot{y}(t) + 5y(t) = x^2(t)$

3: $\ddot{y}(t) + t^7 y(t) = x(t)$

Sol

1: $\ddot{y}(t) - 4y(t) = \tanh(x(t))$ → time-invariant, causal, but nonlinear

2: $\ddot{y}(t) + 5y(t) = x^2(t)$ → time-invariant, causal, but non-linear

3: $\ddot{y}(t) + t^7 y(t) = x(t)$ → Linear, causal, but time-variant

Answer: 3: $\ddot{y}(t) + t^7 y(t) = x(t)$

Problem 3

Angiv hvilke systemer der er LTIC.

1: $\dot{y}(t) + 2t^2 y(t) = x(t)$

2: $\dot{y}(t) + y(t) = x^2(t)$

3: $\dot{y}(t) + y(t) = x(t+3)$

4: $\dot{y}(t) + y(t) = x(t-3)$

Sol

1: $\dot{y}(t) + 2t^2 y(t) = x(t)$ → Linear, causal, but time-invariant

2: $\dot{y}(t) + y(t) = x^2(t)$ → Time-invariant, causal, but non-linear.

3: $\dot{y}(t) + y(t) = x(t+3)$ → Linear, time-invariant, but non-causal because the current output depends on future values of the input.

4: $\dot{y}(t) + y(t) = x(t-3)$ → LTIC - output only depends on previous values of the input.

Answer: 4: $\dot{y}(t) + y(t) = x(t-3)$

Problem 4

Which of the systems is non-causal?

1: $\dot{y}(t) + 2t^2 y(t) = x(t)$

2: $\dot{y}(t) + y(t) = x^2(t)$

3: $\dot{y}(t) + y(t) = x(t+3)$

4: $\dot{y}(t) + y(t) = x(t)$

Sol

1: $\dot{y}(t) + 2t^2 y(t) = x(t)$ → Linear, causal, but time-variant.

2: $\dot{y}(t) + y(t) = x^2(t)$ → Nonlinear, time-invariant, causal

3: $\dot{y}(t) + y(t) = x(t+3)$ → Linear, time-invariant, but non-causal

4: $\dot{y}(t) + y(t) = x(t)$ → LTIC

Answer: 3: $\dot{y}(t) + y(t) = x(t+3)$

$\underbrace{\dot{y}(0) + y(0)}_{\text{Present output}} = \underbrace{x(3)}_{\text{Future input}}$

Problem 5

Which of the systems is time-invariant?

1: $\dot{y}(t) + ty(t) = x(t)$

2: $\dot{y}(t) + y(t) = tx^2(t)$

3: $\dot{y}(t) + y(t) = \sin(t)$

4: $\dot{y}(t) + y(t) = x(t)$

Sol

1: $\dot{y}(t) + ty(t) = x(t)$ → Linear, causal, but time-variant.

2: $\dot{y}(t) + y(t) = t^2x(t)$ → Linear, causal, but time-variant.

3: $\dot{y}(t) + y(t) = \sin(t)$ → Not a system (no $x(t)$)

4: $\dot{y}(t) + y(t) = x(t)$ → LTIC.

Answer: 4: $\dot{y}(t) + y(t) = x(t)$

Problem 6

Which of the systems is LTIC?

1: $\dot{y}(t) + y^2(t) = x(t)$

2: $\dot{y}(t) + y(t) = x^2(t)$

3: $\dot{y}(t) + y(t) = \frac{10}{3} x(t)$

4: $\dot{y}(t) + y(t) = x(t) + 1$

Sol

1: $\dot{y}(t) + y^2(t) = x(t)$ → Time-invariant, causal, but nonlinear.

2: $\dot{y}(t) + y(t) = x^2(t)$ → Time-invariant, causal, but nonlinear.

3: $\dot{y}(t) + y(t) = \frac{10}{3} x(t)$ → LTIC

4: $\dot{y}(t) + y(t) = x(t) + 1$ → Time-invariant, causal, but nonlinear.

Answer: 3: $\dot{y}(t) + y(t) = \frac{10}{3} x(t)$